A New Coalition for a Challenging Battlefield

Military and Veteran Health Research

Edited by
Stéphanie A.H. Bélanger
Alice B. Aiken

A New Coalition for a Challenging Battlefield

A NEW COALITION FOR A CHALLENGING BATTLEFIELD:

MILITARY AND VETERAN HEALTH RESEARCH

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ACKNOWLEDGEMENTS

This collective aims to bring together the different research challenges that have been undertaken by researchers from across Canada on the topic of military and veteran health. The researchers who contributed to this volume were part of the second Military and Veteran Health Research (MVHR) Forum that took place in November 2011, hosted by Queen's University and the Royal Military College of Canada (RMCC) in Kingston, Ontario, under the auspices of the Canadian Institute for Military and Veteran Health Research (CIMVHR).

This volume is one of the many ways CIMVHR is connecting researchers, government stakeholders, and, most importantly, the beneficiaries – still serving military members of the Canadian Forces (CF), veterans and their families – through knowledge exchange while also working towards our mission: *To optimize the health and well-being of Canadian military personnel, veterans and their families by harnessing and mobilizing the national capacity for high-impact research, knowledge creation and knowledge exchange*.

A special thank you is extended to our interim Board of Directors; without their support, CIMVHR could not undertake such high impact projects as the annual Forum and the publication of the best research it showcased. Our sincere word of gratitude to the Chair of the Board, Ms. Susan Marlin, Associate Vice Principal Research at Queen's University; Dr. Jean Fugère, Vice Principal Research, RMCC; Dr. Jennifer Medves, Director of the School of Nursing and Associate Dean, Faculty of Health Science at Queen's University; Mr. Michael Brennan, Chief Executive Officer of the Canadian Physiotherapy Association; and Dr. Heidi Sveistrup, Vice Principal Research and Professor in Rehabilitation Sciences at the University of Ottawa.

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The Editors would also like to thank the mentor and co-chair of CIMVHR Implementation Committee, Brigadier-General (Ret'd) William Richard who has dedicated endless hours to the development of CIMVHR, to the planning of the MVHR Forum and in engaging the Canadian community.

Many aspects of this project would not have been possible without the combined support of Queen's University, Principal Daniel Woolf and Dr. Steven Liss, Vice Principal Research, and of the RMCC, Brigadier-General Eric Tremblay, the Commandant, Principal Joel Sokolsky, as well as Dr. Jean Fugère, Vice Principal Research.

Kingston is the hub of the Institute, its Forum and its collective; but even more important are the collaborative efforts of all our university partners. Beyond a hectic research and publication program, 26 universities (and counting) from all provinces are joining us in collaborating in Military and Veteran Health Research. This has an extremely high impact on our goals of increasing the health and well-being of military members, veterans and their families, as well as educating the first responders to this community that is spread throughout Canada.

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The opportunity to create a volume such as this would not exist without the leadership and logistical support of the Canadian Defence Academy (CDA) Press, particularly the CDA Press Program Manager, Mélanie Denis. The Chairman of the CDA Press, Colonel Bernd Horn, is keenly aware of the importance of providing an opportunity for the academic community and our military members, past and present, to exchange knowledge and share experiences. He has provided ready access to the resources of CDA Press to see this volume through to completion, a contribution that is extremely important to us, as we are proud of this joint venture that is extremely meaningful to CIMVHR.

As editors, we are very proud of the final product. The copy editing and layout were handled with expertise by 17 Wing Publishing Office. We would also like to thank for their support Lauren Hanlon, Angela Whitehead, Parth Bhowmick and Filza Naveed: their professionalism and attention to detail have helped bring this book to completion. The edit, layout and design of both the content and the cover of this manuscript have resulted in a volume in which we can all take great pride.

But none of this would have been possible without the great support that we have from our military colleagues, from the community of veterans that have approached us in the past few years, and from their families who also provided us with great inspiration. If they did not believe in it, who would? Thank you.

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FOREWORD

I am pleased to introduce this second volume published under the auspices of CIMVHR: *A New Coalition for a Challenging Battlefield: Military and Veteran Health Research*. The most current research in the area of military and veteran health are reflected in these pages.

From the tunnels under Vimy Ridge to the skies above Libya, Canada's military and veterans have been ordinary people doing extraordinary things, and this nation will never forget what they have done and are doing to protect our freedoms. We ask these special Canadians to contribute to society by putting their lives on the line, sometimes at a moment's notice, in far-flung dangerous locations, leaving their families for months at a time. And we recognize that they have unique health needs as a result of their service.

Canada is experiencing a renaissance of health research relating to its military and veterans. This rebirth was evident in the range of themes and topics addressed by researchers at the 2011 Forum: physical and mental health, rehabilitation, operational and environmental health, health care policies and programs, combat casualty care and, of special importance to my department, transition from military to civilian life. The Forum provided an excellent opportunity to learn from and contribute to national and international research in these areas.

Such research is not without its challenges. We need to understand military service and health from a life course perspective that considers Canada's military population and their families from enlistment through the end of their lives. This information will allow us to identify the best approaches to the care of serving members, veterans and their families in response to changing needs. Finally, we must work together to strengthen the capacity in Canadian military and veteran health research, while managing the expanding pool of such knowledge to use it most effectively.

All of these challenges point to the importance of the Institute and its annual Forum. Together, we can put the right information and research into the right hands to develop effective and responsive programs and policies for our nation's veterans. Together, we can honour them and recognize their contributions.

The Honourable Steven Blaney
Minister of Veterans Affairs

PREFACE

It is with great pleasure that I am able to announce the release of *A New Coalition for a Challenging Battlefield: Military and Veteran Health Research*, which represents the latest addition to the growing list of publications from the Canadian Defence Academy Press. The subject area is of a tall order: to collect and disseminate new information on the health of military members and veterans. Health issues associated with combat exposure are becoming a priority for the Canadian Forces, interests well-shared with the Department of National Defence, Veterans Affairs Canada as well as a pan-Canadian community of researchers. As such, this book brings together these key stakeholders in a novel way.

This publication is multidisciplinary, exploring all areas of research and providing the reader with the most recent findings in the areas of mental health, physical health and new technologies, as well as the challenges due to transitions from combat arms to other occupations. Clearly, the health and well-being of our serving troops and veterans is a key part of our mission success as an institution and by supporting the publication of books such as *A New Coalition for a Challenging Battlefield*, the Press is contributing significantly to the larger good.

As such, this most recent addition to the CDA Press collection continues our objectives of creating a distinct and unique body of Canadian leadership literature and knowledge that will assist leaders at all levels of the Canadian Forces to prepare themselves for operations in a complex security environment; sharing knowledge and research, as well as informing the public with respect to the contribution of Canadian Forces service personnel to Canadian society and international affairs.

In closing I wish to reiterate the importance of this latest addition to the CDA Press collection. I believe you will find this book both interesting and enlightening. As always, we welcome your comments.

Colonel Bernd Horn
Chairman, CDA Press

INTRODUCTION

> "In the beginning and in the end, the civility of a society and the quality of its civilization is measured by how it embraces the needs of its most vulnerable. This measurement is even more vital when we are dealing with those who were our most strong, most agile, most determined..."

These were the opening comments of Senator Hugh Segal at the MVHR 2011 Forum. Not only do these words resonate across every society in the world, they are of particular importance to Canada – a country which prides itself on its values. As we move forward as a country, and as we become one of the focal points for commerce, culture and society in the world, it is vital that we, as Canadians, continue to look after those who have served on our behalf.

Over 700,000 Canadian war veterans have served their nation bravely with the CF. Whether in war zones, aid missions or humanitarian missions, the CF have been deployed on missions in Afghanistan, the Former Yugoslavia, Somalia, Rwanda, Kosovo, Lebanon, Libya, the Persian Gulf, and many others. These deployments can change the lives of those who serve and their families. Battlefield injuries may manifest themselves in both physical and mental forms, and trauma from exposure to chemicals, diseases and extraordinary environments is a risk. Those who return from deployments may also fight the unseen dangers presented by mental health issues, and deal with the stigma and negative associations with seeking help. The concerns of these brave men and women can spread to their families as well, who are proud of their loved ones and yet must deal with the day-to-day consequences of injury.

After winding down from the Afghanistan mission and considering the health needs of the military and veteran health community, the immediate need for health programs, research and assistance for CF members, veterans and their families is apparent. Queen's University and RMCC thus founded the annual MVHR Forum in 2010. Its success was only an indicator of the research needs in this domain; in its second year, the MVHR Forum aimed more specifically to enhance the health protection of CF personnel, veterans, and their families. 2011's Forum was organized by CIMVHR. Following the 2010 MVHR Forum, CIMVHR was founded to engage existing academic

resources, to facilitate the development of new research, and to facilitate knowledge exchange amongst Canadian universities that have agreed to work together to address military health concerns. Representatives from 26 (and growing) organizations including Canadian universities, Canadian Forces Health Services Group (CFHS), VAC, and Defence Research and Development Canada, in addition to other organizations, form the basis of CIMVHR.

This volume brings together research presented at the 2011 MVHR Forum. Following a foreword from The Honourable Steven Blaney, Minister of Veterans Affairs, and a Preface from the Chairman of CDA Press, Colonel Bernd Horn, this book has also the honour of receiving opening remarks from Rear-Admiral Andrew Smith, the Chief of Military Personnel (CMP), discussing the CF personnel management strategic model and the impact of research; Commodore H.W. Jung, the Surgeon General of the CF and Commander of CFHS stressing the importance of understanding the uniqueness of the profession of arms; and Suzanne Tining, the Deputy Minister of VAC, concludes this section by discussing research at VAC. These chapters lay the groundwork for the research presented in this volume, and offer an excellent glimpse into the research being done on military and veteran health.

The remainder of this volume is arranged into four sections: Mental Health, Physical Health, Novel Technologies, and Transitions. This unique multidisciplinary arrangement provides a clear guide to the various areas of research which have, and are currently being explored within the subject of military health.

Mental Health

Captain H. Christian Breede, CD, MA, PhD Candidate, starts the Mental Health section of the book by providing an experiential account of the importance of leadership in the pursuit of mental health in an infantry company. By focusing on de-stigmatizing the pursuit of mental health, military leadership can improve the health of soldiers returning from deployment. This chapter offers a personal account of how leadership was utilized to encourage soldiers to seek mental health assistance upon redeployment from a demanding deployment.

Susan L. Ray, PhD, RN, Julie Salverson, PhD, and their contributors, focus on understanding the experience of contemporary peacekeepers healing from

trauma. Ten peacekeepers (six soldiers, two chaplains, one medic and one nurse) who had sought treatment following deployments to Somalia, Rwanda and the former Yugoslavia were interviewed. The findings of this study focus on the impact of a brief dramatization presented by Queen's University drama students during the MVHR Forum 2011.

Peggy Shannon, MFA, investigates ancient Greek plays, which were written during a century dominated by war, and as such often address the ravages of war. This chapter looks at whether ancient Greek plays can be utilized to help the contemporary veteran experience catharsis through situational recognition. The chapter includes studies on performances of war-themed plays, a photo exhibition, symposia and conferences in multiple countries, case study research, and pre- and post- paper-based questionnaires to evaluate awareness and discover specific attitudinal or behavioural change as a result of exposure to the theatrical performances.

Kate St. Cyr, MScPPH, and Maya Roth, PhD, C.Psych., review Prolonged Exposure Therapy (PE) for military members and veterans with Post Traumatic Stress Disorder (PTSD). PE therapy is considered by many to be one of the most efficacious, evidence-informed treatments for PTSD across a wide array of clinical populations. With this chapter, the authors provide a brief overview of the theory behind PE therapy, its implementation, and the processes underlying its use; and review the published literature of PE therapy, identifying its strengths and limitations in treating individuals with PTSD, with an emphasis on the use of PE therapy for combat-related PTSD.

Debbie L. Whitney, PhD, Jennifer C. Laforce, PhD, C.Psych. and Kristen Klassen, MSc, attempt to find alternatives to traditional mental health treatment. Many military personnel do not seek treatment for concerns such as PTSD, often citing travel time, costs, and the attitudes towards and stigma surrounding mental health as primary reasons. The authors investigate technology-based treatment modalities such as video-teleconferencing, which have been theorized as a means of ameliorating the aforementioned barriers. The chapter aims at conducting a preliminary investigation on the effectiveness of using Telehealth to deliver individual psychotherapy for PTSD in an outpatient setting.

Physical Health

Sivan Almosnino, MSc, PhD Candidate, *et al*., begin the Physical Health section by investigating anterior cruciate ligament (ACL) knee injuries in the military. Presently, physicians use a combination of manual muscle testing and clinical judgement to determine a patient's ability to return to normal activity, which the authors consider to be highly subjective and imprecise. The study explores the requirement of a precise assessment method to determine with accuracy whether a patient is ready to return to regular military duties. The purpose of the investigation is to develop an objective measure to evaluate current muscular status in people that have suffered a knee injury.

Captain Pauline Godsell, BSc (PT) and Lieutenant-Colonel Markus Besemann, BSc, MD, FRCPC, discus high-level mobility measurement in CF amputees. Findings from the Comprehensive High-level Activity Mobility Predictor (CHAMP) project, an easily administered, clinically friendly measure that discriminates between levels of amputation, are discussed and reviewed. The findings provide a glimpse into joint control and its impact on multi-directional ability and levels of functionality amongst different levels of amputees.

David R. Pichora, MD, FRCS, Heather J. Grant, MSc and Roumen V. Milev, MD, PhD, FRFPsych, FRCPC, conclude this section by examining the link between depression and workplace disability. With the objective of determining if depression preceded or was a result of an injury, data was collected on Workplace Safety Insurance Board (WSIB) claimants presenting to a clinic with an upper extremity occupational related injury. Workers completed questionnaires relating to their shoulder, hand and/or elbow pain and function in addition to questions on depression and anxiety. The study shows depressed patients were significantly more disabled, and 69% of those reported being depressed were also depressed before their injury.

Novel Technologies

Davide Bardana, MD, *et al*., introduce the novel technologies section by discussing Computer Assisted Mosaic Arthroplasty (Mosaicplasty), which is a treatment used for knee dysfunction. Whether due to trauma or normal wear and tear, cartilage defects in knees are common. Due to its limited healing potential, surgical treatment is often necessary to restore the cartilage.

Mosaicplasty, in which cartilage and bone plugs from relatively non-weight bearing areas of the knee is harvested and transplanted into the cartilage defect, is the preferred surgical technique.

Mohit S. Verma, Benjamin C. Lehtovaara and Frank Gu, PhD, examine a lightweight powder-based medical formulation that can be used for wound care management outside of theatre hospitals. The authors discuss curdlan polysaccharides which have been of growing interest due to their ability to form unique single and triple helical structures and a range of immunomodulatory properties includes antitumor activity, infection resistance and wound healing. They also discuss new drug delivery systems synthesized by utilizing curdlan.

Derek Tilley, MSc, *et al*., study *Acinetobacter baumannii*– one of the leading causes of infections in soldiers injured in combat. Despite its clinical significance, *A.baumannii* virulence factors remain poorly understood. The authors demonstrate Factor V cleavage by a novel virulence factor released from clinical isolates of *A. baumannii*. It is hoped that this research will lead to a greater comprehension of bacterial growth, survival and transmission; and will assist with the development of treatments, drug design and vaccines to improve clinical outcomes in war zones.

Diana E.K. Flood, MSc Candidate, OCdt Abby Edmison, BSC Candidate and Valérie S. Langlois, PhD, conclude the novel technologies section by investigating the explosive compounds perchlorates. Perchlorates are oxidizing agents used in rocket propellants and a variety of munitions and military training aids, and are known to inhibit thyroid hormone production. This chapter examines the effects of potassium perchlorate on thyroid gland related expression during the development of frogs. The findings provide evidence that perchlorate exposure during embryogenesis has little effect on thyroid hormone-related genes during early vertebrate development.

Transitions

Isabelle Côté, MD, CM, FRCPC, discusses the Pilot Project on Incarcerated Former Military Personnel in Three Ontario Detention Centres. This chapter aims to determine the characteristics of these offenders and to identify factors associated with veterans' incarceration. It provides valuable information about the needs of this population to assist in preventing and reducing future

violence by veterans. Once completed, the results of this pilot study may help in connecting incarcerated former military personnel with services provided by the Department of National Defence (DND) and/or VAC.

Brenda Gamble, PhD, *et al.*, aim to understand if managing in the hospital is the same as managing in the community. Results from two national surveys demonstrated that healthcare leaders in the hospital and the community identified the same management competencies. The shift of the site of care from the hospital to the community/home and the increasing needs of an aging population, suggest that leaders/managers can play an important role in the community. However, the application of competencies varies due to the delivery setting, the experience of the healthcare worker and most importantly the needs of the client.

Tina Pranger, PhD, *et al.*, explore the work experiences of veterans with mental health conditions and their service providers, and attempts to discover barriers and facilitators to optimal workplace re-integration of veterans with mental disorders. This chapter chronicles a study which is part of a larger project aiming to build a team of experts in the civilian workplace reintegration of veterans. By examining data collected from focus groups, individual interviews, clinicians, counselors and mental health and rehabilitation consultants, numerous barriers and facilitators for reintegration are discovered.

Stéphanie A.H. Bélanger, PhD, concludes the book by examining the reintegration of military personnel after combat. By exploring testimonies of CF members deployed to Afghanistan, issues surrounding soldiers' identities and training – from build-up to deployment to rehabilitation – are identified. This chapter aims to explore the inner-workings, from reintegration to combat readiness, and the effectiveness of the CF training program when in theatre and upon return, through its impact on health challenges. *Note: the opinions expressed in this chapter reflect the opinion of the author and do not necessarily represent the opinion of the Canadian Army, the CF or the Department of National Defence.*

We are confident that this second volume of work dedicated to the health needs of military personnel, veterans and their families will motivate further exploration of the ongoing research possibilities for this very important segment of Canadian society.

OPENING REMARKS

CHAPTER 1

The Canadian Forces Personnel Management Strategic Model and the Impact of Research

Rear-Admiral Andrew Smith, CMM, CD, Chief of Military Personnel, Canadian Forces

Personnel-related research has a tremendous impact on protecting both the psychological and physical health of the men and women who serve in the CF and the well-being of those family members who support them. Despite the end of the combat mission in Afghanistan, our CF members and their families continue to experience great personnel tragedies including the ultimate sacrifice of loss of life. Their commitment to their country, to serve unquestioningly, to put themselves in harm's way, and to accept that in so doing, there may be some associated stress and discomfort to those they love, does not go without a return commitment to do everything possible to support them and protect them from harm.

Some media reports suggest that DND and the CF are not doing enough to meet the needs of our men and women in uniform, especially those who have become ill or injured, whether in combat, or in the course of routine duty or training exercises, but this is simply not the case. Every member of the defence team staunchly adheres to the precept that personnel are our most important resource and capability asset, and consequently their well-being is our number one priority. While their physical and psychological well-being are paramount to maintaining a capable force of CF members ready to serve their country at home and abroad, we don't provide personnel support and services only to meet this strategic end – we do so because we have a social and moral imperative to care for them. They have put their faith and trust in us, and we will not let them down. In order to discover new ways to serve, protect, and prepare them even better than we already do, we have joined forces with Canadian industry and academia to generate dialogue, exchange ideas, and conduct innovative personnel research.

Every year, DND invests approximately $7.5 million in personnel-related research. The disciplined management of this investment is one of my primary functional responsibilities as the Chief of Military Personnel, but it is not mine alone. The Assistant Deputy Minister (Science and Technology) shares this responsibility with me, and together we co-manage the personnel research function through what is called a Partner Group. A Partner Group is an enterprise system that seeks to harness the capabilities of its various research entities and harmonize their efforts to achieve maximum efficiencies and effectiveness. This enterprise system is comprised of several DRDC establishments located across Canada, each one specializing in a few fields of research and development, but with many areas where multiple centres collaborate to achieve a desired effect. As concerns military personnel research, the primary research centres are the Director General Military Personnel Research and Analysis (DGMPRA) located in Ottawa, and DRDCs Toronto and Suffield. DGMPRA conducts the majority of the workforce analysis and social science research related to families, recruiting, job design and such; while the focus of DRDCs Suffield and Toronto is more towards human systems integration, medical and personnel protection research. This integrated in-house research capability is augmented by strong partnerships with other DND entities, other government departments such as Statistics Canada, Canadian academia and industry, as well as international collaborations such as The Technical Cooperation Program (TTCP) and various North Atlantic Treaty Organization (NATO) working groups.

While the main focus of CIMVHR forum is to discuss issues related to health research it is important to understand that health care is but one component of our comprehensive personnel care and management framework. To provide an appreciation of the more fulsome context and address the range of personnel services and research initiatives that are equally relevant to the maintenance of personnel well-being, this article will briefly describe this framework, or system of systems.

Managing the military personnel portfolio is a complex challenge because the individual factors that contribute to the wellness and effectiveness of the military system as a whole (and to the individual members within that system) are all interconnected, so that before making changes to policies or programs in one management area we need to consider the potential repercussions on other areas. For example, changing a personnel selection criteria to ensure we recruit the right individual may have a downstream impact on the length of time to train that individual to their functional operational point, which in

turn may have an impact on the number of qualified instructors we need in the training system and the number of combat ready troops available to deploy at any time. The military personnel system is also complex because CF members have an unlimited liability to serve; because the nature of the profession and military life in general includes frequent life-altering disruptions; and because all these conditions related to military service have an equally disruptive impact on the family, potentially resulting in loss of employment, lower incomes, loss of family health care providers, etc. For all these reasons, the CF personnel management system has to have policies and programs that take into consideration the well-being of members and their families across a spectrum that no other Canadian organization has to consider. Moreover, the evolving nature of our business and the changing face of global security issues both speak to a dynamic future security environment that, by extension, demands that military personnel, and the policies and programs that affect them, be flexible, responsive and evolving. This is why we continually strive to be the leading practitioner of military personnel management through an integrated personnel management system that is operationally focused, that is responsive to our stakeholders, and that reflects the priorities of the CF.

The resultant dynamic and complex military personnel management system is organized along five pillars representing the various elements in the personnel cycle that are linked in a cohesive and constructive manner. These include recruitment, training and education, preparing, supporting, and honouring and recognizing our members.

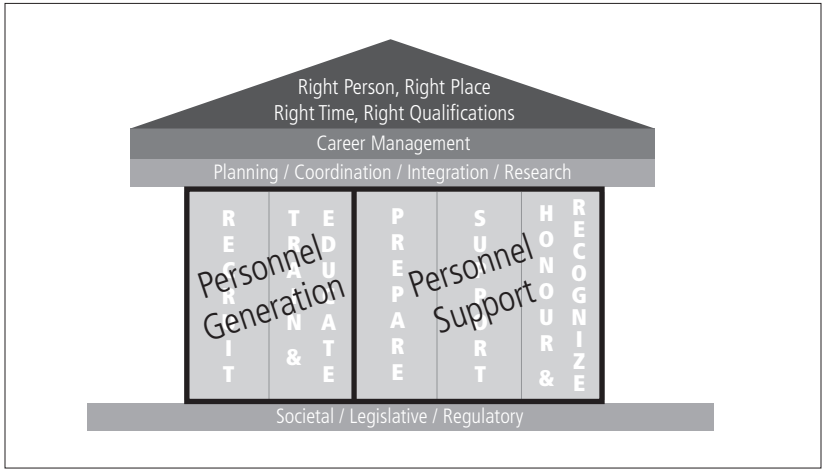

Figure 1.1: Dynamic and complex military personnel management system

Although depicted as pillars in this graphic, the system is not entirely linear: with research enabled advances in medical and psychological sciences we are able to reintegrate previously ill and injured members into the system so that it becomes in fact a more circular system. The following paragraphs will briefly describe some of these functional areas with examples of related research and its impact.

Recruiting efforts aim to attract highly capable, well-motivated and representative individuals from across all geographical areas, official language groups and ethnic communities in the right types and numbers to meet organizational objectives. The selection of the right person for the right job is accomplished through the administration of valid, reliable and legally defensible military selection procedures and tests. In developing these military aptitude and personal suitability tests, the social science research cell has examined such variables as the relationship between personality profiles and the likelihood of succumbing to stress, and developed measures to test and predict this relationship. The relationship between initial recruit health and nutritional habits has also been examined in terms of short- and long-term individual and organizational consequences such as the propensity to pass/fail basic recruit training on a first attempt.

Career Management is one of the primary enablers to achieve the R4 strategic effect.[1] Our goal is to optimize the personal and professional development of our members, and their assignment to duties in various locations, in a manner that will utilize and enhance their individual skills and knowledge so as to maximize their effectiveness. Clearly, policies related to the length of postings and frequency of operational tours have the potential to affect the health and well-being of members and their families, as do the relative "health" of the communities they are posted to. To understand and mitigate the effects of postings, our researchers examine such factors as the ability to find family physicians, and the availability of local social amenities and social services. Research results then inform the development of policies to close possible social service gaps such as might exist in remote locations.

The training delivery system, managed by CDA, is integrated with career management and takes into consideration operational imperatives. CDA develops and implements an expansive system that delivers Individual Training and Education (IT&E) and professional development for CF common occupational qualifications such as basic training, language training, military

colleges, Staff College and the national security program. Research focused on lessons learned from ill and injured members returning from Afghanistan has led to recommendations to incorporate stress and resiliency training at various functional points. Such training seeks to teach members a variety of coping skills that are intended to help them both in their career and personal life.

Ensuring Health and Support Services, the Surgeon General is responsible for the development and implementation of measures, processes and practices that provide the CF with a second-to-none health care system. In addition to clinical health care, we have also put into place a number of Joint Personnel Support Units (JPSU) that provide a comprehensive, decentralized and integrated network of support to ill and injured members and their families. JPSU capabilities include a Return to Work Program, a Transition Assistance Program, a Peer Support Network, mental health awareness training, health care services, and military family services. The concept of care envisioned for JPSUs consists of an integrated and consistent delivery and administration of benefits and services as members navigate through the three stages of recovery following injury or illness. Program evaluation research is currently underway to determine the effectiveness of the JPSU construct and identify possible areas for improvements.

The Chaplain General is responsible for the implementation of programs that enhance and protect the physical, emotional, and spiritual well-being of members and their families. The Chaplain General also ensures access to spiritual care and religious ministrations to all members and their families who desire such services. CF Chaplains perform this role both at home and in various theatres of operations. Reported incidences of occupation related stress and burn-out specific to chaplains returning from theatre is being investigated through research aimed at developing spiritual-wellness and resiliency measures to attain an appropriate work/life balance.

The CF are committed to developing and implementing services and activities that enhance the morale and welfare of members and their families. This includes the provision of messes, canteens and sports equipment for deployed troops, and physical education, recreation and amenity programs for both members and their families. Military Family Resource Centres (MFRC), located in every base across Canada, are community-based not-for-profit organizations established to provide military spouses, children and friends with

information, support, referrals and other services. MFRCs offer programs such as affordable daycare, adult education in official languages and resume writing that are designed to provide opportunities to enhance quality of life and assist family members to cope with the disruptive conditions of military service. A recent survey looked at the issue of spousal employment and income, whereby various indicators measured the satisfaction of CF spouses as compared to spouses of other Canadians subject to similar conditions of employment, namely various police services. Not surprisingly, CF spouses did not fare as well on measures of satisfaction or well-being, largely due to frequent relocations. The results of this research are being considered for their potential to inform compensation and benefits programs and policies.

Our goal is to develop a pay and benefit package that provides fair remuneration and benefits within the guidelines and constraints imposed by the Treasury Board. Compensation needs to consider the extraordinary skills and knowledge of our CF members and the unique conditions of service resulting from frequent disruptions and operational deployments. The benefits package covers areas such as pension, travel, housing costs and movements related to postings, disability, severance, dependent education, dependent health and dental coverage, and Foreign Service allowances. Clearly, an adequate compensation and benefits package is something which has significant potential to impact the quality of life and well-being of members and their families. Research helps to determine where benefits are needed, how to structure them to achieve maximum impact, and how much of something is enough to achieve the desired effect.

Under this line of operation, several divisions are responsible for Work Environment by overseeing the implementation of statutory requirements including the application of Official Languages, Employment Equity and Human Rights Acts, all of which function together to ensure the provision of a harassment free workplace that is supportive of all DND employees and CF members. The overarching goal is to promote Canadian societal values and reflect the diverse fabric of Canada. To this end research is conducted on areas such as effective Alternative Dispute Resolution (ADR) techniques, and the attraction of ethnic minority groups.

Honours and Recognition/History and Heritage is an imperative, timely and appropriate recognition of serving and deceased CF members and their families for their service, performance and sacrifices. We have only to remember

the aftermath of Vietnam to see the adverse health effects that the duality of an absence of recognition of service under extremely difficult circumstances combined with public criticism of defence policy can have on health, morale, and effectiveness. Fortunately, we have learned our lessons: the very touching public recognition of individual sacrifices as seen along the Highway of Heroes which stretches between Trenton and Toronto, Ontario, testifies to how far we have progressed in honouring our fallen.

The functional areas described above outline those aspects of the personnel management system that are mostly related to members during their active period of service. The system must also consider their transition to civilian life and the continuing care of Canada's veterans. To this end, VAC and the DND have recently completed a joint project entitled the Life After Service Study (LASS) that examined the issues faced by members who are no longer able to continue, or no longer wish to continue their career in the CF. The study examined employment and income, physical health, mental health, the mitigation of disabilities and social support networks. The findings of this study will shape policies and programs of the future. This was a very important start to what we hope will be a continuing, mutually supportive relationship as together, we seek to do the best we can for those members who have given their best to us.

It is clear that CIMVHR's mission goals of research, knowledge creation, knowledge exchange and education are aligned with the outcomes that DND and the CF strive to achieve. By developing and fostering collaborative opportunities between academia, industry and government researchers; by simplifying the procedures for research collaboration in the important area of member and veteran health; and by working cooperatively to leverage our joint resources, we will all gain access to a broader network of expertise and expand the ability to conduct research beyond that which is feasible using government resources alone.

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1 The R4 strategic effect is having the right sailor, soldier, airman, airwoman, having the right qualifications, in the right place at the right time.

CHAPTER 2

Defining Canadian Military Health Protection – A Unique Research Imperative

Commodore H.W. Jung, OMM, CD, Surgeon General of the Canadian Forces, Commander of Canadian Forces Health Services

The Canadian Forces – The Difference

Canada's national health care system sustains a robust and productive health research and development industry. Is it therefore necessary to have a distinct research program and a unique institute dedicated to the health issues of military personnel, veterans and their families? Can't defence scientists and clinicians simply adapt the existing body of knowledge produced by our universities and industry for military or veteran use? Wouldn't this accomplish the same outcome and be more cost effective? What is the need for CIMVHR?

To put this issue into context, it is necessary for those unfamiliar with armed forces to understand that military commanders are responsible for the protection, health and well-being of their personnel, while medical staff provides the advice and services necessary to promote, protect, and restore their health. Like their civilian counterparts, CF medical authorities use science and technology to guide and support health policy and programs, clinical quality improvement, and clinical research. For example, CF population-specific epidemiology and public health are fundamental functions of the CF Health Services, just as civilian health authorities are responsible for health care and surveillance of a distinct population subset. The unusual nature, activities, occupational exposures, and culture related to military service are such that the assessment and improvement of CF health and health capabilities require unique military health research in order to provide the best possible protection and treatment and to optimize military health and performance.

The CF, veterans and their families form a unique sub-population in the Canadian context, but this is often misunderstood by the Canadian public.

Part of the difference is described by excerpts from the book *Duty with Honour: The Profession of Arms in Canada*, 2009, published by the Canadian Forces Leadership Institute:

> …the fundamental purpose of the Canadian profession of arms is the ordered, lawful application of military force pursuant to governmental direction. This is done without question. This simple fact defines an extraordinary relationship of trust among the people of Canada, the CF as an institution and those members of the Forces who have accepted the "unlimited liability" inherent in the profession of arms…. Unlimited liability is a concept derived strictly from a professional understanding of the military function.[1]
>
> As such, all members accept and understand that they are subject to being lawfully ordered into harm's way under conditions that could lead to the loss of their lives. It is this concept that underpins the professional precept of mission, own troops and self, in that order, and without which the military professional's commitment to mission accomplishment would be fatally undermined. It also modifies the notion of service before self, extending its meaning beyond merely enduring inconvenience or great hardship. It is an attitude associated with the military professional's philosophy of service. The concept of unlimited liability is integral to the military ethos and lies at the heart of the military professional's understanding of duty.[2]
>
> All uniformed personnel fulfilling operational, support or specialist functions are considered military professionals.[3]

General Sir John Hackett described the concept of unlimited liability in his book *The Profession of Arms* using these terms:

> The essential basis of military life is the ordered application of force under an unlimited liability. It is the unlimited liability which sets the man who embraces this life somewhat apart. He will be (or should be) always a citizen. So long as he serves he will never be a civilian.[4]

Unlimited liability accounts for why our cultural and occupational environments and circumstances differ considerably from anything that most

Canadians can imagine. After ten years in Afghanistan, most Canadians have caught glimpses of this harsh workplace through short video clips of CF personnel in action. These vignettes graphically illustrate the difficult and extraordinary circumstances under which medical care and support must be provided. Even dramatizations, such in the television series "Combat Hospital", demonstrate only one narrow element of the types of situations under which CF medical professionals are engaged.

Military Medical Practice – The Difference

In 2007, approximately 900 surgeries were performed by Role 3 surgeons. Multiple surgeries were frequently performed on the same patient to save life and limb. Surgeries were performed for battle and non-battle injuries on Canadian soldiers, coalition troops and Afghan civilians. Roughly 1,300 Canadian soldiers, coalition troops, and Afghan civilians were admitted to the Role 3 Intensive Care Unit and ward. In addition, an average of 35 patients were seen daily at the walk-in. Most patients were civilian contractors, coalition troops, and some Afghan civilians. There were over 4,000 physiotherapy appointments, while the dental clinic (with two Dental Officers) saw approximately 3,000 patients. The battle injuries sustained were primarily penetrating injuries and poly-trauma to the extremities, very unlike the types of injuries seen at emergency centres across Canada. Exceptionally, 98% of the casualties treated at the Role 3 during this timeframe survived their injuries. This is a testament to the competence and dedication of our medical teams and their desire to continually introduce advanced practices and technologies to optimize care of the wounded.

The beneficiaries of research into the protection and health of CF personnel are not only the combat arms. Some military medical personnel are also front line troops who risk their lives practicing medicine in the hostile environments where the armed forces operate. Some of these individuals were present at MVHR Forum 2011. For their efforts, these five individuals were awarded the Medal of Military Valour (MMV) to recognize acts of valour, self-sacrifice or devotion to duty in the presence of the enemy or were Mentioned in Dispatches (MID) for their valiant conduct, devotion to duty or other distinguished service:

- Sergeant Gilles-Remi Mikkelson MMV from 22 CFHS Centre Cold Lake,

- Sergeant Michael Bursey MMV from 1 Field Ambulance Edmonton,
- Sergeant Brent Gallant MMV form CFHS Group Headquarters (HQ) Ottawa,
- Sergeant Kelly Harding MID from 2 Field Ambulance Petawawa, and
- Master Corporal Erkin Cicekci MID from CFHS Centre Atlantic.

They all employ specialized knowledge and technology generated by general and military medical research scientists to save lives.

It may surprise you to learn that, next to the Combat Arms, the Medical Service has suffered the highest rate of casualties in Afghanistan. This reality is one of the drivers for our focus on continuous research to improve CF health capabilities. Whatever the research area, medical researchers may well be personally applying their own research outcomes to their medical and non-medical CF colleagues shortly thereafter. Hostile operational & environmental threats evolve constantly, and in order to do the best we can to protect ourselves and our country, a robust national military health research capability is critical.

Military medicine involves much more than just the application of medical interventions on the battlefield. Our three priorities are to:

1. Protect our personnel wherever they serve. To achieve this goal CFHS personnel are involved in modeling and simulation, ballistic protection, Chemical, Biological, Radiological and Nuclear (CBRN) defence initiatives including vaccines and other medical countermeasure, diving medicine, submarine medicine, human factors, aerospace medicine and training, occupational and environmental health protection, and many other areas not necessarily found in a civilian health care program.

2. Return our highly trained military personnel to duty as soon as possible in the event that we have not been able to protect them from injury or illness, and;

3. Facilitate a successful transition to civilian life in partnership with VAC if our patients cannot reach a recovery point which permits them to return to full active duty.

Civilian health research is generally applicable to in-garrison care to our military community. There are situations, however, particularly during operations, where this is not the case. For example, the distance and time from point of injury to a well-equipped trauma facility is often much greater than in civilian setting. Frequently, the extent or location of injury may require unusual efforts to sustain life. For example, the use of tourniquets, an old technology which had fallen out of favour in civilian medicine, had to be reintroduced in Afghanistan and proved to be a life-saving modality. In operations, a device or drug that may not contribute medically in civilian settings might provide a significant logistical benefit. For example, the use of hypertonic saline as a resuscitation fluid was the subject of a multi-centre, multi-million dollar clinical trial across North America to determine its effectiveness. The trial was terminated at one-third progression because there was no perceptible difference in the clinical outcome of patients receiving hypertonic saline versus the standard. In a military context, however, hypertonic saline presents a major logistical benefit to the clinical outcome of injured troops because it requires less space to store and has a much smaller footprint for transport. Medical technicians who would normally carry up to 3 litres of normal fluid per patient could now dramatically reduce their fluid load, and thus carry more medical supplies of other kinds or could increase the number of casualties they could treat. In this case, the aims of civilian research did not aim to address the military context.

In contrast, evidence-informed best practices are often challenged as a result of military conflict. For example, it was found in Afghanistan that tension pneumothorax was the second leading preventable cause of death on the battlefield. To address this problem, Tactical Combat Casualty Care (TCCC) training was expanded to permit medics to decompress with needles. When CF medical specialists in Kandahar studied the outcomes and analyzed cases of underuse and misuse, they identified a training gap in that catheters were being applied too medially in the cardiac box. Their recommendation for a new guideline for decompression at the nipple line was adopted by key TCCC Committees and by the Pre-Hospital Trauma Life Support Course, and is now standard pre-hospital practice around the world. This is one example of military health research translating well into civilian practice.

Many opportunities for advances in military and veteran health exist in the mental health realm. We are beginning to understand, for example, that combat-related PTSD is quite different than the condition generally

experienced by civilians. The civilian literature quite appropriately discusses PTSD in the context of victimhood. This makes sense in the context of rape, abuse, etc. In contrast, soldiers are not victims of combat. They voluntarily deploy to high risk environments, have multiple exposures over time, are separated from loved ones, and experience sleep deprivation amongst many other physical and psychological stressors. What's needed then is a careful look at the traditional definition and symptom clusters of PTSD (Re-experiencing, Avoidance and Hyper-arousal) in the context of deployed soldiers. Retired US Army Psychiatrist Colonel Charles Hoge suggests that it is more appropriate to think of the symptoms as predictable "reactions" to combat. In the combat setting, these reactions may actually be suitably adaptive. For example, re-experiencing could be a mental rehearsal anticipating and preparing for the next enemy contact. Hyper-arousal may reflect the alert and vigilant state required to survive high risk operations. The challenge is to transition from this adaptive state when troops return home.

A challenge to the research community is to explore the many aspects of combat-related PTSD. Does Resiliency training help? Will neuro-imaging provide objective markers for disease and recovery? Will treatments be adapted so that we can use them during operations and reach forward-deployed soldiers?

The 14th Health Jurisdiction – The Difference

Given the exclusion of CF members under the Canada Health Act, the Canadian Occupational Health and Safety Act, and the responsibilities of the Defence Minister under the National Defence Act, the CFHS Group constitutes a comprehensive and unique health system to promote, protect, and restore the health of Regular and full-time Reserve CF members. In partnership with allies, civilian partners, the CF chain of command, and CF personnel, the Group provides medical, dental, public health, occupational health, educational, regulatory, research, administrative and advisory functions and services. It also fulfils command and control, operational planning, and other operational support functions by virtue of its mission to provide health service support to shield and sustain the armed forces during military operations. In addition to fulfilling military-specific functions, it fulfils for the CF most functions of provincial ministries of health, health-related functions of education and labour ministries, most functions of Health Canada and the Public Health Agency, of industrial occupational health services, health research

establishments, pharmaceutical and medical supply agencies, third party health insurers, workers compensation programs, as well as functions of organizations like the International Committee of the Red Cross with respect to the capability to internationally deploy mobile field health capabilities.

A National Responsibility – The Difference

Although there is a very large and well-funded (from a Canadian perspective) community in the US working on military health research, we as Canadians have the duty and responsibility to rebuild our once proud and productive Canadian military health research effort to ensure that the health protection and care delivered to CF personnel continues to be evidence-informed best practice. Combined efforts with DRDC and our allies over the years continue to yield benefits, but this is only the tip of the iceberg of potential advances through broader collaboration with outstanding Canadian scientists and clinicians in academia and industry. CFHS, the CF, the Government of Canada, and Canadians generally would reap the ensuing benefits. To re-establish a viable, sustainable and productive national military health research capacity, we call on the support of academia and industry alike through CIMVHR.

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2 Ibid., 27.

3 Ibid., 10.

4 General Sir J. Hackett, *The Profession of Arms* (London: Times, 1963), 4.

CHAPTER 3

Research at Veterans Affairs Canada: In Support of Veterans and Their Families

Suzanne Tining, Deputy Minister, VAC

The purpose of this chapter is to provide a high level overview of the VAC's health research program as presented in remarks made at the opening plenary of the MVHR Forum hosted by Queen's University and RMCC in November 2011.

Since Confederation, Canada has recognized veterans' services and sacrifices both by compensating them for health effects of military service, and by helping them to re-establish in civilian life. Veterans' health research has played a key role in providing sound evidence on which to base effective policy, programs and services.

Throughout the last half of the 20th century, Canadian veterans' health research was dominated by the one million Canadians who served in uniform in the Second World War. The focus of both veterans' administration and research shifted with them as they aged; from acute care and re-establishment, to chronic health disorders and midlife issues, and then to care of the elderly.[1]

At the end of the Second World War, Canadians agreed on the importance of providing outstanding medical care to returning veterans, but Medicare was not yet in place and veterans' services were focused on aging First World War veterans.[2] To meet this challenge, the Department of Veterans Affairs (DVA) was established in 1944 and immediately developed a comprehensive rehabilitation, health care and financial benefits program called The Veterans Charter.[3] The 1963 DVA Annual Report listed 89 veterans' health research projects in DVA facilities.[4] With the transfer of departmental hospitals to the provinces, some of this capacity diminished in the 1960s and 70s. Veterans' health research then had to compete for resources with diverse civilian interests. While some research work continued, notably at Ste. Anne's Hospital,

by 2000 it was recognized by VAC's senior management that the Department needed more research to inform policy and program development. Considerable research work was undertaken to support the development of the New Veterans Charter (released in 2006) and its enhancements.

Currently, War veterans no longer account for the majority of VAC clients (VAC Statistics, 2011), as demonstrated by the following graph.[5]

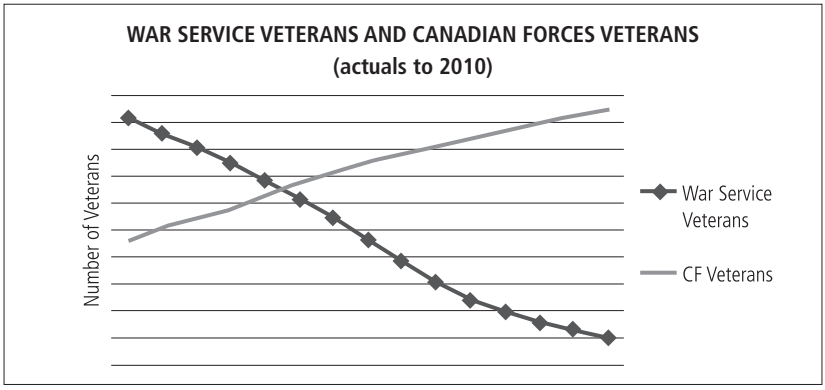

Figure 3.1: Changing Demographics of VAC clients 2006 to 2020

The large group of Second World War veterans experienced a more homogenous military experience and civilian support systems than the more recent veterans. To respond to this challenge we are witnessing the emergence of an increasingly strong and coordinated sector of interest that includes the formation of CIMVHR and a network of over 20 universities, increased interest of the Canadian Institute for Health Research (CIHR) and a robust collaboration between VAC, the CF and DND on shared research goals, priorities and projects.

The Role of Research at Veterans Affairs Canada

VAC's mandate, according to the Department of Veterans Affairs Act, is to support "*the care, treatment, or re-establishment in civil life of any person who served in the Canadian Forces or merchant navy or in the naval, army or air forces or merchant navies of Her Majesty, of any person who has otherwise engaged in pursuits relating to war, and of any other person designated ... and the care of the dependants or survivors of any person referred to*…".[6] VAC has several business lines to meet this mandate: compensation and financial

support $2.13B, health care and re-establishment $1.14B, and remembrance and commemoration $46M.[7]

VAC research functions (Figure 3.2) support the innovation that is essential for VAC to meet its mandate. Research informs effective programs, services and benefits that best fit the needs of veterans and their families.[8]

- Interpret and monitor military and veteran health issues.
- Conduct primary research linked to VAC priorities.
- Review expert opinion and scientific evidence to support decision-making for policy, programs and service delivery.
- Research partnerships with DND/CF, advisory bodies, universities, and allied countries.
- Promote leadership and capacity building in military and veteran health in Canada.
- Knowledge exchange

Figure 3.2: VAC Research Functions

Research Culture at Veterans Affairs Canada

Research is embedded is all aspects of VAC work. It supports innovation in the organization by providing high quality evidence to inform decisions as well as policy and program changes. Information about the mental, physical and social health of Canada's veterans is crucial to building effective programs to meet current and future needs. An understanding of the impacts of military service on health across the veteran's life course is of particular importance, especially since many of the department's programs, including disability benefits, require establishing a connection between military service and health conditions – often many years after release.

VAC's research capacity has three major components: the Research Directorate, located at the departmental headquarters in Charlottetown; a nationwide mental health research network working out of 10 Operational Stress Injury Clinics (OSIC); and Ste. Anne's Hospital, the Department's remaining long-term care facility, which conducts clinical research, including aging, pain management and dementia.

Enhancing and Leveraging Research Capacity

The Department approaches its applied research in a number of ways, including in-house studies; partnering with other federal departments and agencies

and academic researchers, and purchasing research through Government of Canada competitive processes. Despite, and largely because of, VAC's modest research capacity, the department has built strong partnerships and networks, both nationally through its work with DND/CF and Statistics Canada, universities and individual researchers, and internationally through solid connections with its counterparts in the US, the United Kingdom, Australia and New Zealand. VAC's support to the establishment of CIMVHR contributes to building this capacity.

Life Course and Re-establishment

VAC is particularly interested in transition and re-establishment over the life course of veterans. According to a life course perspective on health research, the experiences and exposures earlier in life determine health and other outcomes later in life.

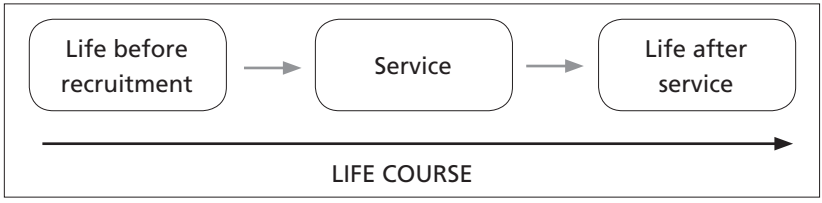

Figure 3.3: Life course view of Veterans' research[9]

Many studies have shown that military service is a critical life experience which may have short, medium and long-term outcomes – both negative and positive. For example, veteran research shows that, for some, military service is like wind at the back helping in civilian life; however, for others, it can have impacts on health and disability across the life course, sometimes into old age.[10]

Therefore, the goal of transition programs, like those under the New Veterans Charter, is to facilitate re-establishment into civilian life after service – to optimize health, minimize disability and support functioning at work, at home and in the community.

Life After Service Studies Program of Research

Over the past 18 months, VAC has developed a solid evidence base to support the evolution of its New Veterans Charter programs. This evidence base is

founded on a groundbreaking program of research called LASS.[11] For the first time in Canada, this research studied the broader population of recently released veterans and not just departmental clientele. This population-wide focus enables us to develop a comprehensive understanding of the ongoing effects of military service, including the military to civilian transition experience, and the reach of VAC programs. Three studies have been completed so far under this innovative research program that was conducted in partnership between VAC, Department of National Defence, and Statistics Canada. The Income Study[12] focused on sources of income, income changes and low income levels pre- and post-release. The Survey on Transition to Civilian Life[13] studied health, disability and determinants of health. These two studies included all CF members who released over a recent 10-year period. The third was the Mortality Study[14] which examined causes of death, including suicide. This study was led by the CF and focused on a larger population of both veterans and still-serving personnel who enrolled between 1972 and 2006. The Cancer Study is currently underway.

These studies, as well as ongoing analysis of the data, have revealed the following high-level findings:

- Regarding ease of adjustment to civilian life, 65% had an easy adjustment, but 25%, or one in four, reported a difficult adjustment.

- The department is reaching many clients with high needs. For example, seventy-five per cent (75%) of veterans who medically released were VAC clients. However, the study identified that there are some veterans not being reached – of those who had a difficult adjustment to civilian life, 20% were not VAC clients.

- Compared to the general Canadian population, veterans reported lower levels of well-being and higher rates of musculoskeletal disorders, pain and disability. A high percentage attributed their health problems to military service.

- While many veterans experience good health, there is a group with complex health problems. 16% of veterans reported a complex combination of pain/discomfort, a chronic musculoskeletal condition, and a mental health condition.

- The mortality study showed that veterans in Canada had 23% lower mortality rate, from all causes, compared to the general population. The exception in these findings was suicide, with the study showing that male veterans had a risk of suicide 1.5 times higher than the general population.

The data from the studies is being used to better identify and reach veterans who are potentially at risk. These findings have a direct impact on program design and development to ensure that VAC is responsive to the needs of Canadian veterans.

Research Priorities

VAC has identified a number of priority areas for research, with the first being support for program design relating to transition and reestablishment to civilian life. That support is strengthened as departmental and external researchers delve deeper into the rich LASS data investigating a wide range of subjects including identifying vulnerable populations, mental health, suicide, co-morbidity, income adequacy and many others.

The Department is currently exploring with partners the possibility of conducting a population health study of former Reserve Force personnel and of longitudinal data collection as potential research avenues. For example, VAC is partnering with the Canadian Institutes for Health Research on the Canadian Longitudinal Study of Aging. These initiatives would support innovation and responsiveness to emerging health needs and issues and lead to significant progress in measuring the impacts and outcomes of VAC programs.

Another major priority is determining the long-term impacts of military service on civilian life, necessary to make the connection between health conditions and military service for the purposes of disability benefit entitlement and to identify health needs. Synthesizing and analyzing the burgeoning body of expert opinion and scientific evidence is an important aspect of determining those impacts.

Ultimately, VAC continues to utilize opportunities to enhance Canadian and international capacity to conduct military and veteran health research, through engagement with CIMVHR and partnering in its annual Forum, ongoing connections with its counterparts in Allied countries, and collaboration with universities and individual researchers.

Moving Forward

Research has provided key support for innovation in Canadian veteran care and compensation since the Second World War. In order to continue to effectively inform policy, programs and services to meet the needs of today's veterans and their families,[15] a coordinated national vision and partnerships with federal, provincial and university researchers is required. VAC's current need for Canadian military and veteran health research is greater that our current research capacity.

The rich data acquired through the recent LASS can feed the interest in military and veteran health research in this country. Already departmental researchers are engaged with external organizations such as CIMVHR and with individuals interested in further investigation of this data to provide clearer insights into the transition experience as well as the long-term impacts of military service on veterans and their families – a positive sign that this important sector of health research is of prominence and important to Canadians.

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SECTION 1:
MENTAL HEALTH

CHAPTER 4

Mental Health and Small Unit Leadership: An Autoethnographic Examination

Captain H. Christian Breede, CD, MA, PhD Candidate in War Studies, RMCC

ABSTRACT

Leadership has been equated with the mental health of soldiers but practical examples are rare, and simply suggesting that it is a leadership responsibility leaves key pieces out of the analysis. This chapter provides an autoethnographic analysis of the importance of leadership in the pursuit of mental health in an infantry company. It aims to demonstrate a series of initiatives that were taken by the leadership to address the importance of the link between mental health and leadership. It also stresses the importance of the destigmatization of mental health and how it cannot be dissociated from the role of the leadership. The unit described in this chapter met this endeavour with moderate success but it was a step in the right direction that readers in similar situations will hopefully try to emulate in the future.

Introduction

I want to tell a story. This piece, a deviation of sorts from the normal style of much of the work in this field, is fundamentally a memoir. By employing the autoethnographic approach,[1] I hope that this story can resonate with others either having been in similar situations, or about to embark on such experiences. My intent is to support theoretical research by providing some evidence[2] through the experiences of a small unit, which was deployed to Afghanistan during a particularly difficult phase of operations in that country.[3]

It is a story about a small unit of infantry soldiers for whom I had the privilege of serving as their second-in-command. I commanded the company – as

all second-in-commands have done while deployed in contemporary Canadian operations – for about a month during the deployment, which ran from September 2008 to March 2009, and saw our company deployed to the city of Kandahar, Afghanistan. I had the additional opportunity to command again upon our redeployment to Canada in the spring of 2009 for about another six months. In total, I was that company's second-in-command and commander for almost three years. Needless to say, I got to know the soldiers quite well.

Immediately following our redeployment, I came across an article in a contemporary edition of *Armed Forces Journal*, to which I had been subscribing for several years at that point. In it, I read a short article by US Army Major Eugene Kim entitled "Do as I Do" which told several stories of senior leaders within units conducting what Major Kim refers to as "mature self-disclosure and help-seeking behaviors".[4] Kim recounts several stories of leaders at various rank levels sharing their mental health challenges with their subordinates and sharing that they are getting help.[5] Kim makes the point that as an institution, leadership by example is an imperative principle that must penetrate all aspects of a unit's life. The leadership demonstrated by the soldiers discussed in Kim's article is an excellent example of how one can operationalize the often ephemeral concept of leading by example. If an institution wants to remove the stigma of mental health, the leadership of that institution has to take concrete steps to do so. Mature self-disclosure is a vector through which the stigma can be removed.

Upon reflection, in the three years since our company's rotation ended and having seen operations in general cease in Kandahar province, it has become clear that the actions of our unit leadership, not just during operations, but also before and after our specific deployment, had a direct impact upon the mental health of our soldiers and our unit in general.

The Story

I want to tell the story of "Golf" Company in five stages. First, I will explain how the Kim article echoes other literature that relates leadership and mental health. Then, I will discuss some of the preparations we completed before deployment in the counter-insurgency environment of Afghanistan. Third, I want to outline a few initiatives that we took during our deployment that attempted to mitigate the impact of several stressors upon members of the

company. Next, I will examine some of the actions that we took as a group upon our return to Canada and finally, I will conclude with a personal assessment of how effective we were in encouraging positive mental health within our small unit.

The importance of leadership has been articulated in the past. For example, Allan English stated that "Leadership, at all levels, is the key to reducing the effects of operational stress."[6] Terry Copp and Mark Osborne Humphries elaborate on this particular concept by indicating that although deceptively simple, the idea of mental health as a leadership responsibility has a variety of implications such as the fostering of unit cohesion and affording opportunities for rest for the soldiers within a unit.[7] By making mental health a leadership consideration and responsibility, one is able to take a proactive and preventative approach to mental health within a unit, rather than a reactive and treatment-based approach.

The Kim article struck a chord with me and I presented it to my company commander, who was about to be transferred out of the company to Ottawa, leaving me in command. The Kim article was one of the few pieces that clearly and articulately demonstrated the positive impact that leadership can have upon the mental health of a unit. There is no clearer illustration of leading by example than that of a small unit leader actively and openly seeking the help of a mental health professional. I suggested to the company commander that we adopt this same attitude of mature self-disclosure and he agreed. A few weeks later, now in command of the one hundred or so soldiers of the company, and during a meeting with the company leadership, I presented my plan for dealing with mental health within the small unit and it was well received. However, before this book elaborates on that particular process, it is important to discuss the other activities and initiatives that we undertook prior to, during, and after our deployment to Afghanistan as these shaped the receptive environment that had been built, in some ways by accident, for the active pursuit of mental health within the organization.

Before We Left

Upon receiving word that "Golf" Company would form the principal component of the Force Protection Company for the Kandahar Provincial Reconstruction Team (PRT)[8] for the sixth rotation of Task Force Afghanistan (since 2006)[9], three key activities were initiated by the company leadership in

order to prepare for the deployment. These activities were in addition to the extensive pre-deployment training that took place.

It quickly became apparent that within the company there was a feeling that an assignment to an organization such as the PRT was not in keeping with the traditional scope of tasks for an infantry soldier. A common feeling shared by most soldiers was one of disappointment of not being part of the battle group as well as being detached from our parent unit, 2nd Battalion, The Royal Canadian Regiment.[10] In general terms, outside of assignments to various headquarters or support roles, infantry soldiers deploying to Afghanistan served with one of three broad units within the Canadian mission to Afghanistan. Soldiers either served with the PRT, with the Operational Mentor Liaison Teams (small teams of soldiers who trained and conducted operations with the Afghan National Army), or with the battle group, which conducted the majority of the offensive operations in the theatre of operations. It was the battle group that sought contact with the insurgents in order to destroy them where as the PRT sought contact with the locals in order to assist in reconstruction efforts. These tasks were very different, and from an infantry soldier's perspective, assignments to the battle group were the most desirable whereas the PRT was seen as less so.[11]

The deployment posed a unique challenge thanks to the operational tempo of working in a supporting role within the context of a PRT. This organization, comprised of some 300 civilian government workers and soldiers (from both the US and Canada), was in many ways the operational side of Canada's comprehensive approach to Afghanistan. This approach argued for a holistic application of Canadian influence abroad, beyond just the deployment of military forces into a theatre of operations. The comprehensive approach sees a deployed role for officers from the Department of Foreign Affairs and International Trade, the Canadian International Development Agency, Correctional Services Canada, and others including civilian police officers. With all these partners in one unit each bringing forward their priorities and tasks for their particular departments, our Force Protection Company was the only element within the unit that could move these different groups around the battlespace. To put it simply, the pace of operations – specifically the time from notification of a patrol to the patrol's execution – was short and not in our control. As infantry soldiers and leaders, we are accustomed to being the supported piece of any operation.[12] In this case we were supporting the needs of our civilian and military development agents. In military jargon, we became the *enablers*.

Our company leadership recognized the potentially toxic attitude that such a sense of envy and disappointment implied. We sought to address this issue by tackling it head on; we tried to change our culture, principally, by focusing on education. We held sessions not only on what the PRT does, but on general counter-insurgency theory as well in an attempt to demonstrate the operational role of the PRT within that framework. We elevated the role of the PRT as the line of operation that would bring about a lasting solution to Afghanistan's problems. Simply killing insurgents only serves to generate more insurgents. The role of the battle group was not diminished as the provision of security is vital to enable other operations, but the other operations are the piece that will bring about change. This message was transmitted on several occasions to all members of the company.[13]

Secondly, but equally important, we emphasized the unique challenge posed by operating in a whole of government context. Again, by introducing theories and methods of counter-insurgency with the emphasis on political solutions (not military ones) as having the best chance for success implied that operations within the PRT were closer to meeting the challenges of the counter-insurgency environment than other types of activities within the Task Force.

Another feature of our pre-deployment activities included a session with former US Army Lieutenant-Colonel Dave Grossman. Most notable as the author of *On Killing*,[14] Grossman is now the director of the Killology Research Group[15] which examines the psychological impact of taking another person's life. Through this group, Grossman delivers a half-day session tailored to law-enforcement, military organizations, and non-governmental organizations as preparation for those who are about to engage in violent action against others.[16] In January 2008, he spoke to the soldiers of our company. One of Grossman's key points was that seeking mental health treatment is something that all soldiers should do if they need it and he emphasized that there is no shame in admitting that they need it. This session, conducted for all soldiers of our company almost a year prior to our deployment in September 2008, set the tone for the remainder of our training, which would include several major exercises both in our home unit in New Brunswick, as well as in Texas and Alberta.

The final area in which the company deliberately attempted to reduce pre-deployment stressors involved efforts to keep as much training close to the home base as possible. This was particularly challenging in that the majority

of the soldiers and civilians assigned to the PRT for rotation 6 came from Ontario, not New Brunswick and as such, the PRT, once formed in January 2008 prior to deployment, was established at Canadian Forces Base (CFB) Petawawa in Ontario, about two hours north of Ottawa. On several occasions, there was temptation to deploy the company to Petawawa for significant periods of time prior to deploying to Afghanistan. With two brigade-level, month-long exercises already scheduled, additional time away from home for the soldiers from our company in CFB Gagetown in New Brunswick, would have been detrimental to the morale of the company. The choice to train in New Brunswick was a balance between minimizing additional time away from the soldiers' families and ensuring that sufficient collective training was conducted prior to deployment. The company had an advantage in that our organization in Gagetown was a close approximation of the organization we would have when deployed in Afghanistan despite the number of people in Petawawa. It should be noted however that one-quarter of the company (a complete infantry platoon) was comprised of reservists from across Ontario. They, unfortunately, were assigned to Petawawa for their entire pre-deployment training cycle. We were able to bring that part of our organization to New Brunswick for about a week during which some additional collective training was achieved.

While We Were Gone

In late August, our soldiers started to deploy to Afghanistan. It took almost six weeks for the entire company to arrive at the PRT as our organization was broken up over more than ten different flights from Canada to Kandahar Airfield in Afghanistan. The first few months of the deployment proceeded without any serious incident, but on 13 December, a roadside bomb detonated under the LAV III armoured vehicle of one of our platoons, killing three and seriously injuring a fourth soldier. The reality of the conflict had touched our company directly for the first time.

The vehicle that struck the Improvised Explosive Device (IED) that day was part of the Quick Reaction Force (QRF) that had been dispatched to investigate a suspicious device along a main route west of Kandahar City in the vicinity of the town of Senjaray. The patrol was based on two sections from our company's second platoon and included an ambulance and an explosive ordnance disposal team. As the acting company commander, I was informed of the incident and reassured by our commanding officer that we would

be given time to grieve our loss. Initially, I was told that we had sustained casualties, some fatally, but no names were as yet available. By mid-morning, I had their names and our company sergeant-major gathered the company and I delivered the details.

Upon informing the soldiers – one of the hardest things I have ever had to do[17] – I passed along to the soldiers the intent to allow them time to talk and grieve within their own lines and we arranged for our unit chaplain to circulate through the building where our troops lived. The sergeant-major and I then organized to have the troops gather around the vehicle compound upon the return of the stricken patrol to our base camp. We did this in order to provide support to the patrol members as they returned. As they disembarked from their vehicles and made their way to our unit lines, friendly faces were present to offer support. We were fortunate that as a company we were able to suspend operations for the remainder of the day. Luckily, given the nature of operations at the PRT, this had little to no tactical impact. What meetings were planned that day could be rescheduled and although we maintained the QRF, the rest of the day was relatively quiet.

This desire to give time to the soldiers was not taken to extremes, however. Within twenty-four hours, the very same soldiers from the very same patrol that had just suffered casualties were back on the road, doing the jobs for which they were sent to Afghanistan to do in the first place.

A second way in which stressors were alleviated during the deployment was through a strict adherence to the conduct of After Action Reviews (AARs). Most commonly used within the military after a training event, the after action review is used to discuss what went well, what went poorly, what gaps in the abilities and capabilities need to be addressed, and what actions need to be continued. It is a vital tool with which groups learn to improve how they work together. Our company continued to use the reviews while deployed, after every patrol or significant event, like improvised explosive device strikes[18], in order to learn from experience. From time to time, the review was ignored upon the completion of the patrol and it became clear within the planning cycles for subsequent activities when this had happened, as tempers would often flare between members of the previous patrol because of unresolved issues. The review proved to be not only a learning tool, but also a way to relieve the stress of the patrol and to discuss difference of opinion that otherwise go unaddressed. Feedback from the participants of

patrols during these reviews also led to the identification of other stressors that our unit could address, namely the reactive nature of operations within the PRT.[19]

It became apparent after only a few weeks of operations at the PRT that the unit, at the tactical level, was operating in a reactive manner. Although tasks associated with the QRF were by definition and necessity reactive in nature, the normal (or framework) operations of the unit did not need to be. The operational schedule that our organization assumed upon taking over the security duties for the PRT provided only a twenty-four hour forecast of tasks. Within a few weeks, the effect on morale (to say nothing of the missed synchronizing opportunities) started to take its toll. With this in mind, our company headquarter took the lead in attempting to rationalize, synchronize, and plan all the patrols that originated from the PRT. Although we were only able to achieve a reliable forecast out to about seventy-hours, the extra three days of notice (and planning time for the patrol commanders themselves) had a discernable, positive impact on both morale and the overall effectiveness of the tactical tasks being conducted.

Again, recalling the points raised by Copp and Humphries,[20] specific actions taken by the leadership during operations in an effort to reduce stressors or the impact of stressors of can have huge impact upon the mental health of individual soldiers. The synchronization of operations, the conduct of reviews and affording space (rather than simply time) for the soldier to grieve a loss all served to reduce the impact of stressors.

When We Got Home

Upon redeployment to Canada, again taking about six weeks from the time the first soldier left Afghanistan to the time that the last soldier from "Golf" Company was back in Canada, the company was keenly aware of the challenges that this homecoming would pose. Along with attempting to return the company to regular duties as soon as possible, it was during this period that I read the Kim article[21] and it was his lessons that I tried to implement in our company upon our return to work.

Employing the same logic as was used following the loss of three of our soldiers in Afghanistan, the company was – by the summer 2009 – back in their armoured vehicles, conducting small unit training in preparation for a major

battalion-level exercise that fall at CFB Gagetown. For the most part, we were able to transition smoothly from deployment to training in those few short months. In August 2009, the company deployed into the training area of CFB Gagetown and conducted a series of tactical activities that covered all aspects of offensive and defensive operations culminating in a battalion-level exercise for a period of four weeks.

Superimposed upon this training schedule, the company began implementing the suggestions from the Kim article. After proposing the idea to the company leadership, I planned to conduct my own "mature self-disclosure" to the soldiers of "Golf" Company. Each company within our battalion has a small space within which to store equipment and conduct some basic maintenance. The company also met as a group in this space on a regular basis and at the next meeting, I told my story.

On many levels, I was very lucky during my deployment to Afghanistan. I returned alive, with all my limbs and I did not have to kill while I was there. Although I got very close on a number of occasions, the need to fire my weapon in anger never arose. For that I am grateful. Soldiers were killed under my command and I did not get along with everyone – either in the PRT or within my own company. However the deployment was a professionally rewarding experience. It also proved to be a huge strain on my marriage. My wife and I had been in counseling for several weeks when I told my story to the soldiers of the company and I was also seeing a counselor on my own in an attempt to make sense of what was happening to me emotionally.

I told my company that I had used the CF Member Assistance Program number to get help and that it worked well. I told the company that there are other ways to reach out. Finally I told the company that not only was I getting help, but I expected all of them to do the same if they needed it. I told them I was selfish and that we, as an Army, have invested too much money and time in each and every soldier to have them cease to be operationally effective. We, as a group, had some horrible experiences but that taken in context these events could make us better soldiers and it would be a shame to waste this hard-fought knowledge and experience. I told the company that I expected them to take the time needed to get back into their platoons as soldiers ready to do their jobs to their fullest abilities as soldiers. What I asked of them was no different from the vehicle maintenance or weapons maintenance that we conduct on a routine basis as part of our job. Seeking mental health assistance

is just like cleaning a rifle. If you fire a thousand bullets through your rifle without cleaning it, it jams; in a similar fashion, if you do not tend to your mental health, you cease to be an effective soldier. Various members of the company leadership, down to the platoon and section levels, modeled this mature self-disclosure, and encouraged soldiers who needed it, to seek help.

Normatively Sensitive and Operationally Sensible

The mature self-disclosure coupled with an operational imperative and rapid return to training served as mechanisms to minimize the impact of mental health challenges to the soldiers upon our return to Canada from Afghanistan. The time and space to grieve loss, the pursuit of proper planning and tactical techniques, and the imposition of after-action reviews following every patrol worked to minimize the impact of stressors while deployed in Afghanistan. Also, the deliberate attempt to change the culture of our unit from the enabled to the enabler, the formal instruction in coping with mental health stressors and the attempt to train close to home as much as possible all served to mitigate the challenges to mental health prior to deployment.

The activities and initiatives we pursued during all three stages mentioned above were not only normatively sensitive (in that they were done in order to assist soldiers in coping with stressors), but the activities and initiatives also proved to be operationally sensible. First, by pursuing improvements in planning, the operations themselves became more effective and enjoyed an improved chance of success. Proper synchronization of a patrol schedule was not just good for the mental health of the soldiers, but it was also a way to conduct more tactically effective and materially efficient patrols. Second, by placing an operational imperative upon the mental health of soldiers, one was able to retain the cohesion and professionalism of the team, which also lead to better tactical outcomes. Finally, given the unique nature of operations within the PRT, training at home was crucial to ensure that our activities more closely represented the particular realities we would face upon deployment to Camp Nathan Smith in Kandahar City. This was fortunate as Camp Nathan Smith proved to be a very different environment than that which faced the rest of the Task Force.

Despite all these efforts however, it was still not enough. The leadership of "Golf" Company tried to remove the stigma associated with mental health and the results were mixed. Many soldiers still felt uncomfortable with the

idea of seeking help. In the two years that have passed since our redeployment, several soldiers are still dealing with challenges to their mental health and two in particular took their own lives during the summer 2010. However, many soldiers are in treatment and receiving care, as well many soldiers have returned to full duties and continue in the infantry, putting their experiences to work for the benefit of others, ready for the next mission.

Mental health disorders are an occupational hazard of work in the military, but there is a careful balance that one must achieve between implying an inevitability of mental injury and reducing the stigma associated with it. John Keegan, in his classic *The Face of Battle*, writes that "almost all soldiers exposed to continuous or semi-continuous combat broke down"[22] and in quoting the official US report on the same topic, states that "There is no such thing as 'getting used to combat'".[23] This must be balanced however with the concerns raised by Copp and Humphries[24] that by normalizing the incidence of mental health injuries, one creates an irrational fear of it or even in some cases, induces it. A nuanced approach is required, and that approach, advocated for in this book and based upon the experiences of our company, is that should a soldier receive a mental health challenge associated with the deployment, the occurrence should be considered normal. The event remains extraordinary, especially for the soldier (which is why they have suffered the injury in the first place), but the subsequent process of treatment should be normalized.

Summary

The story I just told stresses the importance of mental health challenges and questions the fact that it is treated differently than physical fitness or equipment maintenance. This is not to say that mental health injury is to be expected, but should it occur, considerations could be made to the way it is approached so that it becomes treated no differently than a physical wound. No soldier goes into operations expecting to be wounded – the same holds true for a soldier in a unit that has a mature and healthy understanding of mental health challenges during these same operations. This attitude needs to start with the leadership cadre and it is a leadership responsibility in the truest sense. The leadership – at all levels – has an enormous impact upon removing the stigma and ensuring soldiers get the help they need so the they can return to duty – as soldiers. It is imperative we get this right as our soldiers, our families, and ourselves deserve nothing less.

1 For other examples of this method, see Nancy Taber, "Learning How to be a Woman in the Canadian Forces/Unlearning it Through Feminism: An Autoethnography of my Learning Journey," *Studies in Continuing Education* Vol. 3 (2005): 289-301.

2 The evidence for this book is drawn from an extensive personal journal that I kept while deployed in Afghanistan from 2 September 2008 to 31 March 2009.

3 Several commentators on the situation in Afghanistan have noted that the period from 2006 to 2009 was particularly challenging for NATO and Afghan security forces as the Taliban were reasserting their influence and the impact of the diversion of resources from Afghanistan to Iraq by the major contributors to International Security Assistance Force (the US and the United Kingdom) was fully appreciated. See "Briefing Afghanistan," *The Economist*, 8762 (2011): 32.

4 E. H. Kim, "Do As I Do," *Armed Forces Journal* 6 (2009) <http://armedforcesjournal.com>, accessed 24 Nov 2011.

5 Ibid.

6 A. English, "Leadership and Operational Stress in the Canadian Forces" *Canadian Military Journal*, Vol. 3 (2000): 36.

7 T. Copp and M. O. Humphries, eds. *Combat Stress in the 20th Century: The Commonwealth Perspective* (Kingston, ON: Canadian Defence Academy Press, 2010), 357.

8 PRTs are an operational application of the doctrinal concept of Civil Military Transition Teams (CMTTs) that are designed to coordinate and integrate efforts of both military and civilian agencies operating within the battlespace. See *B-GL-323-004/FP-003 Counter-Insurgency Operations*, (Kingston, ON: Army Publishing Office, 2008) 5-4. Canadians provided military support to the Kandahar PRT from 2005 (when Canada assumed command of the unit) to 2011 (at which point is handed command back to American forces. See "History of Canada's Involvement in Afghanistan 2001-2011", <http://www.afghanistan.gc.ca>, last modified 16 Aug 2011 and accessed 12 Dec 2011. The PRT as an operational concept and the idea of PRTs was conceived out of necessity by American forces in Afghanistan in 2001 in order to facilitate the transition from military to civilian control of the country. The first fully operational PRT was established in Gardez, Afghanistan in 2002 and more quickly followed, now under NATO's International Security Assistance Force as opposed to the American Operation Enduring Freedom. The concept of PRTs was also exported to American efforts in Iraq in 2005. See Kenneth Holland, "The Canadian Provincial Reconstruction Team: The Arm of Development in Kandahar Province", *American Review of Canadian Studies* Vol. 2 (2010), 278.

9 "Operation ATHENA", <http://www.cefcom.forces.gc.ca>, last modified on 5 Dec 2011, accessed on 12 Dec 2011.

10 This particular rotation of Task Force Afghanistan saw elements of all four battalions of The Royal Canadian Regiment deployed to Afghanistan. The Operational Mentor Liaison Teams were based on the 1st Battalion while the Battle Group for this rotation was centered on 3rd Battalion. 2nd Battalion, as mentioned above, provided one company to the PRT while 4th Battalion (the reserve battalion), provided individual augmentation across the Task Force.

11 "Operation ATHENA", <http://www.cefcom.forces.gc.ca>, last modified on 5 Dec 2011, accessed on 12 Dec 2011.

12 Infantry units are the basic component around which battle groups, brigade groups, and other tactical formations are created. Additional elements – such as artillery units or armoured units are attached to the infantry unit depending upon the tactical or operational requirements at the time. Although superseded by *B-GL-323-004/FP-003* (see endnote 7), the notion of the foundational nature of the infantry is captured in *B-GL-300-002/FP-000 Land Forces Tactical Doctrine,* (Kingston, ON: Army Publishing Office, 1997), 2-1.

13 For the most succinct account of best-practices in counter-insurgency operations and the centrality of a non-military solution, see J. A. Lynn, "Patterns of Insurgency and Counterinsurgency." *Military Review*, (July-August 2005): 22-27. The importance of a non-military solution to counter-insurgency has also been effectively captured by both American and Canadian doctrine. See FM 3-24/MCWP 3-33.5 *Counterinsurgency* (Washington: Department of the Army, 2006) and *B-GL-323-004/FP-003 Counter-Insurgency Operations*, (Kingston, ON: Army Publishing Office, 2008). K. Holland demonstrates the centrality of PRTs to the non-military focus of counter-insurgency in Holland, "The Canadian Provincial Reconstruction Team" (2010) as does T. Piiparinen, "A Clash of Mindsets? An Insider's Account of Provincial Reconstruction Teams," *International Peacekeeping*, Vol. 1 (2007), 143-157.

14 D. Grossman, *On Killing: The Psychological Cost of Learning to Kill in War and Society* (New York: Little, Brown and Company, 1995). The book was nominated for the Pulitzer prize in 1995.

15 See <http://www.killology.com>, accessed 24 Nov 2011.

16 Grossman's presentations are often well-received by both the soldiers and the leadership and he has been presenting this material to Canadian soldiers since 2005. <http://www.killology.com>, accessed 24 Nov 2011.

17 I vividly remember this event and I was terrified that I would forget the names of the three dead soldiers. I had their names written in my notebook and I remember standing in front of my soldiers and pausing for what seemed like minutes as I verified the names of the soldiers in my head. I knew all three of them, had had a rather lengthy conversation with one about the emotional impact of "making contact" with the enemy and I had played basketball the day before with one other.

18 The events of 13 December were no exception, and although difficult, we conducted an after-action review for that patrol as well.

19 It was not only through AARs that such feedback was received; however, it was one of the lines of communication that were maintained within our unit. Other mechanisms included daily orders groups as well a routine meetings and simply talking with the soldiers and leaders of within the unit.

20 Copp and Humphries, *Combat Stress*, 356.

21 Kim, "Do As I Do".

22 J. Keegan. *The Face of Battle: A Study of Agincourt, Waterloo, and the Somme* (London: Pimlico, 1976), 328.

23 *Combat Exhaustion* in Keegan. *The Face of Battle*, 329.

24 Copp and Humphries, *Combat Stress*, 356.

CHAPTER 5

Dramatizing Research: The Experience of Contemporary Peacekeepers Healing From Trauma

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ABSTRACT

The findings of an interpretative phenomenological inquiry on contemporary peacekeepers healing from trauma were presented as research-based theatre. The research question, "What is the experience of contemporary peacekeepers healing from trauma?" reflected a commitment to understanding the nature of healing from the trauma of contemporary peacekeeping deployments. Ten contemporary peacekeepers who had sought treatment resulting from deployments to Somalia, Rwanda, and the former Yugoslavia were interviewed. Themes emerged from the analysis of the transcribed interviews to understand the ways contemporary peacekeepers heal from trauma. The peacekeepers' descriptions of the situated-ness of their bodies in time, space and relation provided a fresh way into understanding the embodied nature of healing. Queen's University drama students presented the findings through the creation of an embodied dramatization, *Fracture*, based on the experience of one peacekeeper. Three major themes were dramatized: (1) the centrality of time and body in suffering and healing from trauma; (2) the centrality of brotherhood and grieving loss in the military family; and (3) the military response as betrayal and creating trauma from within. Research-based theatre represents an innovative approach to disseminating findings in a way that helps to clarify and transform social understandings, where insights occur because of audience engagement with dramatic material.

Introduction

We begin as one being, representing a person. We don't necessarily need to look like a person but it needs to be seen through some sort of movement sequence that we function as one. We move strongly and confidently.

> Piece 1: I shouldn't have been surprised when I got to the military.
>
> Piece 2: They tell people you will be cared for. We have strong leadership and the best health care in Canada.
>
> Piece 3: We are here for you.
>
> Piece 4: All around you, it's we're here to help.
>
> Piece 5: Sadly they build expectations.[1]
>
> Movement: The being begins to break apart, struggling to stay together but being torn and thrown around as if they were blown apart. The pieces reach for each other because they are meant to be one but forces beyond their control have become much stronger and they eventually find themselves isolated. They are always trying to get back together.

The description and quotes above were drawn directly from an interpretative phenomenological inquiry related to healing from trauma and were spoken in the opening scene of a brief twenty minute embodied dramatization, *Fracture*. The dramatization was presented at the second annual MVHR Forum to a mixed audience of military personnel, academics and clinicians. In this chapter we will provide a rationale for research-based theatre, describe the process we underwent to transform research data into drama, and discuss the results from audience feedback.

Since Euripides, Sophocles, and other dramatists in ancient Greece, there has been a long tradition of using traditional theatre to engage the public in moral, social, educational, therapeutic and political issues.[2] Traditional theatre has also been used to educate the public on issues of compassion in health care such as the *Elephant Man*,[3] *Wit*,[4] and *Whose Life Is It Anyways?*[5] Some theatre productions have employed participatory strategies in script development and have used the actual voices of members of the community under study.[6]

Whilst research has definitely been an aspect of this work, the emphasis has most often been on educational, political, and/or aesthetic considerations.[7] Traditional theatre has been used sparingly in regards to the presentation of health care research findings.[8] Drama that emphasizes research is much more recent, with only a handful of authors publishing their attempts to foreground research in the construction of drama. This new approach to dissemination of research findings work has varied along a number of dimensions, including how the audience is included or not, how much dramatic structure appears, how many (if any) narratives run through a performance, and how the performers approach the work (e.g. the use of scholarly versus lay syntax).[9]

Two main arguments have been made in support of research-based theatre. The first has to do with the often-neglected responsibility of researchers to have their work make a difference in the everyday world.[10] Linking research data to drama presented to a variety of different audiences is arguably much preferable to many manuscripts that collect dust and lie unread on library shelves, or are commented upon perhaps occasionally by other like-minded academics.[11] Theatre has the potential to present research material in a way that helps to clarify and transform social understandings; where insights occur because of audience engagement with dramatic material, the potential for positive individual change is heightened.[12]

The second argument made for research-based theatre, attractive especially to those with a predominantly realist (as opposed to post-modern or constructivist) perspective, is that it has advantages over purely textual reports in terms of validity (i.e. remaining true to qualitative research data and ultimately to lived reality).[13] This is because it sustains connections to emotions, bodies, and the full range of sensory experience that was present in the original data-gathering situation.[14] Audiences, often comprised of members of groups under study, can further validate research-based drama through provision of post-performance feedback, potentially affecting the shape of future presentations.[15]

Qualitative research is particularly suited to being presented through theatre because audiences can engage both cognitively and emotionally to the new knowledge. The fullest use of drama in presenting qualitative research material has been provided in the ground breaking "ethno drama" work *Syncing Out Loud: A Journey Into Illness*[16] by Mienczakowski and his colleagues. During the past decade, they have mounted major research-derived

productions related to schizophrenia, substance abuse and sexual assault.[17] Formal and recognizable adherence to the principles of ethnographic research methodology are stressed above and beyond the artistic demands of aesthetics, in its attempts to produce cultural critique. He also provides cogent theoretical arguments that create a foundation of relevance for research-based theatre.[18]

An interpretative phenomenological study, *A Child On Her Mind: The Experience of Becoming A Mother*[19] was produced as a play *A Child On Her Mind*[20] which wove together the experience of birthing, adopting and placing a child with research on socioeconomically disadvantaged women as egg donors and surrogate mothers. Through the stories of six women, the play explores the perceptions of the multiple routes and possibilities of mothering, as well as the coercive pressures created when technology meets socioeconomic disadvantage.

A dramatic production, *Handle with Care? Women Living with Metastatic Breast Cancer*[21] based upon research results of two studies, one conducted with women with metastatic breast cancer and the other with medical oncologists treating breast cancer patients toured cities in Ontario. Slightly different versions were presented to audiences of health professionals, and the general public. Questionnaires were distributed at performances held for both health professionals and the general public. All (100%) of those attending presentations for the public agreed or strongly agreed that they enjoyed the drama, and that they benefited from seeing it.[22] Similarly, 99% agreed or strongly agreed that there "was a lot of truth in this drama". The vast majority (99%) also agreed that the fact that the research was based on research made it more "true to life".[23]

All (100%) members of health professional audiences who completed the feedback form agreed or strongly agreed that they enjoyed the presentation and that the format of the presentation was engaging. Very importantly, all attendees also agreed or strongly agreed that the use of research transcripts to create the presentation "increased its validity substantially".[24] Although important work has accumulated, there remains much to explore and define in this exciting new field of research-based theatre. Our production of *Fracture* provided the opportunity to investigate challenging aspects of the linkage between research and drama.

The Creation of a Research-based Dramatic Production

The creation of a research-based dramatic production of the experience of contemporary peacekeepers healing from trauma[25] was not a planned outcome when the investigation into healing from peacekeeping deployments started. For this study an interpretative phenomenological approach was utilized that included various literary sources to uncover the lived experience of contemporary peacekeepers suffering while healing from trauma. Data was collected via one tape-recorded interview, lasting between 1½ to 3 hours, with ten contemporary peacekeepers who have sought treatment resulting from deployments to Somalia, Rwanda, and the former Yugoslavia. Participants included six soldiers, two chaplains, one medic and one female nurse; each had received treatment for trauma for a minimum of two years following deployment.

Data Analysis

There are four processes in the analysis of the data, namely isolating themes, reflecting on the four existential lived worlds, formulating thematic categories, and phenomenological writing. No qualitative software was used. A thematizing process by the researcher was used to identify, create and code the initial themes uncovered about the phenomenon. To get at the meaning of the text collected from the participants, the text is organized in terms of structures of meaning or isolating themes. Four existential life-world themes were used as guides for the reflective research process: "lived space (spatiality), lived body (corporeality), lived time (temporality), and lived human relation (relationality or communality)".[26] Phenomenology is an ongoing process of writing, uncovering, seeing, pondering then rewriting only to uncover more beneath, and return to pondering once again. The last component is balancing the research context by considering parts and the whole. The movement from the whole to the parts to the whole forms a hermeneutic circle to seek beyond the surface, deeper, yet always grounded within the larger context. Three major thematic categories of the participants' experience emerged through the combination of questioning and the hermeneutic writing process to understand the ways contemporary peacekeepers heal from trauma.

To ensure rigor, narratives from transcribed interviews were reviewed with four of the participants and reflective journaling by the researcher provided further clarification of the data to understand the experience. The

peacekeepers' descriptions of the situated-ness of their bodies in time, space and relation provided a fresh way into understanding the embodied nature of healing. The metaphor of *Alice in Wonderland* was woven throughout the dissertation to illustrate the three major themes: the centrality of time and body in suffering and healing from trauma; the centrality of brotherhood and grieving loss in the military family; and the military response as betrayal and creating trauma from within. The peacekeepers had much to say about healing from trauma, but they also talked much more broadly about the life issues they were facing. Several peer-reviewed articles, a book and book chapters about the study were published.[27] But, the first author was fascinated by the embodied nature of suffering while healing from the trauma of deployments so vividly described by the peacekeepers. The embodied nature of suffering refers to the phenomenological concept of the life-world meaning how suffering is experienced through the body. The first author felt compelled to engage with the topic further. Therefore, the second author, who is a Drama Professor at Queen's University was contacted to collaborate, together with Queen's University drama students, to translate the findings into a dramatic format: *Fracture*.[28] There was minimum input from the Drama Professor into the play, who opted instead to let the students put it together.

Transcripts from one of the peacekeepers illustrating the three themes were provided by the first author. Five drama students collaborated together to produce the script. They met over the course of four weeks almost every day to discuss the transcripts and then improvised scenes to explore in depth the three themes identified by the first author. Many more improvisation exercises were conducted in an effort to substantively return to the transcript data. The drama students read in the evenings and came prepared with key quotes to exemplify the three themes from the research.

The drama students decided to represent the peacekeeper as a being that breaks apart and struggles to stay together with the pieces reaching for each other. The drama students dressed in black and walked to the front of the room. Projected on a screen behind them were images and quotations from *Alice in Wonderland*. They talked about feeling let down and abandoned by their military family, about an uncontrollable tumble down the rabbit hole to depression, addiction and illness. As a finale to the work, one of the drama students provided an audio recording of her grandfather talking about their family members who suffered the same illness from different conflicts: shell shock in the First World War, battle fatigue in the Second World War and now

PTSD. At the end the students explained their reasons for wanting to create the dramatization, *Fracture*. The following are their reasons:

> Hi my name's Smita, and I was interested in doing this project so that I could get some insight into a different perspective.
>
> I'm Susan, and I wanted to gain more insight into Canadian Peacekeeping, and maybe have the chance to help someone.
>
> Hi I am Dustin; I wanted to learn more about trauma within the military.
>
> Hi, I'm Lauren, and I wanted to take this opportunity to bring what we have learned to a conference.
>
> Hi I'm Kylie and my family has a fairly strong military history so I decided to take this opportunity to talk to my grandparents and see what they and to say. At first they were a little hesitant but by the end they seemed to enjoy telling me about it.

All of the drama students were visibly moved by the dramatization and by the audience response. Many of the drama students had tears in their eyes and expressed the desire to tell the stories of veterans suffering from trauma. The drama students had the demanding responsibility to both tell the veterans' stories, respect the dramatic process and the audience response.

Audience Response

More than many presentations at the conference, the dramatization prompted a discussion among audience members. The audience response was mixed and varied among military personnel, clinicians and academics. While the academics' and clinicians' reaction to the dramatization was generally positive, there were some from the military who cautioned about criticizing or pointing fingers at the CF and their treatment of military personnel with mental health problems. However, clinicians in the audience responded that they hear these stories about feeling let down and abandoned by their military family every day in their practice. One retired high ranking officer stated that he felt responsible for sending these young men and women overseas. The dramatization resonated with him and moved him to help make changes within the military culture towards those who are suffering from trauma.

The back and forth discussion ensued for many minutes among the audience members. That is in itself a success, as it elicited a gut reaction and stirred up the audience. However the dramatization was received, the process of transforming research data into a script and performing this material in front of an audience uncovered realities that elicited a heightened awareness of the multiple voices, loyalties and perspectives that commonly characterize professional and personal interactions.

Discussion

Did the dramatic presentation *Fracture* stay true to the research conducted with contemporary peacekeepers healing from trauma? The influence of post-modern and constructivist critiques acknowledges that "all stories, including accounts of scientific knowledge, are relative and provisional and temporary way points in the ongoing construction of meaning."[29] The original research provided a provisional perspective on issues related to healing from the trauma of peacekeeping deployments, and the dramatization that followed did the same. Whilst recognizing the limits of qualitative research for establishing immutable truths, the drama students did their very best to represent the perspectives of contemporary peacekeepers healing from trauma in a way that they would recognize. This required a strong reliance on the transcripts to guide their writing of the script. Continually, the words that the one peacekeeper had spoken representing all of the contemporary peacekeepers were returned to in the discussions.

Our experience with *Fracture* has led us to conclude that dramatic presentations of research results have tremendous power to trigger audience members' insights and change. In part, we wonder whether the overwhelming audience responses to this dramatization about healing from the trauma of peacekeeping deployments are due to the societal avoidance of issues related to military trauma, suffering and mental illness. Have we helped to fill a gap, or create a place for discussion where there has mostly been silence? Similar responses to research-based theatre have been achieved by others in relation to different content.[30]

One aspect of media in modern times has been to simplify and sensationalize important life issues. In the case of the military trauma, movies and television programs have made us witness to countless heroic struggles by military personnel. Many of these screen heroes overcome formidable odds and beat any

lasting effect of their deployments. The predominance of this type of narrative blocks out other potential narratives, reducing the places in which military personnel and their families can recognize their own complex reactions and even potentially reducing their options for coping. The inclusion of multiple voices and perspectives in productions like *Fracture* allows for more points of recognition for audience members, thus helping to normalize their experiences, and also extending the meanings that can be created and derived from trauma. This approach is in keeping with the insights provided by postmodernism, such that unitary, streamlined versions of truth are understood to always limit and obscure the full range of lived experience.[31] The responses received from the audience revealed that the research foundation for *Fracture* was important for ensuring a sense of relevance. This finding is critical, and argues for the importance of programs within the health care context that consciously employ systematic research to mould dramatic productions.[32] Whilst theatre can certainly be profound without a research base, audiences that are oriented towards empiricism (e.g. health care professionals, academics) appear to be more receptive and respectful with "data" that has been accumulated within traditions of research inquiry.

Conclusion

Research-based theatre served several needs by validating the research and providing the audience, the researcher, the drama professor and the drama students with new and valuable insights into the project. Further research is required to develop methods for evaluating the impact of research-based theatre as a method for both validating data and disseminating research findings. As more researchers disseminate their findings through research-based theatre and other art based mediums, it will important to establish rigorous criteria for evaluations of the ongoing effects of dramatic productions, in order to better understand benefits and limitations. In addition, more researchers need to detail the process including the successes, dilemmas and resolutions when creating research based theatre. In the process, it will hopefully become possible to articulate the core principles that allow research-based theatre to make a positive difference outside of academia, in clinical and community settings.

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CHAPTER 6

Women and War: Archetypes, Catharsis, and Healing

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ABSTRACT

Ancient Greek tragedy has provided mental health practitioners with a unique lens through which to view war-related trauma. Psychiatrists, family practitioners, theatre, music, dance, and art therapists have utilized the Greek plays and poetry in treating veterans, family members, and active duty personnel. A new generation of research brings together social scientists and humanities scholars with the shared objective of increasing dialogue regarding women's role in war locally, nationally, and globally. "The Women & War Project", a three-year study funded by the Social Sciences and Research Council of Canada, is investigating the experience of women in war and mental health treatments for resulting trauma. Through this study, researchers aim to bring awareness to the treatable nature of trauma-related symptoms as a result of exposure to war and to reduce stigmatization of these same trauma-related symptoms. The study includes performances of war-themed plays, a photo exhibition, symposia and conferences in multiple countries, case study research, and pre- and post- paper-based questionnaires to evaluate awareness, and discover specific attitudinal or behavioral change as a result of exposure to the theatrical performances.

Introduction

> "Perhaps I should say a word or two on the duties of women … the greatest glory of a woman is to be least talked about by men, whether they are praising you or criticizing you."
>
> -- Thuc. 2.46.2[1]

Written during a century of extensive battles, the ancient Greek plays often addressed the ravages of war and regularly featured female characters. By choosing to emphasize women as wives, mothers, patriots, and prisoners of war, Homer, Aeschylus, Sophocles, Euripides and Aristophanes placed a female face on the currency and collateral damage of war. The devastation of war infected all stratum of 5th century Before Common Era (BCE) Greek society, for every person experienced war through combat, loss, rape, enslavement, victory, diminished or increased power. The gendered constructions of female characters served as a device for exploring war-related anxieties of loss, sacrifice, loyalty to the dead and to family, sexual desire, revenge, and of the resolution of war through peace. Women were rarely seen in public during this time, let alone served in the military. They were represented onstage as larger-than-life characters grappling with war-related trauma and issues of justice. Twenty-five hundred years later, women remain affected by war, now as officers and active duty personnel, and still as mothers, wives, daughters, and victims of rape. Can these same ancient plays be used today to provoke catharsis through situational recognition? Do they remain a conduit for embodied and aesthetic appreciation of the theatre of war? Researchers, mental health practitioners and artists have, over the past forty years, examined the question of whether the ancient Greek plays remain potent in modernity. Believing that theatrical performance can serve as a critical model for understanding cultural and social action by providing a lens through which to view and process cultural innovations, gender assignments, actions and responses, new research launched in Canada in 2011 looks specifically at correlating female characters carrying war-related plots and themes with females engaged in the military or affected by war in the 21st century.

Up until the mid-1990s, there was little research linking war-induced psychological trauma in modernity to the trauma and grief portrayed in the ancient Greek tragedies.[2] There had been research analyzing the ancient plays' characters, plots, themes, myths, and constructions of gender, acts of barbarism, and the role of grief in discrete areas of scholarship such as gender studies, theatre history, grief studies and the classics. Jonathan Shay, MD, PhD. was one of the first North American medical professionals to see the potential for employing the epic poems of Homer to draw parallels between the warrior-hero Achilles and the experiences of individual veterans whom he was treating at a Boston-area Veterans Affairs' Outpatient Clinic. Shay, who knew that the ancient plays were originally created to aid warriors and veterans in understanding certain effects of battle and to promote catharsis, used Homer's

poetic structure and iconic war heroes to discuss the psychological damage experienced by returning U.S. combatants. In 1994, Shay's *Achilles in Vietnam: Combat Trauma and the Undoing of Character*[3] compared the experiences of soldiers in two wars: the Trojan and the Vietnam Wars, suggesting that PTSD had always existed. Focusing on the Vietnam veteran's experience in combat, *Achilles in Vietnam* juxtaposed case study narratives with Achilles' journey into and throughout war. Shay's claim that a soldier's spiritual injuries did not occur from killing the enemy or from torture inflicted by the enemy but rather from the consequence of experiencing a perceived ethical breach by a commander or fellow military officer, was a significant departure from mainstream psychology that suggested the former was to blame. Shay asserted that soldiers serving in Vietnam experienced a sense of betrayal when they believed they were not properly cared for, or were told ill-fated missions were noble by their commanding officers, just as Achilles had perceived betrayal by Agamemnon.

In a 2009 interview[4], Shay described his advocacy for veterans and his ongoing commitment to minimizing their future psychological trauma.[5] He has argued for structural reform of the ways the United States armed forces are organized, trained, and counseled. Respected by humanists and military leaders alike[6], Shay has spent years addressing the emotional problems faced by military active duty personnel and veterans. He discusses military experience on three levels:[7] brain chemicals such as cortisol and dopamine; military concepts such as cohesion and morale; and the necessity of the human emotions of trust and love.[8] When working with veterans in a clinical setting, Shay describes looking for more than a change in brain chemistry when prescribing Selective Serotonin Reuptake Inhibitors (SSRI). He understands that these drugs will alter the balance of serotonin in the brain and provoke a psychological effect, a calming of the rage experienced by the veteran. "Social recognition has a physiological impact, and an SSRI triggers some of the same mechanisms as that social experience…though I know enough about the nervous system to know that any drug we have is a crude simulacrum."[9] It was his search for new methods of understanding and treating PTSD that led to Shay's integration of the ancient Greek poetry of Homer with his mental health research and practice.

There has not been a great deal gender-specific research into trauma-related sequelae and stigmatization for women in and around war. Pertinent to a study of women and war is Shay's dedication to a unified theory of trauma.

He has argued that trust-destroying trauma in the veteran stems from a single biology and psychology and is genderless. This trauma, which manifests as PTSD, arises equally from "political torture, prostitution, domestic violence or combat. The experience of trauma is unique to each sufferer. Meanwhile, its biology is common to all."[10] Shay has argued for an official recognition and acceptance by the psychological community of the clinical concept of "Moral Injury" and suggests treatment strategies to repair it. This concept of "Moral Injury" is central to understanding the soldiers described in *Achilles in Vietnam and Odysseus in America*.[11] Drawing on Homer seemed obvious to Shay, who argued that elements of his veteran patients' stories recalled Homer's depiction of the moral and social world that soldiers inhabit. The most potent danger for soldiers in the *Iliad* and in real life is the "loss of trust in others."[12] This need for trust, Shay has suggested, comes from human prehistory because "without claws, wings or other natural weapons, human ancestors survived by watching one another's backs. As a result…the need for trust is part of human biology. Trust makes us feel safe; feeling safe is good for our mental and physical health."[13] By drawing the analogy of Achilles and Odysseus and their men with American troops in Vietnam, Shay hoped to define the necessary therapeutic element of restoring trust – a trust often not established because soldiers were rotated in and out of combat as individuals and not as teams. Shay describes troops fighting next to strangers as being at odds with a military doctrine from the industrial age – "replaceable parts, centralized control and a division of labor."[14] Likening the situation to Achilles and Agamemnon, Shay witnessed patients expressing grievances against their leaders who betrayed their sense of "right" and "moral fairness". He suggested that the female experience in war was more complicated than his male patients. Women, Shay has argued, are much more likely to experience betrayal in the form of sexual harassment and rape by their fellow soldiers than their male counterparts.[15] This betrayal of trust in the female soldier by a male directly above her is, according to Shay, what most often triggers her PTSD.[16]

Theatre of War

Using theatre and theatrical concepts to address pressing public health issues such as combat-related psychological injury, end of life care, prison reform, learning disabilities, and the de-stigmatization of the treatment of substance abuse and addiction, is not a new concept,[17] as arts-based therapy has been an accredited therapeutic form for the past three decades, beginning in England with the work of Sue Jennings.[18] New York-based writer, translator,

director, and educator Bryan Doerries[19] and his partner, Phyllis Kaufman, a New York-based producer and lawyer with expertise in social impact-oriented entertainment that combines traditional and digital media,[20] created the "Theater of War". This live performance company has been designed to present readings of ancient Greek plays to service members, veterans, caregivers and families to serve as a catalyst for town hall discussions about the challenges faced by military communities in the late 20th and early 21st centuries. In 2009, the U.S. Pentagon provided $3.7 million in funding for this company to visit fifty military sites in order to stage readings from two plays by Sophocles, *Ajax*[21] and *Philoctetes*[22] for service members. Doerries and Kaufman selected Sophocles' *Ajax* because it "told the story of a fierce warrior who slips into a depression near the end of The Trojan War; (who then) attempts to murder his commanding officers, fails, and takes his own life. It is also the story of how his wife and troops attempt to intervene before it's too late."[23] As Doerries explained in a *New York Time*s interview,[24]

> …the ancient Greeks had a shorthand for the mental anguish of war, for post-traumatic stress disorder and even for outbursts of fratricidal bloodshed like last week's shootings at Fort Hood.[25]

The Greeks, Doerries offers,

> …would invoke the names of mythological military heroes who battled inner demons: Achilles, consumed by the deaths of his men; Philoctetes, hollowed out from betrayals by fellow officers; Ajax, warped with so much rage that he wanted to kill his comrades.[26]

Doerries and Kaufman selected *Philoctetes* because it offered:

> …a psychologically complex tragedy about a famous Greek warrior who is marooned on a deserted island by his army after contracting a horrifying and debilitating illness.[27]

Both *Ajax* and *Philoctetes* have male characters in the leading roles and the majority of attendees of the workshops and presentations of the "Theater of War" have been male soldiers, their partners, and families. By presenting these plays to military audiences, the company has tried to:

> …de-stigmatize psychological injury and open a safe space for dialogue about the challenges faced by service members, veterans, and their caregivers and families.[28]

Doerries and Kaufman argue that plays such as Sophocles' *Ajax* and *Philoctetes* read like:

> …textbook descriptions of wounded warriors, struggling under the weight of psychological and physical injuries to maintain their dignity, identity, and honor.[29]

Like Shay before them, Doerries and Kaufman suggest that the ancient stories have:

> …something important and relevant to say to military audiences

and that military audiences:

> …might have something to teach us about the impulses behind these ancient stories.[30]

The staged readings presented by the "Theater of War" have taken place across the US and Europe, with performances for the U.S. Army, Marine Corps, Air Force, West Point cadets, the Navy, National Guard, Reservists, and homeless veterans. Each of the theatrical readings is followed by a panel discussion, facilitated by military community members. At these performances and post-show discussions, service members speak openly about their experiences in combat and at home. Often, the soldiers asking questions are male.[31] Approximately 25,000 service members, veterans, and family members attended the "Theater of War" performances and discussions throughout 2009 and 2010.[32]

The Women & War Project

While Shay was one of the first medical professionals to actively connect the ancient Greek myths, archetypes and plays with modern war-induced trauma and the treatment of PTSD, and Doerries and Kaufman were among the first theatre professionals to offer readings of Greek plays to audiences of predominantly male veterans at military installations, "The Women & War Project" (WWP) combines artistic creation, social science research, and mental health

practice in a multi-year, multi-discipline, and multi-national study aimed specifically at the female experience of war. In order to increase dialogue regarding women's role in war locally, nationally, and globally; to increase awareness of the treatable nature of trauma-related symptoms as a result of exposure to war; and to reduce stigmatization of these same trauma-related symptoms, researchers from six countries working together to determine whether ancient Greek female characters carrying war-related plots and themes correlate for female active duty personnel, veterans and their extended family members in modernity and if so, discover if these characters and plotlines can assist women in dealing with PTSD. The research team is aware that female characters were once necessary to provide returning soldiers in antiquity the requisite emotional and psychological distance needed to attend the theatre, and to express their subjective experience of the:

> …traumatic events and the desperate suffering caused as a result of military conflict.[33]

It has been documented (Aristotle, Plato, *et al.*) that attendance at these plays helped heal the psychological wounds of war of the male veterans. Female characters became emotional surrogates to carry male experience and pain, thus enabling men to psychologically dissociate from their own war-related trauma.[34] Researchers within "The Women and War Project" have begun to question whether these same plays, full of strong female characters, can provide situational recognition and catharsis for women today.

The WWP Methodology

Participants of WWP attend one or more of three separate fully-produced war-themed plays based on ancient Greek dramas ("The Women & War Trilogy" in Greece, Croatia and Canada). Each performance is followed by a "question and answer" session with the cast and crew of the show. Prior to the show's performance, participants are given a paper-based questionnaire to determine their current views on women and war, their knowledge regarding trauma-related sequels and the extent to which they believe trauma-related symptoms are stigmatized. Following the question and answer session, participants complete a questionnaire to assess intentionality to change any specific behaviours related to themes of war, remembrance, or trauma, changes in knowledge, and changes in attitude. Finally, participants are invited to participate in a three-month follow-up consisting of a third questionnaire

designed to determine their engagement in any of their intended behaviours post-participation, as well as any changes in attitudes and knowledge about the themes discussed.

Alternatively, participants take part in a participatory workshop using the themes of women and war in Greek theatre where they engage in a scene performed by several actors with the opportunity to play the role of the Greek chorus. Prior to watching the scene, participants will be given a paper-based questionnaire to determine their current views on women and war, their knowledge regarding trauma-related sequels and the extent to which they believe trauma-related symptoms are stigmatized. Following the scene, participants will engage in a guided discussion about the themes elucidated in the scene, and will then participate in a "question and answer" period designed to shed light on misconceptions regarding the nature and treatability of mental-health related outcomes of being affected by war. Participants will complete a post-participation questionnaire to assess intentionality to change any specific behaviours, changes in knowledge and changes in attitude. Finally, participants will be invited to participate in a three-month follow-up consisting of a third questionnaire designed to determine their engagement in any of their intended behaviours post-participation, as well as any changes in attitudes and knowledge about the themes discussed. Beginning in September 2012, workshops will take place regularly in secondary schools close to military bases in Ontario, and in community centres on the military bases.

Data collection for "The Women and War Project" occurs using several platforms. Female subjects participating in the workshops are measured by paper-based questionnaires, demography, written assessments, and performance measuring tools for stress and behavioural change. They are also assessed for length and type of military/war-related engagement.

Theoretical approaches combine the work of pivotal clinicians and theorists in the field including Candice Monson, Sue Jennings, Robert Landy, Dorothy Langley, Adam Blatner, David Read Johnson, and Helen Payne[35] with the creation of new applied therapeutic techniques through collaboration across artistic, historical, and social science sectors. Dr. Monson's theories on Cognitive Processing Therapy, intimate relationships and PTSD, and the treatment of traumatic stress reactions[36], as well as Dr. Shay's theories of "moral character within war" and "situational recognition" are central therapeutic elements of workshops. These concepts will continue to frame workshops,

public forums, symposia, and the performances which will, over the three years of the study, tour to five countries (Canada, Greece, Croatia, the US and Britain). Utilizing key psychotherapy principles such as establishing trust through safe and contained boundaried space, the workshops in schools, community centres and at bases are designed to include a Preparation (warm-up and relaxation); an Incubation (main activity of role play, mask work, narrative building); an Illumination (reflective exercises); and a Verification (the conscious and subconscious processing of information and revelation).[37] Certain core processes such as "dramatic projection" can be combined with techniques that enable participants to act out their personal narratives in order to witness them externally.[38] This "Narrative of Change" draws on the work of narrative therapists J. Freedman and G. Combs[39] as well as Western theatre techniques of "sense memory" and the "inner monologue". Additionally, participants read/perform extracts of ancient Greek war-themed plays that possess female archetypes within war as well as write their own war narratives. Methodology and theoretical frameworks developed by Lindsay Chipman, based on psychotherapists Cosden and Reynolds, two psychotherapists who have used photographs as tools in the therapeutic relationship, are options to be employed.[40] All core processes are aimed at examining and articulating healing and transformation while evaluating effectiveness of treatment methodologies and the de-stigmatization of PTSD. The WWP aims to promote innovative and effective mental health treatment for females suffering war-induced PTSD, and incite much-needed public discourse on the important topic of female engagement with war.

Involvement of students and new scholars alongside leading highly qualified personnel is critical to this research. An international and interdisciplinary team of a PTSD clinician and psychologist, a theatre director, three playwrights, twenty-three undergraduate actors/dancers, four undergraduate, three masters and four doctoral research assistants, four Ryerson University professors (theatre, psychology, and image arts), two University of Athens professors (literature and theatre), one University of Southern California professor (School of Theater), five professional Greek artists (one director, one actor, a dancer, a mask maker, and technician), and two Croatian scholars are building upon their expertise to design and test new and innovative approaches to public discourse surrounding the incidence and treatment of PTSD. As mental health professionals, creative artists and scholars, the team is most interested in "responding to the complexity, diversity and creativity of the new knowledge paradigm of the 21st century"[41] by integrating the

complexities of gender as related to historical and contemporary wars. Working across sectors to co-create knowledge and a deeper understanding of gender, war, and new and improved treatment of PTSD and war-related stress is an exciting premise.

"The Women and War Project" will facilitate meetings & workshops for all three years of the study (ending in Spring 2014) through a series of public forums intended for female veterans, active duty personnel, their children, and extended family members to discuss war-related trauma and isolation. Planned are half-day educational workshops at military installations, schools, community centres and hospitals. With a stated objective of determining whether engagement with the ancient Greek war-themed plays can effectively assist women in resolving moral injury and attain a higher level of self-knowledge and self-esteem, "The Women and War Project" will actively analyze connections between the female archetype in battle-themed classical dramaturgy and women's role in contemporary global warfare, interrogating multi-national and historical issues of self and identity in the arena of war. The team has commissioned new adaptations of the ancient Greek plays to provoke ethical and moral questions surrounding women and war. This performances aim to enhance knowledge and inform a country's thinking about critical social and cultural issues such as the notion of sacrifice, and the roles of women in war as both active and passive participants. The following research questions are being posed throughout all aspects of the study:

- Can the recovery process for war-related PTSD be assisted by the transformative power of theatre?

- Does interaction with classical Greek drama serve as an effective medium to interrogate gender, war, and conflict-related trauma?

- Will the consequences of trauma, loss, incapacity, shock and grief yield to the healing power of poetry, story, and dramatic text – all intended to enlarge an understanding of the human condition?

Two symposia on campuses in Greece and Croatia, and a four-day conference on the campus of Ryerson University, all entitled, "The Ancient Greeks, Women & War: Theatre, Mental Health, Ethics & Gender in Contemporary Society" are planned for the summer of 2012 (Hydra, Greece and Dubrovnik, Croatia) and the summer of 2013 (Toronto, Ontario). These symposia and

the conference will examine the fusion of historical, aesthetic, theoretical, psychological and imaginative investigations into the enactment of identity and the understanding of female roles and archetypes within war. Papers on such topics as "Acting and performing identity: How to define 'Practice-as-Research in the 21st Century"; "Can the humanities help healthcare professionals better understand the long-term effects of trauma on their patients?"; "Might trauma and experiences of war be positively affected by the power of telling and recording stories as a part of post-traumatic stress treatment?"; 'The future of inter-disciplinarity: creating identity: performative contributions from writers exploring "Practice-as-Research;" and "Shaping future research on women, war, and identity" will be offered by international and Canadian mental health professionals, leading researchers, social scientists, and theatre artists.

WWP responds directly to the complexity, diversity and creativity of the new knowledge paradigm of the 21st century by bringing together art and science in bold and transformational research partnerships with the academic, public and private sectors. The research team believes that by bringing the humanities together with the social sciences to investigate women, war, gender, and mental health, it offers new and meaningful examples of the power of inter-disciplinary work. Originating the research in Canada, the research team and creative personnel will travel to Greece and Croatia for performances in five locations within Greece including theatres in Athens, Delphi, Hydra, and Spetses. From Greece the team will travel to Croatia for several performances in the Dubrovnik Summer Festival. Then the research team will return to Canada for additional performances, outreach and engagement with female veterans, active duty personnel and their families. In 2014, the project will tour to the US and the UK. Leadership of the research is shared by women who are leaders in their particular areas of expertise. I[42] have more than twenty-five years of professional theatre, training, and educational experience. Dr. Candice Monson[43] has built an impressive career dedicated to researching and treating veterans, active duty personnel, women, and families affected by PTSD in the US and in Canada. Velina Hasu Houston[44] is an award-winning playwright and scholar whose work often addresses the ravages of war. Judith Thompson[45] is the premiere female playwright in Canada, often writing about pressing social, political, sexual, and class issues facing women and girls. Timberlake Wertenbaker[46] is a leading playwright in Britain, with a history translating and adapting the ancient Greek plays into modern versions. The Hydrama Theatre & Arts Centre in Greece[47] has been attracting some of Europe's most renowned artists and scholars over the past fifteen

years. The University of Athens is one of the oldest and most distinguished universities in the world today. Dr. Liana Sakelliou[48], Professor of American Literature and Creative Writing at the University of Athens, is a prominent scholar and artist whose work has been published in the US, Greece, and Europe. As an emerging model of collaborative leadership, this team is working together in person and digitally.

Discussion

Investigating new and ongoing scholarly, creative research by mental health professionals and humanities-based scholars engaging with ancient Greek plays and poetry to treat veterans has yielded interesting results. In the 1990s, one North American psychiatrist (Dr. Shay) was articulating a connection between the veterans of the fifth century BCE and the deployed and returning veterans of the 20th and 21st centuries. He argued that the poetry of Homer provided a therapeutic vocabulary and offered medical value in treating soldiers suffering war-induced psychic trauma. By 2011, and inspired by Shay's seminal works *Achilles in Vietnam* and *Odysseus in America*, researchers, therapists, counsellors, clergy and former veterans were drawing on the ancient Greek plays and poems, and personal narratives to treat war-induced trauma. One such researcher, Dr. Stéphanie A.H. Bélanger,[49] has examined catharsis, and the impact of the discourses used in ancient Greek theatre on the modern soldier's communication of war experiences. In 2011, Bélanger embarked upon a new research study in which she interviewed one hundred soldiers, both female and male, who served in either Afghanistan or Iraq for first-person accounts of their experience in war.[50] She hopes to add to the field of knowledge about a soldier's actual experience in and of war by documenting a verbatim account of what each one has encountered.

Another researcher, Roberta Stewart[51], has examined how combat veterans in a book group obtain a vocabulary for articulating and an insight into their war experience through the active act of reading aloud Homer's *Iliad* and *Odyssey* versus passively listening to literature read aloud. Stewart suggests that Homer's representations of soldiers, veterans, their families and friends, can provide soldiers, veterans and their loved ones with an understanding of the complex effects of war within society. By reading the poems aloud, she examines if participants are able to make comparisons with their

own experiences. "The book group also offers an understanding of the power of narrative to shape individuals and communities, and it allows us to identify a shared human experience."[52]

Family doctor and palliative care specialist, Dr. Jonna Goulding, has studied how wounded veterans, who have healed from psychological and physical trauma, are now in a position to help others heal. She offers workshops in deep listening, the receptive "other side" of storytelling, through the medium of Greek "legends of wounded healers, monsters and queens, mythical beasts and ordinary women and men who, through illness, madness, battle wounds, or accidental wounds are forced to descend to a literal or metaphorical underworld from which they returned transformed, bearing healing gifts for their people."[53]

Psychiatric nurse Janet M. Cromer's research looks at the role of reflective engagement through the creation of partnerships for veterans and soldiers with traumatic brain injuries. Her work explores the role of narrative, poetry, blogs, and journals writing in the treatment of brain injured veterans.[54] Clinician Dr. Elizabeth Balsam Hart, a family physician with board certification in Geriatrics and Hospice and Palliative Medicine, works with people in hospices and nursing homes who have experienced severe trauma in their lifetime. Specifically, Hart employs poetry, narrative, short video clips and ancient Greek texts with patients near death to explore how trauma histories reemerge at the end of the life cycle, particularly post-traumatic stress issues.[55] Many other women researchers such as Laura Simms ("The Stories We Tell: Medicine for the Heart")[56], Kerryellen Vroman ("Towards Knowing: Can We Teach and Develop the Capacity for Empathy?")[57], Gala True ("Veterans' Stories: Trauma and the Experience of War")[58], Roberta Stewart ("From Ancient Greece to Baghdad and Beyond: Reading Homer with Combat Veterans")[59], Susan Brison (*Aftermath: Violence and the Remaking of a Self*)[60], and the research team of Suzanne Brown,[61] Celeste Campbell[62] and Debjani Mukherjee[63] are women whose research and practice originate from the humanities, ethics and sciences and who are exploring everything from veteran-violence to first-person spousal narratives in the treatment of traumatic brain injuries in soldiers and veterans. Finally, the creative research of Helen Benedict (*The Lonely Soldier: The Private War of Women Serving in Iraq*)[64] takes her first-person interviews with female veterans of war and incorporates them into a dramatic play format in order to illuminate the experience of war for a civilian audience. Through her playwriting, story-telling, and

workshops, she provides information to therapists and doctors working with veterans. Benedict examines the issues of childhood trauma, military and sexual assault, the female experience of combat, military culture and women, health hazards in the Iraq and Afghanistan wars, the needs of women once they come home, and how to help and not harm female veterans who suffer from multiple traumas and the aftermath of war. The aforementioned women and research are examples of a much broader landscape of research occurring around the issues of gender, war, and mental health.

Conclusion

With Doerries and Kaufman's creation and tour of "The Theater of War's" staged readings and paneled discussions at military installations throughout the US, there has been great exposure to two ancient Greek plays, *Ajax* and *Philoctetes* within the U.S. military. The concept of theatrically representing war-induced trauma through the lens of ancient Greek tragedy as a medium for discussing modern war experience and trauma was started by Shay and then heavily supported by the Pentagon's financing of "The Theater of War". However, what "The Theater of War" has lacked throughout its existence is a formal assessment of the impact of its readings and discussions on the military bases for soldiers and veterans. The newest generation of research, "The Women and War Project" hopes to provide important and necessary diagnostic assessment through its multi-national and multi-disciplinary study on the effects of war on gender. As stated at the beginning of this chapter, the ancient Greek tragedies of the fifth century BCE and the epic poems of Homer have served as a contemporary tool for investigating new insights into trauma's effects on veterans. The challenge of examining moral and ethical issues pertaining to war and gender continues to confront social scientists, theatre scholars, practitioners, classicists and in some instances policy-makers in communities locally and globally. With the Social Sciences and Humanities Research Council (SSHRC)-funded WWP, gender-related, war-induced trauma, public policy, and social engagement will receive a global platform.

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1 Thucydides, *History of the Peloponnesian War*, Translation by R. Warner, (New York and London: Penguin, revised in 1972).

2 The connection between trauma, the ancient Greek tragedies, and their relevance to gender and war was investigated in more traditional forms of research by such theatre scholars and historians as S. de Beauvoir (The Second Sex), F. Zeitlin (*Playing the Other*), S. Pomeroy (*Goddesses, Whores, Wives, and Slaves: Women in Antiquity*) and E. Hall (*Inventing the Barbarian*). Shay was the first physician to make the connection between modern veterans and war-induced trauma such as PTSD and the archetypal portrayal of war-induced trauma in the poetry of Homer.

3 J. Shay, M.D., Ph.D., *Achilles in Vietnam: Combat Trauma and the Undoing of Character* (New York: Scribner, 1994, re-edited 2003).

4 P. Shannon, "Discussion with Shay," (2009). In this interview, Shay suggested that Achilles was revolted by his commander's betrayal of the warrior code, and therefore dropped out of life, leading to the death of his best friend. Odysseus' lack of trust in anyone makes him deceive his men, leading to the deaths of every member of his crew.

5 In "Book 1" of Homer's *Iliad*, a major quarrel ensues when Agamemnon, Achilles' commander, decides to take Achilles' prize of honour, the woman Briseis – a prize that was voted to Achilles by his troops. Achilles felt so betrayed by Agamemnon that he retreated to his tent and refused to engage in combat. See: A. Lesky, *A History of Greek Literature*; trans. De Heer & Willis (London: Methuen & Co., 1966). Shay picks up on this betrayal of Achilles by Agamemnon and condenses the archetypal relationship to the destruction of a soldier's moral code of honour by his commanding officer. Shay also suggests that this trauma was heightened by arguing that Achilles and Agamemnon had "history" extending beyond the battlefield which intensified Achilles sense of betrayal. For this assertion, Shay cites G. Zanker, *The Heart of Achilles: Characterization and Personal Ethics in the Iliad* (Ann Arbor: University of Michigan Press, 1994), 75-79.

6 D. Berreby, "Scientist at Work, Exploring Combat and the Psyche, Beginning with Homer" in *The New York Times* (Science Section; March 23, 2003).

7 P. Shannon, "Discussion with Shay," (2009).

8 Ibid.

9 Ibid.

10 Ibid.

11 See Shay, *Achilles in Vietnam* (2003), 3-35; and Shay, *Odysseus in America* (2002), 149-200.

12 In Shannon's, "Discussion with Shay," (2009), Shay suggested that Achilles was revolted by his commander's betrayal of the warrior code, and therefore dropped out of life, leading to the death of his best friend. Odysseus' lack of trust in anyone makes him deceive his men, leading to the deaths of every member of his crew.

13 Berreby, "Scientist at Work," 2003.

14 Berreby references B. Martin, *Uprooting War* (London: Freedom Press, 1984). Chapter 8, "Bureaucracy."

15 Shannon, "Discussion with Shay," (2009). Shay spoke about the under-reporting of female soldiers on their abuse; he referenced a the lack of support systems for female veterans seeking psychological support for betrayal and physical abuse and suggested that women, much more than men, choose not to disclose this abuse for fear of reprisals.

16 Shannon, "Discussion with Shay," (2009).

17 Examples of theatre addressing public health issues abound. See P. Jones, ed., *Drama as Therapy: Clinical Work and Research into Practice Volume*, (London and New York: Routledge, 2010). For drama therapy work with young people, see: M. Kellett, *Rethinking Children and Research: Attitudes in Contemporary Society*, (London: Continuum, 2010); H. Montgomery and M. Kellett, M. (eds.), *Children and Young People's Worlds: Developing Frameworks for Integrated Practice*, (Bristol: Policy Press, 2009); Kellett, "Small Shoes, Big Steps! Empowering Children as Researchers" in *American Journal of Community Psychology*, Vol. 46, No. l/2 (2010); Kellett and A. E. Sahin, (Guest editors), "Children as Researchers: Pedagogy and Praxis," *Eurasian Journal of Educational Research* Special Issue for the 20th Anniversary of the Convention on the Rights of the Child, May 2009, pp. vii-xii; see also: P. Jones, "Dramatherapy: Five Core Processes," *Dramatherapy: The Journal of the British Association of Dramatherapists* Vol. 14, No.1, (1991): 5-10; P. Jones, Drama as Therapy: Theatre as Living, (London, Routledge, 1996); P. Jones, *The Arts Therapies: A Revolution in Healthcare*, (London: Routledge, 2005); and P. Jones, *Drama as Therapy. Theory, Practice and Research*, (London: Routledge, 2007).

18 S. Jennings is a leading theorist and practitioner of drama therapy in England. She is an author, Creative Group Worker Supervisor, Play Therapist and Dramatherapist, LRAM (drama).

19 B. Doerries is an American theatre director who a self-described "evangelist" for classical literature and its relevance to the modern world.

20 P. Kaufman is the producer of the Theater of War, a company that presents readings of ancient Greek plays to service members, veterans, caregivers and families as a catalyst for town hall discussions about the challenges faced by military communities today.

21 *Ajax*, originally written by Sophocles (circa 450 - 430 BCE), has been adapted by Doerries for Theater of War.

22 *Philoctetes*, originally written by Sophocles (first performed at the Festival of Dionysus in 409 BCE), has been adapted by Bryan Doerries for Theater of War.

23 P. Healy, "The Anguish of War for Today's Soldiers, Explored by Sophocles" in *The New York Times* Theater Section, online edition (November 11, 2009).

24 Healy, "The Anguish of War" (2009 - online).

25 In November 2009, N. M. Hasan, a U.S. Army major and staff psychiatrist, shot and killed thirteen people and wounded another twenty-nine. The shooting took place at Fort Hood, the largest U.S. military installation in the world.

26 Healy, "The Anguish of War" (2009 - online).

27 See Berreby, "Scientist at Work," (2003); and A. Levin, "Homer's War Experiences Resonate with Today's Troops," on *PBS Newshour* (February 3, 2010).

28 Doerries speaks about this on <http://www.outsidethewirellc.com/tow/watch.html> and on PBS Newshour (February 3, 2010).

29 See the Podcast of the Maine Humanities Council for the conference, "After Shock: Humanities Perspective on Truama" (November 2010).

30 See EN xxiv.

31 The attendees in the audiences, and those veterans asking questions, have been documented through photographs which I have viewed, in articles about the performances, and in interviews with Doerries.

32 Kaufman and Doerries keep accurate attendance records to comply with reporting requirements for the Pentagon grant of $3.7 million which the company received in 2009.

33 E. Hall, *Greek Tragedy: Suffering Under the Sun* (Oxford: Oxford University Press, 2010), 104-155.

34 Ibid., 104-155

35 See Bibliographic Notes for seminal work by arts therapists referenced in this chapter.

36 C.M. Monson, S. J. Fredman, and K.C. Adair, "Cognitive-Behavioral Conjoint Therapy for PTSD: Application to Operation Enduring and Iraqi Freedom veterans," *Journal of Clinical Psychology* Vol. 64 (2008): 958-971. See also C.M. Monson, P.P. Schnurr, P.A. Resick, M.J. Friedman, Y. Young-Xu, and S.P. Stevens, "Cognitive processing therapy for veterans with military-related post traumatic stress disorder," *Journal of Consulting and Clinical Psychology* Vol. 74, (2006): 898-907.

37 N. Gardner-Hynd, *Drama as Therapy* Vol. 2, Ch. 9, (Routledge: New York, London, 2010), 172-188.

38 For more background on "dramatic projection", see the following works by P. Jones, *Drama as Therapy: Theatre as Living*, (London: Routledge, 1996); *Drama as Therapy. Theory, Practice and Research* (London, Routledge, 2007); "Dramatherapy: Five Core Processes", *Dramatherapy: The Journal of the British Association of Dramatherapists* Vol. 14, No. 1 (1991): 5-10; *The Arts Therapies: A Revolution in Healthcare*, (London: Routledge, 2005).

39 J. Freedman and G. Combs, *Narrative Therapy With Couples…And a Whole Lot More! A Collection of Papers, Essays and Exercises*, (Adelaide: Dulwich Centre, 2002).

40 C. Cosden and D. Reynolds, "Photography as therapy", *Arts in Psychotherapy* Vol. 9, No. 1 (1982): 19-23.

41 <http://www.sshrc-crsh.gc.ca/funding-financement/programs-programmes/priority_areas-domaines_prioritaires/innovation_research-recherche_innovation-eng.aspx>. Last accessed on 24 October 2010.

42 P. Shannon has directed over 100 productions at leading theatres throughout the US, England and within Greece. She has served as Artistic Director of two large professional theatres, and as Associate Producing Director at L.A. Theatre works where she helped launch *The Play's The Thing* radio program. This partnership with National Public Radio affiliate KCRW produced plays for the radio with distinguished American actors recorded

before a live audience. She is the Chair of the Ryerson Theatre School, Ryerson University, in Toronto, Ontario.

43 Dr. C. Monson is Professor of Psychology and Director of Clinical Training at Ryerson University. She is also an affiliate of the Women's Health Sciences Division of the VA National Center for PTSD. Her primary research focus is on the development and testing of treatments for PTSD. She recently completed a grant-funded trial of Cognitive Processing Therapy for military-related PTSD, and is currently conducting a funded project to further develop Cognitive-Behavioural Conjoint Therapy for PTSD. In addition to her treatment outcome efforts, Dr. Monson investigates gender differences in the perpetration of interpersonal violence and its consequences.

Dr. V. H. Houston is an internationally acclaimed playwright, poet and essayist, and screenwriter. She has published two anthologies of Asian-American drama, one of them being the first anthology of plays by Asian-American women. She is the recipient of twenty playwriting commissions from distinguished institutions such as Manhattan Theatre Club, Los Angeles Opera, Asia Society, Lila Wallace-Readers Digest Foundation, Mark Taper Forum (two), State of Hawaii Foundation on Culture and the Arts, Jewish Women's Theatre Project, Sacramento Theatre Company (three), Cornerstone Theatre Company, Mixed Blood Theatre Company, Honolulu Theatre for Youth, and Silk Road Theatre Project in association with the Goodman Theatre.

44 Ibid.

45 J. Thompson is one of Canada's most highly regarded playwrights. Thompson is particularly interested in the theories of Freud, and is more absorbed in the psychology of her characters than in their actions. In 2007, Thompson was awarded the Walter Carsen Prize for Excellence in the Performing Arts. The $50,000 prize, administered and presented by the Canada Council for the Arts, recognizes the highest level of artistic excellence and distinguished career achievement by Canadian artists who have spent the major part of their career in Canada in theatre, dance or music. In 2008, Thompson was awarded the Susan Smith Blackburn Prize for *Palace of the End*. This American award celebrates outstanding plays in English by women.

46 T. Wertenbaker is one of England's foremost playwrights of the past thirty years. Wertenbaker has adapted and translated work by Marivaux, Anouilh, Maeterlinck, Pirandello, Sophocles, Euripides and Preissova. She has written the screenplays for film adaptations of Edith Wharton's *The Children* and Henry James' *The Wings of the Dove*. She is the author of a television play, *Do Not Disturb*, and her work for radio includes *Dianeira*, broadcast by BBC Radio 3 in November 1999, an adaptation and translation of Euripides' play *Hecuba* broadcast by BBC Radio 3 in 2001. She has adapted five of the ancient Greek plays, with productions at the American Conservatory Theatre and the National Theatre in London, England.

Hydrama Theatre & Arts Centre was founded by Corinna Seeds in 1999 to promote the study and practice of ancient Greek theatre internationally and to encourage drama and dance activities locally through the provision of performances, workshops, seminars and courses. Hydrama liaises with leading drama schools, theatre companies, universities and schools internationally as well as with the island community.

47 Ibid.

48 L. Sakelliou, PhD is a professor and former Chair of the School of Philosophy, Faculty of English Studies, Department of Literature and Culture, at the National and Kapodistrian University of Athens.

49 S.A.H. Bélanger, PhD is a Professor in the Department of French Studies at RMCC and is the Associate Director of CIMVHR.

50 This information comes from meetings between Bélanger and P. Shannon. See also: S.A.H. Bélanger and Karen D. Davis, *Transforming Traditions: Women, Leadership and the Canadian Navy*, 1942-2010 (Kingston, ON: Canadian Defence Academy Press, 2010).

51 R. Stewart teaches Roman history, Latin, and Greek at Dartmouth College. She has published articles on Roman history, religion, and numismatics, and her first book (*Public Office in Early Rome: Ritual Definitions and Political Practice*) treated the early development of Roman government. Her current book project explores the system of chattel slavery in Republican Rome and the experience of slaves who survived within a system of domination. She has offered workshops in "From Ancient Greece to Baghdad and Beyond: Reading Homer with Combat Veterans" at mental health conferences. She is an Associate Professor of Classics, Dartmouth College.

52 In November 2010, the Maine Humanities Council presented the Conference: *After Shock: Humanities Perspectives on Trauma*. Roberta Stewart, Associate Professor of Classics at Dartmouth College, along with two colleagues, presented the workshop: "From Ancient Greece to Baghdad and Beyond: Reading Homer with Combat Veterans."

53 J. Goulding, MD, presented the workshop "Wounded Healer Stories Help Us Heal" at the Conference: *After Shock: Humanities Perspectives on Trauma* presented by the Maine Humanities Council in November 2010.

54 J. M. Cromer, RN, MA, ATR, LMHR, is a Psychiatric RN, licensed psychotherapist, and Registered Art Therapist with an MA in Expressive Therapies from Lesley University. Cromer's book, Professor *Cromer Learns to Read: A Couple's New Life After Brain Injury* (Bloomington, IN: AuthorHouse, 2010) is the recipient of a Solimene Award for Excellence in Medical Communication and a Neal Duane Award for Distinction from the American Medical Writer's Association—Northeast Chapter.

55 E. B. Hart, MD participated in the early planning of the Maine Humanities Council's *Literature & Medicine* program in March 2010 and has served as a facilitator for groups in Maine for over ten years, including the Veteran Administration Medical Center in Togus, Maine. In a collaborative partnership with the Maine Hospice Council and the Maine Office of Elder Services she leads an advance care planning initiative "Cultivating Meaningful Conversations to Guide Care."

56 L. Simms is a known and respected storyteller based in New York. She offers storytelling, seminars, and training in the fields of healing, education, the environment and peacemaking.

57 K. Vroman is a faculty member in the College of Health and Human Services at the University of New Hampshire. Her research focuses on the psychosocial factors, namely the dispositional characteristics and attitudes of healthcare practitioners and patients that influence health outcomes and adaptation to disability.

58 J. "Gala" True is a medical anthropologist and folklorist whose research focuses on the role of narrative and ethnography to reduce barriers to care and improve post-deployment health outcomes for combat veterans. She recently completed an intervention study investigating the use of Life Story interviews to decrease social anxiety and PTSD symptoms for veterans of the wars in Iraq and Afghanistan. Her current work involves using visual images and first-person narratives to sensitize Veterans Affairs (VA) clinicians to deployment and post-deployment experiences and perspectives of returning combat veterans, and to promote patient-centred care at the VA.

59 R. Stewart, PhD, is Associate Professor of Classics, Dartmouth College and teaches Roman history, Latin, and Greek at Dartmouth College. She has published articles on Roman history, religion, and numismatics, and her first book, *Public Office in Early Rome: Ritual Definitions and Political Practice*, (Michigan Press, 1999), treated the early development of Roman government. She has led workshops on the topic of "From Ancient Greece to Baghdad and Beyond: Reading Homer with Combat Veterans."

60 S. Brison, PhD, is Associate Professor of Philosophy at Dartmouth College and the author of *Aftermath: Violence and the Remaking of a Self*, (Princeton: Princeton University Press, 2002), a philosophical examination of trauma incorporating a first person narrative of her experience surviving a near-fatal rape and attempted murder. Her workshop, "Violence and the Remaking of Self: A Philosophical Perspective on Trauma and Narrative" has been presented to healthcare professionals treating veterans and civilians suffering trauma.

61 S. Brown, PhD, is Assistant Professor at Dartmouth College. She has facilitated discussions in hospitals throughout the U.S. concerning violence and trauma. In 2010-2011, she worked with five hospitals, including leading a fourth year of discussions at the VA hospital in White River Junction, Vermont. Brown is the editor of *Echoes of War*, an anthology of readings published by the Maine Humanities Council for the *Literature & Medicine* program.

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CHAPTER 7

A Systematic Review of the Evidence on Prolonged Exposure Therapy for Military Members and Veterans with Post Traumatic Stress Disorder

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ABSTRACT

Prolonged Exposure therapy has, to date, produced one of strongest bases of empirical evidence to support its efficacy in treating individuals with PTSD out of any psychotherapeutic treatment modality. Its success has been demonstrated in an array of populations, including adults of both sexes who have experienced a traumatic event such as childhood abuse, sexual trauma, motor vehicle accident-related trauma, and combat-related trauma. The objective of this chapter is to a) provide a brief overview of the theory behind PE therapy, its implementation, and the processes underlying its use; and b) review the published literature of PE therapy, identifying its strengths and limitations in treating individuals with PTSD, with an emphasis on the use of PE therapy for combat-related PTSD. A systematic literature review was conducted to identify published, peer-reviewed journal articles detailing the results of studies of PE therapy in a wide variety of populations. Databases searched included PsycInfo and Proquest Psychology Journals; citation searching was also conducted. A study was selected for inclusion in the final stage of the review if it: 1) pertained to military members or veterans; 2) used manualized PE therapy as the intervention of interest; 3) was of sufficient power to warrant generalizability to larger populations; and 4) provided measurable outcome data. The literature search returned well over two thousand studies; however, only five met all inclusion criteria. Despite some mixed findings, a strong base of evidence to support the use of PE therapy for combat-related PTSD emerged

from the review. Previous research indicates that PE therapy is highly effective in treating individuals with PTSD, including complex combat-related PTSD, and should be considered by clinicians seeking to treat active military personnel and military veterans who meet criteria for PTSD.

Introduction

Post Traumatic Stress Disorder

PTSD is an anxiety disorder that may result after exposure to a traumatic event, such as a motor vehicle accident, an assault, or the unexpected death of a close friend of family member; and is characterized by a constellation of symptoms including re-experiencing the event through intrusive thoughts or nightmares, avoidance of reminders of the event and emotional numbing, and hyper arousal.[1] It is estimated that approximately 7-12% of members of civilian populations, including the Canadian general population, will develop PTSD at some point in their lifetime.[2] Individuals in certain occupations, such as law enforcement officers,[3] and at-risk populations, such as individuals with a family history of psychiatric illness,[4] are at greater risk of developing PTSD; and it is well-documented that military personnel and veterans are at increased risk of developing PTSD as a result of military-specific traumatic events experienced during their service.[5]

It is important to note that the elevated risk of PTSD among military personnel and veterans is not limited to those who have engaged in combat in theatres of conflict. Previous research shows that military personnel deployed on peacekeeping missions are often exposed to morally challenging situations, such as witnessing ethnic cleansing and identifying mass graves, and may also be at increased risk for PTSD.[6] This is particularly relevant information when investigating the prevalence of PTSD among Canadian soldiers because, until the CF involvement in the recent conflict in Afghanistan, the majority of CF operations following the Korean War consisted of peacekeeping and the provision of humanitarian aid.[7] However, PTSD continues to be a significant concern for current and former members of the CF. Recent studies estimate that approximately 10-17% of military personnel will develop PTSD at some point in their lifetime.[8] Similar rates have been reported among treatment-seeking CF veterans who have been pensioned with a medical condition.[9]

Prolonged exposure therapy

A number of diverse psychotherapeutic interventions for the treatment of PTSD exist; however, few have accumulated the strong evidence base for effectiveness that trauma-focused therapies have. Trauma-focused psychotherapies, in general, aim to combine anxiety management and stress reduction techniques with psychoeducation to alleviate symptoms of PTSD.[10] Of these trauma-focused therapies, Exposure Therapy (ET) and its variations have been identified as especially effective treatments for PTSD.[11]

ET, at its core, involves repeatedly guiding an individual through a traumatic experience until, through habituation and the challenging of the trauma-based fear structure, exposure to previously distressing stimuli no longer elicits an anxious response.[12] The core components of ET include imaginal exposure (i.e., the repeated retelling of the traumatic event), and *in vivo* exposure (i.e., repeated encounters with objects and situations that evoke anxious thoughts related to the traumatic event rather than memories or thoughts as in imaginal exposure).[13]

Variations of exposure therapy may incorporate additional components to the standardized ET treatment protocol. The treatment modality of interest in the current review, PE therapy, builds upon the aforementioned components by combining elements of both imaginal and *in vivo* exposure with psychoeducation and breathing retraining into a clearly defined, structured protocol.[14] The overall goal of PE therapy is to confront and emotionally process the trauma, which is based on the Emotional Procession Theory of PTSD.[15] The overarching rationale for PE therapy is based on the belief that avoidance and dysfunctional cognitions maintain PTSD; thus, PE therapy directly targets both situational and cognitive avoidance, and challenges dysfunctional cognitions of self and the world.[16] PE therapy is packaged to be delivered in eight to twelve standardized ninety minute sessions,[17] with the objectives for each session clearly laid out. Each session is audiotaped and the patient is required to listen to the entire therapy session for homework. Weekly homework is a key component of the treatment and involves listening to the audiotaped session, as noted, reviewing relevant handouts or readings, *in vivo* exposure exercises, listening to the imaginal exposure recorded in session ideally on a daily basis, and practicing breathing retraining. Trauma specific information gathering, discussion of the treatment rationale, and breathing retraining occur in the first session, while the second session includes psychoeducation about

common reactions to trauma, the provision of the rationale for *in vivo* exposure, and the construction of an *in vivo* exposure hierarchy for the purposes of *in vivo* exposure homework. In session three, participants are asked to repeatedly recount the memory of his or her traumatic event out loud, in the present tense, and with his or her eyes closed. The imaginal exposure is followed by post-exposure processing where the patient's experience in conducting imaginal exposure is discussed; and the cognitions and emotions of his or her fear structure are identified and challenged, where appropriate. As indicated, the session and imaginal exposure are audiotaped, and participants are instructed to listen to it daily until their next scheduled session. The remaining sessions involve reviewing homework, engaging in imaginal exposure, processing the exposure experience, and assigning new *in vivo* homework assignments.[18]

It is believed that several unique mechanisms responsible for improvements in PTSD symptomatology are gained as a result of PE therapy. The use of imaginal exposure serves to reduce anxiety associated with the traumatic memory by providing an opportunity to process and organize the traumatic event and fostering the realization that engaging with the traumatic memory via discussion or recollection does not result in the participant's loss of control. Repeated confrontation of the memory dissuades the individual from finding safety in avoiding the memory altogether and thus facilitates increased perceived self-efficacy and competence. Imaginal exposure in a safe and supportive environment also allows the individual to differentiate between thinking and talking about the traumatic event and re-encountering the trauma, thus bringing about the realization that the traumatic event is not dangerous in the present, rather a memory of a dangerous event that occurred in the past. In addition, remembering and discussing the trauma allows the individual to view it as a specific event and not a representation of him or her self, thereby providing the individual with an opportunity to alter any negative self-images he or she may hold about him or her self as a result of experiencing the trauma.[19] *In vivo* exposure accomplishes many of the same elements but also permits the individual to adjust his or her conditioned negative emotional responses in situations involving stimuli reminiscent of the traumatic event and facilitates the re-engagement with previously enjoyed activities that the participant is avoiding or not engaging in due to emotional numbing or comorbid depression.[20] Thus, participants learn that avoided situations are actually safe and possibly enjoyable, and that the anticipatory and/or initial anxiety that is experienced in a feared situation does not last forever.

It is important to note that, despite its successes in controlled studies, some concerns have been raised by practicing clinicians about the utilization of PE therapy in "real-life" situations – namely related to the perceived rigidity of the PE therapy protocol, and to symptom exacerbation leading to elevated dropout rates when compared to less intensive treatment modalities.[21] However, the importance of therapist flexibility in administering the PE protocol, whether in a controlled trial or in a practical healthcare setting, has been stressed by a number of pioneering research-clinicians, with the key message being that clinicians should not be afraid to make slight adjustments to the PE protocol to suit the needs of each individual patient.[22] Slight modifications to the treatment protocol may circumvent overwhelming frustrations and subsequent abandonment of PE as a therapeutic intervention. Furthermore, clinicians and patients alike may benefit from expecting brief symptom exacerbation during a course of PE. It is also recommended that clinicians and patients alike revisit the rationale for the treatment in order to remind themselves of the reason behind the confronting of the traumatic event in general, and imaginal and in vivo exposure specifically. Previous research suggests that a short-lived increase in PTSD symptomatology is neither related to eventual symptom reduction nor treatment completion; and that individuals who experience PTSD symptom exacerbation can benefit as much from PE as individuals who do not experience an increase in the severity of their symptoms.[23]

Complexities of Treating Military-Related PTSD

While the effectiveness of PE has been demonstrated in civilian populations,[24] previous research suggests that the successful delivery of exposure therapies to military veterans may be difficult to achieve.[25] PE and other therapies that are effective at reducing fearful thoughts related to trauma, have been identified as potentially ineffective or even detrimental in individuals who are experiencing severe guilt related to their traumatic experiences.[26] Because previous research estimates that up to 30% of military veterans with symptoms of post traumatic stress may experience symptoms of survivor guilt in the years following their traumas,[27] clinicians may be reluctant to engage military members and veterans in PE for fear of worsening their symptomatology. Furthermore, it has been suggested that heavy alcohol use, which is common in approximately 20-25% of military veterans,[28] interferes with treatment gains

that would otherwise be made in PE by "chemically enhancing the extinction of anxiety"[29] and subsequently deterring the patient from fully engaging him or her self in treatment. Lastly, previous reviews of the evidence for PE among military personnel have been restricted to mainly Vietnam veterans and, while early evidence is promising, the findings are less consistent than those of civilian trauma samples.[30]

Rational and Objectives of the Current Study

This review aims to identify high caliber published literature related to the use of PE for treating PTSD in military members and veterans. At present, no single recent review has summarized the use of PE in strictly military-related PTSD. The objective of the review is to assess the evidence on the clinical effectiveness of PE for the treatment of combat-related PTSD; in particular, the authors seek to identify: 1) the effects of using PE to treatment military members and veterans with a diagnosis of PTSD; 2) whether PE demonstrates beneficial effects among military personnel, and if these effects surpass those of other PTSD treatment modalities such as pharmacotherapy or present-centred therapy; and 3) whether PE has negative effects on the treatment outcomes of military personnel.

Methodology

PsycInfo (inception to June 29, 2011) and ProQuest Psychology Journals (inception to June 29, 2011) were searched for relevant studies, and an updated search was conducted in November for both of the aforementioned databases (inception to November 29, 2011). Search terms used included combinations of the following terms: "prolonged exposure" or "exposure therapy", "military", "veterans", or "combat", and "post traumatic stress". Reference lists of papers included at Stage 2 were also screened for additional relevant studies.

Study selection took place in a two-stage, unmasked process. In the first stage, titles and abstracts (when available) of all studies revealed in the database searches were screened for relevance. At Stage 1, a study was selected for advancement to Stage 2 if: 1) the study was published in a peer-reviewed published journal; 2) the study was published in English; 3) the intervention described in the study appeared to follow a manualized prolonged exposure

therapy protocol; and 4) if the study was limited to military members or veterans. A study was excluded from further review if: 1) it was a case study; 2) it was not an original research report (i.e., no data, whether qualitative or quantitative, was reported); or 3) it was a duplicate study (i.e., the authors published multiple papers describing similar results from one set of data).

Studies that met the screening criteria in Stage 1 advanced to Stage 2, which involved the first author of the current review reading the full paper. A study was included in the final sample if it: 1) pertained to military members or veterans; 2) used manualized PE as the intervention of interest; 3) was of sufficient power to warrant generalizability to larger populations; and 4) provided measurable outcome data. A study was excluded in Stage 2 if it failed to meet any of these criteria.

In order for a study to be included in the final review, papers identified in Stage 2 were assessed for relevance using a data extraction form (Appendix 7.1) to ensure that key elements of each paper were extracted uniformly. This included publication information such as journal name and date published, study characteristics including design and objectives, participant characteristics including age, sex, and any comorbid conditions, type of intervention and setting, statistical technique(s), measures or tools used to assess outcomes, and any adverse events recorded. Quality of papers were assessed for appropriateness of study design to answer objectives, choice of outcome measure, risk of bias, quality of reporting, statistical issues, and generalizability.

Results

The initial literature searches returned 2,382 published, peer-reviewed journal articles of potential relevance to the current review. Some studies appeared in multiple searches and were counted in Stage 1 each time they appeared. Of the 2,382 studies, 59 were selected as potentially relevant to the current review and carried forward to Stage 2. Citation searching of these papers revealed an additional six papers of potential relevance, which were also obtained and read in full. The number of studies identified at each stage of the review process and reasons for exclusion at Stage 2 are described in Figure 7.1 below.

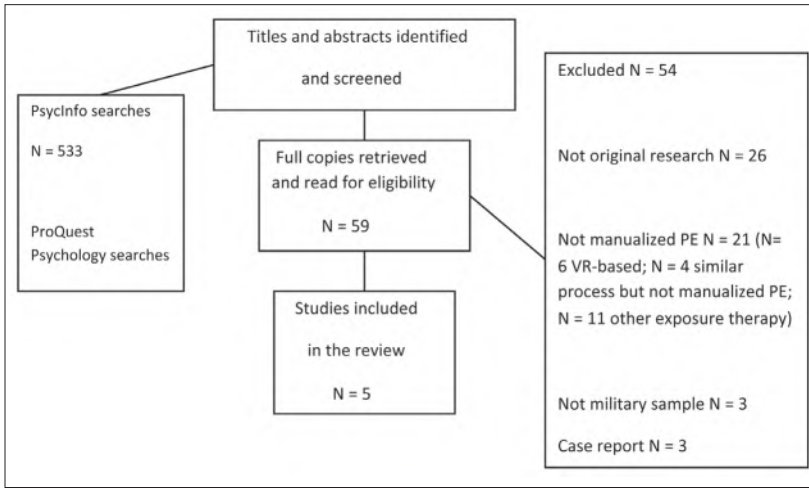

Figure 7.1: Flow chart of studies identified at each stage of the review

It should be noted that, of the 21 studies excluded due to lack of adherence to a manualized PE protocol, four studies (Keane *et al.* 1989[31], Cooper and Clum 1989[32], Boudewyns and Hyer 1990[33], and Pitman *et al.* 1996[34]) used processes very similar to PE, such as imaginal flooding. However, because the objective of the review was to assess the published evidence for manualized PE, these studies were excluded from the final analysis. Six additional studies coded as "lack of adherence to manualized PE protocol" (McLay *et al.* 2011[35], Reger *et al.* 2011[36], McLay *et al.* 2010[37], Ready *et al.* 2006[38], Rothbaum *et al.* 2003[39], and Rothbaum *et al.* 1999[40]) were excluded from the review at stage two because the intervention of interest in each of those studies involved virtual reality-based exposure therapy, which the authors considered to be a rather noteworthy deviation from the manualized PE protocol. Only five studies were included in the final stage of the review (see Table 7.1).

Study	Final N	Intervention	Control group	Sample	Primary outcome measure(s)	Type of analysis
Tuerk *et al*, 2011	43	Manualized PE	None	93% male; OIF/OEF veterans	PCL-M, BDI-II	Repeated measures, dependent means t-tests
Rauch *et al*, 2009	10	Manualized PE w/ slight modification	None	80% male; US Armed Forces veterans	PDS, BDI-II	Dependent t-tests
Schnurr *et al*, 2007	201	Manualized PE	Yes	100% female; US Armed Forces veterans	CAPS	Chi-square analysis; t-tests; generalized linear model
Gros *et al*, 2011	65	Manualized PE delivered via telehealth	Yes	~90% male; US Armed Forces veterans	PCL-M, BDI-II	Paired t-tests; ANCOVA
Tuerk *et al*, 2010	38	Manualized PE delivered via telehealth	Yes	94% male	PCL-M, BDI-II	Repeated measures, dependent means t-tests

Table 7.1 Summary of studies included in the final stage of the review

While only a small number of studies were included in the final stage of the review, the findings of each study demonstrated the effectiveness of PE for the treatment of combat-related PTSD. Tuerk and colleagues (2011),[41] in a post hoc effectiveness study, ascertained that PE could be as effective when implemented in Veterans' Affairs Medical Centres (VAMC) as when used in carefully controlled clinical studies. Although Rauch and colleagues' study (2009)[42] had a very small sample size (N = 10) and was not a controlled study, large effect sizes were noted and significant treatment gains resulted, with 50% of the sample no longer meeting criteria for PTSD following treatment with PE. The study conducted by Schnurr and colleagues (2007)[43] was of adequate sample size for generalization to other populations and was well-controlled. They found that, while dropout was higher in the PE group than the comparison present-centred therapy group, participants in the PE group were more likely to lose their PTSD diagnosis (OR = 2.43) and to achieve

total remission (OR = 3.66) post-treatment. The final two studies, led by Gros[44] and Tuerk,[45] both compared the use of PE delivered via telehealth to PE delivered in-person. Both studies found that significant treatment gains were made whether PE was delivered by telehealth or in-person; however the Tuerk study found that treatment non-completion rates were higher in the telehealth group, while the Gros study found that individuals receiving PE in-person saw slightly greater PTSD and depressive symptom reduction than those receiving PE via telehealth.

Discussion

This review had a number of strengths and weaknesses. First, both language and publication biases were introduced into the review, as only peer-reviewed journal articles published in English were eligible for inclusion. This may have excluded other relevant studies that are unpublished, published in another format (i.e., dissertation, book chapter, or conference proceeding), or published in another language. In addition, only one author evaluated studies for inclusion in the study; therefore, the possibility that some relevant studies may have been overlooked and inadvertently excluded does exist. Further to that, no Kappa statistic for inter-rater reliability is available to attest to the quality of screening for relevant studies. However, the authors did conduct a second literature search five months following the initial search, allowing for previously missed studies to be incorporated into the study at this point. The results of the current review are also strengthened by the use of a two-stage assessment of studies for inclusion in the study with the second stage involving the assessment of the entire paper. This allowed the authors to screen studies in greater detail than by relying on the abstract alone. The use of citation searching as an additional search tool further ensures that relevant studies were included in the current review.

The results of the literature review demonstrate that while a plethora of research resources have been dedicated to better understanding the effectiveness of PE for the treatment of PTSD, few of these studies have been restricted to military samples, and fewer still have been large-scale, randomized controlled trials. The five studies identified in the current review reaffirm that PE, when implemented carefully and modified to meet the needs of the client population, can be an effective means of treating combat-related PTSD. Further research into the long-term outcomes (i.e., maintenance of symptom reduction or sustained remission) of PE would provide further evidence to

support its use for combat-related PTSD, and randomized controlled trials would strengthen the base of empirical evidence in support of PTSD. In addition, research related to predictors of treatment non-completion among military members and veterans receiving PE for combat-related PTSD may influence screening and treatment recommendation guidelines. In summary, while the literature on the use of PE for combat-related PTSD is limited in terms of size, findings thus far have been resoundingly positive; as such, PE should be considered as an evidence-based means of psychotherapeutic treatment for military personnel and veterans with PTSD.

Appendix 7.1 – sample Data Extraction Form:

Data Extraction Form

Date:

Reviewer:

Authors:

Title:

Journal name, volume, and issue:

Objectives:

Study design:

Inclusion/exclusion criteria:

Recruitment procedures:

Age range:

Sex:

Disease characteristics:

Comorbidities:

N size per group:

Intervention:

Setting:

Statistical techniques used:

Case definition used:

Measurement tools/methods used:

N enrolled/included in analysis/withdrew:

Results:

Adverse events:

Resources used:

Bias:

Appropriate study design:

Choice of outcome measure:

Quality of reporting:

Statistical issues:

Generalizability:

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CHAPTER 8

Treatment of Service-Related Post Traumatic Stress Disorder via Telehealth: Preliminary Findings From an Operational Stress Injury Clinic

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ABSTRACT

Many military personnel, both active and retired, do not seek treatment for mental health concerns such as PTSD. These individuals cite travel time, costs, and attitudes and stigma surrounding treatment-seeking as barriers to care. Technology-based treatment modalities such as video-teleconferencing (i.e., Telehealth) have been theorized as a means of ameliorating these barriers. The study presented in the chapter was a preliminary investigation of the effectiveness of using Telehealth to deliver "bona fide" individual psychotherapy for PTSD in an outpatient setting. Outcomes on three screening measures (the PTSD Checklist – Military Version, the Beck Depression Inventory – II, and the Beck Anxiety Inventory) were compared across two groups; Telehealth clients and a matched sample of clients who received individual therapy in-person. The Telehealth sample showed a statistically significant decrease in all three measures. Furthermore, independent sample *t*-tests showed that the Telehealth group did not have significantly different outcome scores from the in-person treatment group on any measure. These preliminary results suggest that Telehealth is an effective medium for delivery of psychotherapy for PTSD.

Introduction

The OSIC at Deer Lodge Centre in Winnipeg opened in 2004 with a mandate to treat service-related mental health problems in active and retired members of the CF and the Royal Canadian Mounted Police (RCMP). The Winnipeg OSIC is one of ten clinics established by VAC. Referral is voluntary. Of the more than 700 referrals received locally since opening, 52% have been for still-serving CF, 43% have been for veteran CF and 5% have been for members of the RCMP.[1] PTSD is the most common mental health problem for which treatment is sought.

It is highly likely that an individual diagnosed with PTSD will have one or more co-morbid mental health problems. This relationship has been shown for those with PTSD in the general population,[2] for war veterans,[3] and for peace-keeping veterans.[4] In an OSIC sample of treatment-seeking veterans with PTSD, 87% had more than one *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV) Axis I diagnosis.[5] PTSD, depression and substance abuse are often observed together. Findings from a 20-year longitudinal study of Israeli war veterans[6] suggested that the core reaction to traumatic stress (i.e., PTSD) was the most powerful risk factor found associated with the development of another mental health disorder. PTSD co-morbidity is the norm rather than the exception. A careful initial diagnosis and consideration of possible co-morbid conditions is essential to the formulation of an effective treatment plan.[7] Treatments for PTSD may then need to be adjusted to address some of the more troubling symptoms of a co-morbid condition. For example, panic attacks may need to be reduced or binge drinking brought under control before trauma treatment can proceed.

There are a number of established treatments with proven efficacy for war-related PTSD.[8] The rate of recovery is estimated to be 60 – 80% among those who complete treatment.[9] Trauma-focused cognitive behavioural therapies for PTSD are recommended first-line treatments. These include PE[10], Cognitive Processing Therapy (CPT)[11], and Eye-Movement Desensitization and Re-processing (EMDR).[12] Other therapies with similar Cognitive Behavioural Therapy (CBT) components (i.e., exposure and cognitive restructuring) may well produce similar results. A recent meta-analysis of psychotherapies for PTSD found good evidence that theoretically grounded, cohesive treatments (referred to as bona fide psychotherapies) could not be differentiated from each other with respect to symptom reduction.[13] There were no superior

treatments among the bona fide psychotherapies, all of which were more effective than wait-list or common element controls.

Despite effective treatments, many active or retired CF with mental health concerns do not seek treatment.[14] Barriers to care are complex and one intervention cannot begin to address them all. Zamorski[15] emphasizes that among soldiers who identify as having a problem, many prefer to manage the condition on their own. A recent study of soldier attitudes about use of mental health care found that barriers to seeking help fell into three broad categories: perceived stigma, organizational barriers which decreased access, and negative attitudes toward treatment.[16] For CF veterans who live in rural locations, travel time and costs were a barrier. Still-serving individuals typically have organizational support to attend specialist care, even at a distance. However, 20% of a sample of active duty soldiers identified stigma (i.e., worry about what others in their unit might think should they become aware of treatment) as a barrier to seeking treatment.[17] It would be important for specialist care to fit easily and unremarkably into a regular day to minimize this concern.

A study of young, active-duty soldiers (mean age of 26 years) reported very positive attitudes about the use of technology-based treatments, including video-teleconferencing, to access mental health services.[18] An older sample of rural primary care patients from the general population (mean age of 46 years), some with significant symptoms of PTSD, also reported willingness to use video-teleconferencing to access psychiatric care. Seventy-five percent of rural participants were willing to use Telehealth if they could avoid a two-hour drive for an appointment.[19]

Despite a generally positive attitude among clients toward the use of technology in psychotherapy, researchers still identify concerns regarding the quality of the experience using Telehealth. The clarity of the Telehealth connection as well as the comfort and privacy of the distant location all contribute to the client experience of virtual presence or "being there" in the room with the therapist.[20] Audio signal delay can critically disrupt capacity to hold a conversation by virtual means, accordingly, a one-way signal latency of less than 200 milliseconds is recommended.[21] Degraded or delayed video signal is more easily accommodated by the participant but can also exceed tolerance if there is large pixilation or screen freeze. Noises outside of the room can impair concentration and serve to remind the participant of their actual location. As with in-person meetings, the sense that others outside the room cannot hear

what is going on within is integral to confidentiality. It is important to keep volume controls at the lowest audible setting. When the factors which contribute to a sense of virtual presence are optimal, clients are generally satisfied with services provided to them via Telehealth.[22]

Recent reviews[23] identify a relatively small amount of research literature on the efficacy of treatments for PTSD delivered via Telehealth. A Canadian study compared CBT delivered either in-person or via video teleconferencing for individuals with PTSD in the general population.[24] Participants (mean age of 43 years) received between 16 and 25 sessions of treatment. Both treatment modalities resulted in significant symptom reduction with no discernable differences between them. Results were similarly positive for two studies of PE with military veterans (the first a pilot for the other).[25] In the pilot study, both in-person and Telehealth treatment produced significant reductions in symptoms of PTSD and depression. Participants (mean age of 39 years) had received between 8 and 15 sessions of treatment. Treatment was standardized to twelve sessions of exposure therapy in the second, larger study. Participants in both treatment modalities (mean age of 45 years) had significant reductions in self-reported symptoms of PTSD and depression. Symptoms were most reduced among those receiving treatment in person. There was a substantial drop-out rate (39%) in the Telehealth treatment modality so the researchers compared treatment completers with non-completers to see if they could better understand why, in this case, the Telehealth treatment was less effective. They found that younger veterans and those recently deployed to Afghanistan or Iraq were more likely to drop out of Telehealth treatment than older and Vietnam veterans. However, neither age nor combat theatre (nor any of the other variables examined) were predictive of treatment outcome. The researchers noted that there may have been subtle differences between their treatment groups because there was no random assignment of participants to the treatment conditions.

Randomized Control Trials (RCTs) of CBT group treatment for military veterans with PTSD have produced mixed results. A 14-session group with targeted social-skills training did not result in symptom reduction for participants (mean age of 55 years) in either the in-person or Telehealth condition.[26] A larger study using a 12-session anger management protocol did find that the CBT therapy resulted in reduced expression of anger and reduced PTSD symptoms for both the in-person and Telehealth conditions.[27] Participant mean age was 55 years. Treatment gains were equivalent between the

two modalities for anger symptoms, however, those seen in-person reported slightly more improvement of PTSD symptoms. In a third study, preliminary findings from the first cohort of an RCT using cognitive processing therapy for veterans with PTSD[28] showed that both the Telehealth and in person treatment modalities were effective to produce symptom reduction. Participants (mean age of 49 years) completed twelve 90-minute group sessions.

Review of these six Telehealth treatment studies indicated that participant age, significant psychopathology and high rates of psychiatric co-morbidity did not appear to distinguish successful from unsuccessful Telehealth treatment. For the RCT in which there were no treatment gains, the authors speculated that secondary gain may have interfered with recovery. On the other hand, Telehealth treatment successes were attributed to use of an empirically-validated treatment protocol with a client manual and optimal performance of the video-teleconference link. Authors of the successful RCTs reported that no treatment sessions were cancelled or postponed by technical difficulties, an admirable standard.

Current Study

The Winnipeg OSIC services a large catchment area extending from the Alberta/Saskatchewan border to Thunder Bay, Ontario. Since 2009, the OSIC has used Telehealth services to enhance access to treatment for its target population and better serve its large catchment area. In 2009, the MB Telehealth installed four video-teleconferencing units: Two were placed within the Winnipeg OSIC and (given that CFB Shilo, located 200 km outside of Winnipeg, was the largest non-Winnipeg referral source for the Winnipeg OSIC) two were placed within the Mental Health Clinic at 11 Health Services Centre at CFB Shilo. Each location has a wall-mounted unit (Tandberg Edge 95 MXP) and a desk-top unit (Tandberg 1700 MXP). These four units are now part of a video-teleconferencing network that links most hospitals and mental health clinics within Manitoba and can link with similar networks in other provinces.

MB Telehealth staff coordinate appointment scheduling and provide technical support when needed. The connection rate is 512 kilo bits per second on the main network and 256 kilo bits per second through an internet service provider to CFB Shilo.

Among other services, the Winnipeg OSIC provides empirically validated psychotherapy treatments, including trauma-focused psychotherapies such as PE,[29] CPT[30] and EMDR.[31] The clinic provides other CBT tailored to diagnosis and individual circumstance. Some examples are Seeking Safety (a CBT approach for co-morbid PTSD and substance abuse); cognitive-behavioural conjoint therapy (a CPT-based couple therapy for PTSD); exposure and Response Prevention for Obsessive Compulsive Disorder (OCD) and CBT for Depression[32] These treatment protocols have therapist and client manuals to guide intervention and as such are very helpful when providing treatment at a distance.

When the Winnipeg OSIC began offering treatment for service-related PTSD via Telehealth in May 2009, some individuals quickly moved to this format for its convenience. Many individuals used occasional Telehealth sessions to supplement routine in-person individual psychotherapy appointments. Others preferred to have most, if not all, sessions via Telehealth, largely for the convenience of local access to a Telehealth site.

Recognizing that this was a different means of treatment delivery for both clients and clinic staff, we believe it is important to closely monitor these early efforts. Given that Telehealth users had the same treatment availability (e.g., types of treatments, flexibility in goal setting) as those who chose to receive services in-person, we expected that this group would be heterogeneous (e.g., receiving a diverse range of treatments). Reviewing treatment outcomes in the context would necessitate working with many uncontrolled variables; nonetheless we believed it accurately presented the clinical reality of many service providers. Accordingly, we decided to examine treatment outcomes for the initial cohort of Telehealth users. This book reports the preliminary findings from this project, which is part of ongoing data collection. We predicted that individual psychotherapy for PTSD provided via Telehealth in the Winnipeg OSIC would be associated with reductions in client-reported symptoms of PTSD, depression, and anxiety. We did not expect that Telehealth treatment would produce different effects than similar treatments provided in person.

Method

This study was a chart review to examine the effectiveness of individual psychotherapy provided for an initial cohort of OSI clients diagnosed with PTSD who chose to receive therapy via Telehealth. Outcomes for the Telehealth

clients were compared with those from a matched sample of clients, also with PTSD, who received individual therapy in-person.

Participants

Telehealth Group. The OSIC medical records were reviewed to identify OSIC clients who were diagnosed with PTSD, had been in treatment for more than three months, and had *received more than half of their treatment sessions via video-teleconferencing*. Twelve potential participants were identified. Of these potential participants, 11 had provided consent to have their clinical data used for research purposes and were included in this study.

All treatment decisions were made in a clinical context on a case-by-case basis. Client choice of treatment modality was never restricted for research purposes. Accordingly, the Telehealth group was defined by having *most* of their treatment sessions via telehealth, but not by exclusive use of Telehealth. Of the 11 Telehealth participants, four (36%) received all treatment session via Telehealth, four (36%) received more than 85% of treatment via Telehealth, and three (27%) received more than 60% of treatment via Telehealth. All were male. Six clinicians provided the treatments: four psychologists, one Masters qualified social worker, and one psychology resident under supervision. All treatment was primarily cognitive-behavioural in orientation including prolonged exposure (four cases), cognitive processing therapy (two cases), cognitive-behavioural conjoint therapy for PTSD (two cases), Seeking Safety for PTSD and substance use (one case), cognitive-behavioural therapy for depression (one case), and cognitive therapy including exposure and response prevention for OCD (one case). Four participants (36%) were also taking medications. The heterogeneity of approaches, tailored to client need, was a realistic sample of clinic practice.

Matched Sample. A matched sample of in-person treatment cases was selected according to the following conditions: (1) clinic referral had been just prior to that for the matched Telehealth case and within the previous six months, (2) clinic assessment had resulted in a diagnosis of PTSD, (3) the PTSD Checklist – Military version (PCL-M) score at intake was close as possible to that of the matched Telehealth case, indicating that the severity of PTSD symptoms was comparable (the closest pairing had the same PCL-M score and the most discrepant pairing differed by nine points), (4) the client had been in treatment for more than three months, (5) the client was male, and (6)

the client had provided consent to use clinical data for research purposes. This last criterion is unlikely to bias the sample, given that 95% of Winnipeg OSIC clients have given consent to be included in the research database. (Only 1% of OSIC clients do not consent to have their clinical data included in the research database; the remaining 4% were not included because they had not been approached about the research).[33] As per clinic policy, all clients had access to services provided either in-person or via Telehealth. However, only two in-person clients made use of occasional appointments via Telehealth (two of 33 sessions for one participant and five of 40 sessions for the other).

Five clinicians provided treatment for these 11 matched in-person treatment participants: four psychologists and one Masters qualified social worker. As with the Telehealth participants, treatments all were cognitive behavioural in approach and included prolonged exposure (six cases), Seeking Safety (one case), EMDR (two cases), and cognitive-behavioural therapy for depression (two cases). Six participants (55%) were taking medications.

Table 8.1 provides demographic information for the Telehealth and matched groups. As shown in Table 8.1, the two groups did not differ on marital status, education, number of treatment sessions, length of treatment, or treatment completion. However, those in the in-person treatment group were older and had more years of service. On average, participants in both groups had been in treatment for more than a year and had received 30 treatment sessions. Approximately half of the participants had completed treatment. As is to be expected in a clinic-based sample, most participants had at least one DSM-IV diagnosis in addition to PTSD (82% for each of the Telehealth and in-person groups). Major Depressive Disorder (MDD) was the most frequent comorbid diagnosis (63% of Telehealth cases and 55% of in-person cases), followed by substance abuse/dependence (55% of Telehealth cases and 27% of in-person cases). The proportion of clients with a diagnosis of PTSD only, PTSD plus one additional diagnosis, or PTSD plus two or more additional diagnoses did not differ across the two groups,

$\chi^2(2, N = 22) = 0.90, p = .64$

	Telehealth (*n*=11) M (SD)	In-Person (*n*=11) M (SD)
Age (Yrs)[a]	30.6 (4.3)	36.8 (7.0)
Service (Yrs)[a]	6.4 (2.4)	16.4 (7.3)
Marital Status		
Married/CL	72% (*n*=8)	54% (*n*=6)
Divorced/Sep	0	27% (*n*=3)
Never Married	27% (*n*=3)	18% (*n*=2)
Education		
< Gr 12	0	18% (*n*=2)
Gr 12	82% (n=9)	64% (*n*=7)
> Gr. 12	18% (n=2)	9% (*n*=1)
# Sessions	31.4 (18.8)	29.9 (12.8)
Months in clinic	13.0 (7.7)	16.4 (9.6)
Treatment completed	55% (*n*=6)	45% (*n*=5)
Diagnoses		
PTSD Only	18% (*n*=2)	18% (*n*=2)
PTSD +1 other Dx	36% (*n*=4)	54% (*n*=6)
PTSD + 2 or more Dx	45% (*n*=5)	27% (*n*=3)

[a]Significantly different, $p < .05$

Table 8.1: Participant demographics by treatment modality

Measures

PTSD Checklist – Military Version. The PCL-M[34] is a 17-item self-report questionnaire that assesses PTSD symptom severity. The respondent is asked to indicate how much the problem described in the statement has bothered them over the last month on a scale from 1 (*Not at all*) to 5 (*Extremely*). Each of the 17 statements corresponds to one of the 17 DSM-IV diagnostic criteria for PTSD. The military version orients the respondent at the beginning of the questionnaire by stating veterans sometimes have these problems in response to military experiences. The first eight items also reference "stressful military experience." A total score is calculated by summing the items with higher scores indicating greater severity (range = 17-85). A cut-off score of 50 has

been recommended in military populations.[35] The PCL-M is the second-most prevalent self-report instrument used by traumatic stress professionals.[36] It has excellent internal consistency across different veteran populations, sexual assault survivors, and motor vehicle accident survivors (*α*s ranging from .94-.97). Test-retest reliability over two-three days for Vietnam veterans was also excellent ($r = .96$).[37]

Beck Depression Inventory – II. The Beck Depression Inventory – II (BDI-II)[38] is a 21-item self-report questionnaire that is used to assess the severity of symptoms of depression. Each item includes a four-point scale (range 0-3) with statements starting with the absence of a symptom and then presenting ascending levels of severity. Respondents choose a statement which best described how they have been feeling over the previous two weeks. Items are summed to provide a total score (range = 0-63). It has excellent internal consistency (*α*s ranging from .92-.93), test-retest reliability over one week ($r = .93$), and shows appropriate convergent and discriminate validity with other measures.[39]

Beck Anxiety Inventory. The Beck Anxiety Inventory (BAI)[40] is a 21-item questionnaire that measures severity of anxiety symptoms that are minimally shared with depression. The respondent is asked to indicate how bothered they were by each of 21 symptoms over the last week on a scale with four options ranging from *Not at all* (scored 0) to *Severely I could barely stand it* (scored 3). Items are summed to provide a total score (range = 0 – 63). The BAI has excellent internal consistency (αs ranging from .85-.93), adequate test-retest reliability ($r = .75$),[41] and correlates better with other anxiety than depression measures.[42]

Procedure

Symptom Measures. As part of routine service within the clinic, all clients were requested to complete symptom monitoring questionnaires (i.e., the PCL-M, BDI-II, and BAI) at regular intervals. These were done at the first appointment (Intake), at the time of diagnostic assessment by psychology or psychiatry (Assessment) and then at regular three-month intervals, on the client's time-line, during treatment. For the purpose of this study, the intake scores represented participants' self-report at either intake or assessment (intake if both were available). The last measure available was then used for each participant. For participants who had completed treatment, this was the final

measure on record near the conclusion of treatment. For those continuing with treatment, their most recent set of measures was used.

Diagnosis. All diagnoses were made by psychologists or psychiatrists at the Winnipeg OSIC after a comprehensive diagnostic assessment, which included both unstructured and semi-structured clinical interviews, for e xample, the use of the Clinician-Administered PTSD Scale (CAPS)[43] to diagnose PTSD.

Treatment Provided. All treatments were provided by clinicians experienced in working with military populations. Treatment decisions including which empirically-based treatment would be used and length of treatment were determined on an individual basis.

Results

Intake Symptom Severity

Both groups presented with moderate to severe symptoms. The in-person matched sample was selected to be equivalent symptom severity of PTSD at intake, accordingly there was no difference between the groups on pre-treatment PTSD Checklist – Military version (PCL-M) score, $t(20) = -0.02$, $p = .99$, with the mean PCL-M scores of 58.18 ($SD = 14.25$; range = 42-79; Telehealth) and 58.27 ($SD = 13.63$; range = 42- 78; in-person), well above the recommended clinical cut-off of 50. The two samples did not differ with respect to initial depressive symptoms ($t(20) = 1.21$, $p = .24$; Telehealth BDI-II $M = 29.45$ ($SD = 6.92$); in-person BDI-II $M = 24.55$ ($SD = 11.54$)). Likewise they presented with equivalent levels of anxiety symptoms ($t(20) = 0.87$, $p = .39$; Telehealth BAI $M = 24.92$ ($SD = 9.10$); in-person BAI $M = 21.18$ ($SD = 10.93$)).

Was Treatment Delivered via Telehealth Effective?

Paired *t*-tests were calculated for each of the three outcome questionnaires to determine if treatment had resulted in significant change for participants on self-reported symptom severity. The sample who received treatment via Telehealth showed significant decreases in symptoms of PTSD, $t(10) = 2.24$, $p < .05$, with mean PCL-M scores of 45.45 ($SD = 21.33$) at the most recent evaluation. See Figure 8.1. Likewise, this Telehealth sample also showed a significant decrease in symptoms of depression, $t(10) = 2.83$, $p < .05$, with

mean BDI-II scores of 20.27 (*SD* = 10.26) at the most recent evaluation. See Figure 8.2. There also was a significant decrease in reported anxiety levels for the Telehealth group, $t(10) = 2.65$, $p < .05$, with mean BAI scores of 16.09 (*SD* = 10.84) at the most recent evaluation. See Figure 8.3.

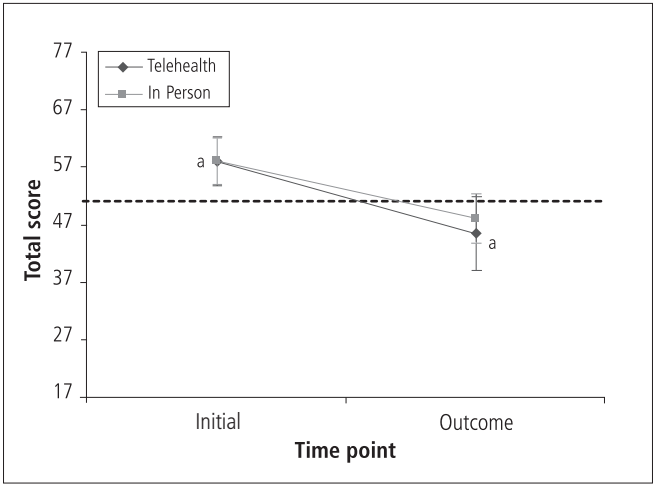

Figure 8.1: Changes in PCL-M scores with treatment

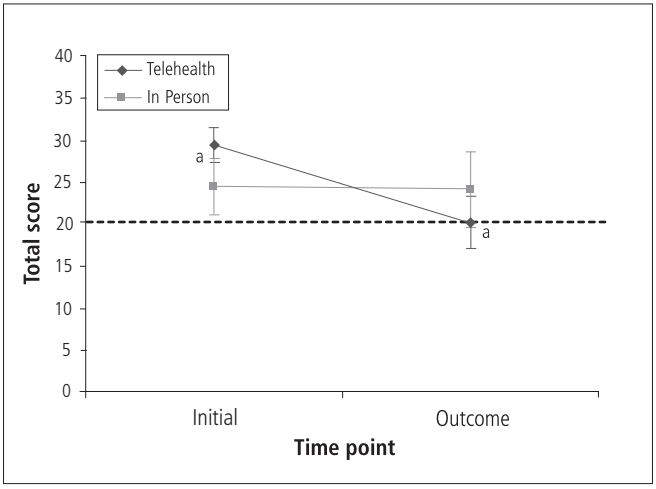

Figure 8.2: Changes in BDI scores with treatment

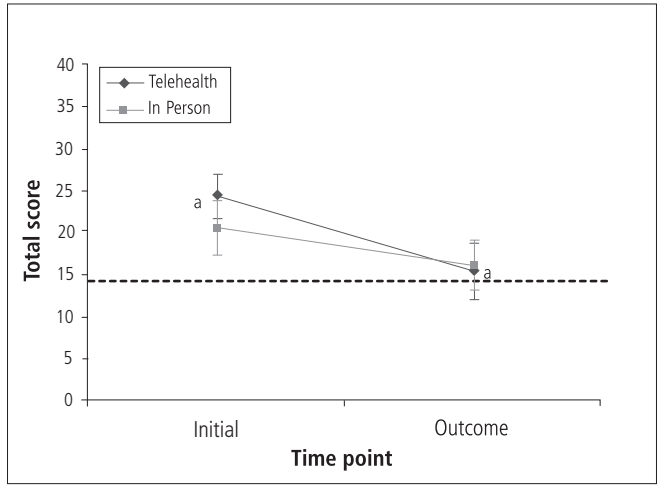

Figure 8.3: Changes in BAI scores with treatment

How do Treatment Effects Compare with the Matched Sample who Received In-person Treatment?

Contrary to expectation, the in-person group did not show significant decreases on any symptom measure (see Figures 8.1-8.3). Three paired *t*-tests comparing intake ratings to most recent ratings within this sample all were non-significant (PCL-M: $t(10) = 1.88$, $p = .09$, in-person most recent $M = 48.18$, $SD = 14.23$; BDI-II $t(10) = 0.09$, $p = .93$, in-person most recent $M = 24.14$, $SD = 11.54$; BAI $t(10) = 1.30$, $p = .22$, in-person most recent $M = 16.73$, $SD = 10.02$).

We wanted to confirm, at a minimum, if the post-treatment outcome measures for the Telehealth and in-person groups were significantly different. Accordingly, independent sample *t*-tests showed that the Telehealth group did not have significantly different outcome scores on any measure. That is, there was no significant difference between the Telehealth and in-person samples in final PCL-M scores, $t(20) = -0.35$, $p > .72$, BDI-II scores, $t(20) = -0.70$, $p > .48$, or BAI scores, $t(20) = -0.14$, $p > .89$. We recognize that this analysis does not support the conclusion that the treatment modalities were equivalent in effect and, once our larger Telehealth treatment sample has accumulated, we will use a test of non-inferiority[44] to confirm the equivalence of treatment modalities.

Discussion

The present study was a preliminary investigation of the effectiveness of using Telehealth to deliver bona fide individual psychotherapy for PTSD in an outpatient setting. Eleven treatment cases were identified who had received more than half of their psychotherapy via Telehealth. These cases were matched by intake PTSD symptom severity with the immediately preceding clinic referral who received equivalent in-person treatment for PTSD. The samples were very similar, primarily differing in age. As expected with real-life clinical samples, both groups showed high diagnostic co-morbidity with clinical levels of symptoms (moderate-severe range) before treatment. Telehealth was shown to be an effective alternative mode of treatment. The Telehealth sample showed significant reductions in PTSD, depression, and anxiety symptoms. These outcomes could not be shown to differ from those for the matched sample who received similar treatments provided in-person.

In this study, the matched sample did not show significant improvement in PTSD, depression, or anxiety symptoms with treatment. This was an unexpected finding given that other samples of clients diagnosed with PTSD drawn from this same OSIC population (with no diagnostic exclusion criteria) have shown large effect sizes on the PCL-M (range 1.31-1.68) and BDI-II (range 0.89-1.43), and moderate to large effect sizes on the BAI (range 0.74-1.20).[45] The results seen here for in-person psychotherapy may be due to the small sample size.

In a recent editorial,[46] long-time researcher of veterans' health, Charles Hoge, identified the treatment drop-out rate as one of the great challenges to veteran mental health. He suggested that bona fide psychotherapies be offered in flexible and innovative ways in order to encourage uptake and increase the reach of treatment. It appears that Telehealth would have much to offer here but its use as a medium for psychotherapy has been slow to enter the mainstream. Negative appraisal of video teleconferencing by clinicians has been cited as one of the reasons for a failure by clinicians to adopt this medium. As evidence of this negative appraisal, one study showed that clinicians rated therapeutic alliance as lower when the treatment was understood to be happening via Telehealth versus face-to-face.[47] Clinicians, in fact, saw identical sessions. Conversely, clients in individual treatment via Telehealth have provided positive ratings of therapeutic alliance, no different from those receiving comparable treatments in-person.[48] A study of group therapy did find that those in

the Telehealth condition rated their alliance with the group leader as lower than those seen in-person, however, these alliance ratings were not associated with diminished treatment effectiveness.[49] Symptom change was equivalent for in-person and Telehealth treatment conditions. Although there is much interest in the role of therapy process variables in Telehealth treatment, as yet no studies have found these predictive of poorer outcome. The construct of "virtual presence" might prove the most intriguing process variable. Only one study was found that looked at this construct in detail.[50] Client ratings of the degree to which they felt present with the therapist in the session were positively correlated with their ratings of therapeutic alliance. It may be that factors in the Telehealth session which enhance or detract from the client's experience of virtual presence are important non-specific treatment factors in psychotherapy via Telehealth.

There is hope, as well, that clinician attitudes are changing. A recent survey of Canadian clinicians, 25 of whom were from the OSIC network, found that attitudes about the use of videoconferencing for clinical purposes were largely positive.[51] Actual use of the technology was associated with being trained in its use, perceiving it to be easy to use, and being a more experienced, possibly a more confident, mental health provider.

The merit of the current study is that it provided a naturalistic test of the effectiveness of bona fide psychotherapies for PTSD delivered via Telehealth to clients typically seen in a clinic setting by a regular staff of mental health clinicians. As such, clinicians in similar settings may have some confidence that similar treatments will work for their clients.

Limitations

In contrast to traditional studies of the effectiveness of psychotherapy, this study used a relatively heterogeneous group of participants with PTSD, several bona fide psychotherapies were chosen to fit individual needs and preferences, and treatment duration was not controlled. As well, there were no adherence checks done on therapist delivery of treatment protocols. There were variations, large and small, in the therapy received by every participant such that it is likely that no two individuals received the exact same treatment. This circumstance is typical of clinic practice where it is usual to have a variety of valid treatments available, much like having a "menu" that accommodates individual differences among clients by either providing treatment that is a

match to the diagnostic profile (e.g., seeking safety for those with both PTSD and substance abuse) or allows an expression of client preference (e.g., PE requires talking and recording memories; CPT requires writing out memories). We have made the argument that these treatments were equivalent and the clients were representative of those found in normal clinical practice, however, it can also be argued that lack of systematic control for this many variables makes findings difficult to replicate and thus reduces generalizability.

Additional limitations of the study are its small sample, lack of random assignment to treatment conditions and minor overlap between the treatment conditions. Since the Telehealth service was installed, clients of the OSIC have been able to access services provided either in-person or via Telehealth. Some were initially seen in-person but moved to Telehealth as soon as it became available. Some used Telehealth but occasionally requested to see their clinician in-person (for example if they were already in Winnipeg for other reasons). And some used in-person services but occasionally requested Telehealth (for example when travel conditions were poor). This flexibility is typical of clinic practice; however, it is fair to say that our findings may have been different if clients had been bound to receive services exclusively in one modality or the other.

Future Research

As noted earlier, this study is the initial phase of an ongoing examination of treatment outcomes using Telehealth. As the Telehealth treatment sample increases in size, we will have great confidence in these findings. We also expect that the outcomes shown for participants in the matched in-person sample will be more consistent with prior results from this clinic. More controlled studies (e.g., use of one treatment protocol with a more homogonous population) may lead to a better understanding of specific differences between Telehealth and in-person delivery of treatment. However, given the possibilities for the expansion of Telehealth as a viable treatment modality to reach otherwise underserved populations, it is also important to continue to investigate applications of Telehealth to more naturalistic, less controlled clinical settings. Some have described this latter approach as seeking "practice-based evidence."[52]

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SECTION 2:
PHYSICAL HEALTH

CHAPTER 9

Anterior Cruciate Ligament Injuries in the Military: A Review of the Problem and Development of Standardized Procedures for Assessment of Readiness to Return to Duty

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ABSTRACT

Anterior Cruciate Ligament (ACL) injuries are of concern in the military setting due to time loss and possible inability to return to pre-injury activity levels. This chapter aims at reviewing the current state of knowledge regarding this type of injury, as well as outlines our proposal to standardize patient evaluation procedures in the CF. Such standardization will allow development of clinical prediction rules for safe and effective return to duty. In the first part of the chapter, a synopsis is provided regarding the prevalence, extent, and costs associated with this particular injury in both the general population and in the military with elaboration provided on known risk factors and

injury mechanisms, as well as general rehabilitative procedures. In the second part of this chapter, we present considerations for standardization of patient assessment methods, and in particular those related to measurements of knee muscular strength and psychological constructs. We then present work done to date concerned with several aspects of reproducibility and validity of scores obtained using the proposed procedures. Finally, we outline our future clinical and research goals.

Introduction

In the previous volume pertaining to Canadian military and veteran's health research, Rowe and Hébert provided an extensive review of the incidence and burden associated with treatment of musculoskeletal injuries in the CF.[1] Of particular interest is information brought forth regarding the profile of musculoskeletal injuries leading to release from the Canadian Forces. In specific, based on data provided by the CFHS it appears that injuries to the lower extremities and particularly the knee joint represent, percentage wise, and the largest contributor to service personnel medical discharge.[2] In this context, injury of the ACL of the knee joint is a particularly problematic in the military setting due to the extensive time needed for recovery; the costs associated with treatment; as well as tribulations in the ability to return to pre-injury activity levels. As an exemplar of the extent of the problem in armed forces, consider that data from the United States military has revealed that approximately 3,000 ACL reconstruction procedures are performed each year.[3] The ACL injury incidence rate in the United States military was 2.96 cases per 1,000 person-years and is approximately 10 times greater than the American general population rate of 0.38 cases per 1,000 person-years between 1997 and 2003.[4] These data are corroborated in a more recent report where it was revealed that among United States active component members since 2000, there have been approximately 4000 incident cases of cruciate ligament injures each year, including the Posterior Cruciate Ligament (PCL), for a total of 42,176 cases.[5]

Throughout this period, injury rates were higher in members of the Marine Corps and the Army than those serving in the Air Force and Navy, and a more than 20,000 surgical operations were performed in US military medical facilities. In this context, it has been conservatively estimated that the total individual cost of surgery and rehabilitation is between $17,000 USD and $25,000 USD.[6]

Unlike the civilian setting, however, there is expectation of military service members to return to full duty that often involves demanding physical activities.[7] This expectation faces clinicians in the military settings with difficult decisions as to the readiness of the patient to commence pre-injury activity levels with minimal chance of re-injury. Although there is an abundance of literature on this subject area, particularly with regards to return to athletic competition, it may be argued that predictions of such matters are still in need of improvement.

This aim of this chapter is to introduce stakeholders affiliated with MVHR Forum to the nature of this specific injury, as well as to our proposal for standardization of patient assessment methods within the CF. Such standardization will allow us to develop rigorous clinical prediction rules for safe and effective return to duty. In specifics, we commence by providing a brief outline of the relevant anatomy and function of the knee joint, followed by a description of injury mechanisms and risk factors. In addition, we describe general rehabilitation procedures following the preferred option of ligament restoration via surgical intervention. It should be noted that much of the research pertaining to understanding of ACL injuries has been conducted in relationship to participation in sports. However, we find that much of the findings are relevant to injuries occurring in the military setting, as there are similarities in the type and level of physical activities performed.

The second part of the chapter elaborates upon our rationale for use of specific tests and procedures during the patient assessment process. Focus is brought forth to the use of isokinetic dynamometers, which are advanced muscular strength testing device currently used by several CF physical therapy units. We also justify the need to assess certain psychological constructs prior and during the rehabilitative process, as these have been implicated to significantly contribute to the ability to successfully recover from surgical interventions and return to pre-injury activity levels in a timely manner. We then provide a description of results obtained from several preliminary investigations associated with this project, and whose aims were to answer specific questions related to the reproducibility and validity of muscular strength and psychological outcomes. Lastly we elaborate on our future goals and the work needed to accomplish these.

Injury of the Anterior Cruciate Ligament – Overview

The knee is a joint that permits flexion, extension, and rotation movements.[8] It consists of three articulations, two menisci, nine muscles, and four main ligaments.[9] The articulations are between the medial and lateral condyles of the femur and tibia (collectively known as the tibiofemoral joint) and between the femur and the patella (known as the patellofemoral joint).[10] The menisci of the knee are cartilaginous tissue found between the femur and tibia and act as impact absorbers.[11] Muscles of the knee are classified based on the knee movement they elicit into two groups: the quadriceps group and the hamstring group. The quadriceps group extends the knee and consists of the rectus femoris, vastus intermedius, vastus lateralis, and vastus medialis muscles while the hamstring group flexes the knee and consists of the biceps femoris, semimembranosus, and semitendinosus muscles.[12] The gracilis and sartorius muscles are not grouped with the hamstring group but also flex the knee.[13] The main ligaments of the knee are medical collateral ligament, lateral collateral ligament, posterior cruciate ligament, and the ACL.[14] These ligaments passively stabilize and help guide the knee during motion.[15]

The ACL passes through the intercondylar notch and attaches proximally to the posterior aspect of the lateral femoral condyle and distally to the anterior aspect of the tibial surface that articulates with the femur.[16] The primary function of the ACL is to resist anterior movement of the tibia relative to the femur and rotation of the knee.[17] This function is achieved by the two bundles that comprise the ACL. The anteromedial bundle is tight during knee flexion and slack during extension and the posterolateral bundle is slack during flexion and tight during extension.[18] The ACL also has secondary functions in resisting internal and external rotation and valgus and varus stresses.[19]

ACL Injury Mechanisms and Risk Factors

Classification of ACL injury mechanisms utilizes the scheme proposed at the American Orthopedic Society of Sports Medicine consensus conference on non-contact ACL ruptures.[20] In specifics, an external force that is directly applied to the injured knee is classified as a direct contact mechanism of injury, whereas an external force applied to the injured individual but not directly to the injured knee is classified as an indirect contact mechanism of injury.[21] On the other hand, injuries occurring due to forces applied to the knee resulting from an individual's own movement and that did not make contact with

another individual or object are classified as occurring due to a non-contact mechanism of injury.[22] This latter mechanism is most prevalent in sport settings, where it is estimated to be manifested in 70% of ACL injuries.[23] In such settings, it was concluded that an individual is likely to sustain an ACL injury due to non-contact mechanisms of injury if: 1) the knee flexion angle was less than 30°; 2) the knee was in valgus ("knocked knee" posture); 3) the centre of gravity was behind the knee upon landing or decelerating to a stop after running, and; 4) the foot was externally rotated relative to the knee.[24] Such circumstances are also common during movement performance in the military.[25] For example cutting manoeuvres, which involve abrupt deceleration of motion and changing of direction, as well as landing after jumping with the knee near full extension are two movements regularly performed as part of duty demands.[26] However, given that the majority of personnel performing such movements do not experience injury, it has been proposed that certain risk factors may predispose a particular individual to injury occurrence.

Extrinsic Risk Factors for ACL Injury

In general, risk factors for ACL injury are classified as extrinsic or intrinsic.[27] The former are due to external factors acting on an individual and are considered to be modifiable to an extent.[28] For example, weather conditions have been implicated as a potential extrinsic risk factor for ACL injuries, and thus training environment may be modified. In specifics, findings in studies examining ACL injuries in the Australian Football League (AFL) and the National Football League (NFL) suggest that ACL injuries are more common on dry playing surfaces.[29] In particular, the study examining ACL injuries in the AFL reported an increase in ACL injury risk when rainfall was low and water evaporation was high.[30] The study investigating ACL injuries in the NFL reported that approximately 95% of ACL injuries occurred on a dry field.[31] It was proposed that the increased risk of ACL injuries associated with dry conditions entailed increased footwear traction on dry playing surfaces.[32] Although we were not able to identify research related to weather conditions as an extrinsic risk factor for ACL injuries in the military, this query may be of interest to the CF due to the variable weather conditions experienced during training and deployment periods.

Another extrinsic factor that has been shown to affect the risk of ACL injury is the surface on which physical activity is performed. Interestingly, the increased risk is observed for women, but not men. In particular, it has been

found that the risk of ACL injury in women playing on artificial floors was found to be higher than the risk in women playing on wooden floors whereas men reported no difference in risk of ACL injury.[33] In another study, no difference in risk of ACL injury was also reported when comparing artificial turf and natural grass playing surfaces in the NFL.[34]

Prophylactic knee bracing was identified as an extrinsic risk factor because past anecdotal evidence indicated that knee braces reduced the rate of knee injuries.[35] A finding of a randomized controlled study involving United States military academy cadets playing football agreed with the stipulation and reported a reduction in knee injury frequency (including ACL injuries) whilst wearing a prophylactic knee brace. However, wearing the brace did not reduce the severity of ACL injuries.[36] On the other hand, a prospective cohort study reported conflicting results where donning a knee brace during football increased the rate of knee injuries including ACL injuries in the second year of the study.[37]

Intrinsic Risk Factors for ACL injury

Evidently, extrinsic risk factors may be influenced by choices such as wearing a brace, and perhaps training on different surfaces. In opposition, intrinsic risk factors are defined as inherent to the individual and are typically non-modifiable.[38] The inability to modify these risk factors is especially problematic when considering that many of these seem to predispose women to injury occurrence. In fact, it is documented that the incidence rate of ACL injuries is 2-8 times greater in women than men in the general population,[39] and research findings have confirmed that women sustain a greater number of ACL injuries than men engaging in the same athletic activities.[40] ACL injuries documented from 1990 to 2002 by the National Collegiate Athletic Association (NCAA) showed that the incidence of injury was 3.6 times greater in female basketball players and 2.8 times greater in female soccer players than the male players of each sport.[41] However, the trend of a gender bias in terms of injury incidence is not as pronounced in the military setting. In specifics, in a report with relevance to the younger military population, it was reported in a longitudinal study of 956 students at West Point Military Academy that women had a slightly higher ACL injury rate of 0.04% compared to 0.027% for men.[42] A more recent report of cruciate ligament injuries and incidence (including the posterior cruciate ligament) in the United States among active component service member revealed that incidence rate were in fact higher in men than

women across all age categories, except those under 20 years old.[43] In this context, it was reported that injury rates were higher among women than men during basic training combat trainees. In an editorial comment provided following this aforementioned report, it was argued that results may be reflective of differences in occupational demands following basic training, or of choice of leisure activities. That is, when the demands placed on the knees are similar across gender, such as during basic training, injury rates may be higher among women than men. However, when the demands are different, such as may occur due to personal choices of sport participation during leisure time, or due to differences in occupations, the trend may be towards a higher injury rate in men. In light of these findings, we provide further elaboration on several intrinsic risk factors that may be of relevance to understanding why the injury incidence rate among women may be higher at a younger age. These factors include the quadriceps (Q) angle, Body Mass Index (BMI), joint laxity, neuromuscular factors, and hormone levels, all of which are reported to be more pronounced in women.

The Q angle as an anatomical risk factor for ACL injuries, and is defined as the angle formed by the line from the anterior superior iliac spine to the centre of the patella with the line from the centre of the patella to the tibial tubercle.[44] The Q angle is considered to be a measure that reflects pelvic angle, hip and tibia rotations, and foot and patella positions.[45] Studies have shown that the Q angle is larger in women compared to men and have associated the greater risk of ACL injury observed in women with larger Q angles.[46]

An increased BMI was reported as a risk factor for ACL injuries due to the findings that an it may alter knee positioning during landing activities, and these knee positions (more extended) are thought to increase the risk of an ACL injury.[47] Scrutiny of the literature revealed that the relationship between an increased BMI and ACL injury is found in women in the military. In specifics, a BMI value that was one standard deviation above the mean put female cadets at a risk for ACL injury that was 3.5 times greater than other female cadets.[48] Joint laxity has been identified to be greater in women than men but its relation to ACL injuries is uncertain.[49] One study reports that individuals with a knee hyperextension greater than 10° were associated with ACL injuries[50] while some studies report no association between joint laxity and ACL injuries.[51]

Neuromuscular factors such as increased knee valgus, decreased hip and knee flexion angles, and muscle activity have been suggested as intrinsic risk factors for ACL injuries.[52] Particularly, women are reported to land from a jump with greater knee valgus compared to males,[53] and landing in such a position is thought to expose the ACL to greater strain.[54] Studies report that female athletes that went on to sustain an ACL injury had significantly increased knee valgus and abduction loading when landing compared to the athletes that did not sustain an ACL injury afterwards.[55] Women were also shown to activate their quadriceps before their hamstrings where as men activated their hamstrings first before their quadriceps in response to an anteriorly directed force.[56] These muscle activation patterns suggest that females are subject to greater risk of ACL injury than men because of the possibility of anterior translation of the tibia with respect to the femur when the quadriceps contract without hamstring contraction.[57]

Another gender biasing intrinsic risk factor relates to differences in hormonal levels, and particularly of estrogen and progesterone. The presence of estrogen and progesterone receptors on ACL cells has been proven and thus suggests that these hormones have a role in influencing the integrity of the ACL.[58] Estrogen was shown to significantly decrease the failure load of the ACL in rabbits.[59] The menstrual cycle, which exhibits fluctuations in estrogen and progesterone levels, has been the focus of some studies looking to examine the relationship between hormone levels and risk of ACL injury.[60] The findings of these studies are not consistent and the need for studies with a large sample size and consistent definitions of menstrual cycle phases are required to make conclusions regarding the relationship between hormone levels and risk of ACL injury.[61]

There are other intrinsic risk factors that are need in consideration, but are not associated with the gender bias in predisposition to ACL injuries. These include anatomical factors such as notch width, tibial slope, foot pronation, pelvic tilt, and genetics. In specifics, a suggested anatomical risk factor is a narrower intercondylar notch width. There are two measures associated with the intercondylar notch width: Notch Width Index (NWI) and Eminence Width Index (EWI). The NWI measures the width of the intercondylar notch and the EWI is an indicator of ACL size.[62] The NWI can be a predictor of ACL injuries since a narrower notch width is shown to be associated with ACL injuries.[63] In the military population, NWI was shown to negatively correlate

with ACL ruptures in men and women while EWI negatively correlated with ACL ruptures in men only.[64]

Another suggested anatomical risk factor for ACL injuries is an increased posterior tibial slope angle. The tibial slope is defined as the angle formed by the posterior incline of the tibial plateau and the line perpendicular to the tibial axis.[65] In a study done by the US Army using ACL injury data from West Point Military Academy it was shown that a greater posterior tibial slope angle existed in the injury group compared to the control group in both sexes.[66]

Foot pronation, as measured by navicular drop values, has been suggested to be a risk factor for ACL injuries.[67] It was reported that individuals with a navicular drop value greater than 8mm were at a risk of ACL injury 20 times greater than that of individuals with a navicular drop value less than 6.3mm.[68] In contrast, another study failed to find the association between foot pronation and ACL injury.[69]

Pelvic tilt is suggested as a risk factor for ACL injuries since it affects lower extremity postural alignment.[70] A case-control study showed that individuals with a history of an ACL injury had a greater anterior pelvic tilt compared to individuals in the control group.[71] Lastly, genetics have been identified as a possible intrinsic risk factor for ACL injuries with studies investigating family history of ACL injuries and a particular genotype of the *COL1A1* gene.[72] Individuals with an ACL injury were 2 times more likely than an individual in the control group to have a relative of 1st, 2nd, or 3rd degree with a history of an ACL injury.[73] The genotype that was investigated was the ss genotype of the *COL1A1* (gene that codes for α1 chain of type I collagen). This genotype was shown to associate with a reduced risk of ACL injuries.[74]

General Rehabilitation Procedures and Success of Recovery Following ACL Injury

Treatment of ACL injuries typically involves a surgical procedure and intensive physical rehabilitation.[75] In this regard, there are two prevalent conduits for physical rehabilitation procedures following reconstruction of the ACL. The first utilizes a conservative approach, where the aims are of returning the patient to pre-injury activities within 10-12 months following surgery.[76] The second, accelerated approach is aimed at enabling the patient to return to regular physical activities within 4-6 months. Whilst the choice regarding

which approach to follow is based on several factors, including patient characteristics and the type of graft used for reconstruction of the ligament, the accelerated approach has been shown to yield improved outcomes in young, athletic patients.[77] This patient group may be argued to be comparable demographic-wise to those injured in military settings.

With regards to guidelines regarding physical performance using the accelerated protocol, there is an emphasis on restoration of knee range of motion immediately following surgery.[78] Specific goals include achievement of 90 degrees of knee flexion within the first week following surgery, with progression to 125 degrees of knee flexion 4 weeks following surgery.[79] The methods used for achieving these targets include examiner-elicited passive range of motion exercises, as well as use of continuous passive motion devices. Incidentally, isokinetic dynamometers proposed for use in this project for assessment of knee muscle strength allow the option of performing continuous passive motion for rehabilitative-training purposes. Concurrently with range of motion training, the accelerated protocol also advocates incorporation of limb weight bearing exercises at a very early stage following surgery. Throughout these early stages, special attention and tailoring of treatment are based on patient tolerance, as well as contraindications such as visible joint swelling.[80] In addition, thigh musculature strength and proprioception exercises are initiated during the first two post operative weeks. These exercises progress in modality and difficulty, and include knee stabilization and perturbation training. Use of electrical muscle stimulation and biofeedback are often incorporated during this stage to facilitate musculature control. Lastly, functional activities such as running, jumping and cutting manoeuvres are introduced (approximately 2-3 months post operatively), with gradual return to the types of activity and intensity performed at pre injury levels. In contrast, conservative treatment advocates post surgical immobilization of the knee for up to 8 weeks and use of crutches for up to 12 weeks. This latter stage permits steady progression from partial to full limb weight bearing activities.[81] Muscle strengthening exercises are limited in the early stage to isolated knee extensor contractions.[82]

Currently, there is support for use of the accelerated program over the more conservative one.[83] However, there are concerns associated with the accelerated protocol; namely straining the graft at a stage where it is still healing.[84] Although there is a lack of data regarding ACL failure due to performance of activities incorporated in the accelerated protocol, it is interesting to consider that ACL re-rupture rates in the sport-participating population were

reported to be between 2.9% and 13% in a follow-up period ranging from 4 to 11 years.[85] Data from the US Army from 1990 to 1998 showed that 87.3% of subjects that underwent ACL reconstruction reported no re-injury.[86] In addition, during performance of the accelerated protocol pain experienced by the patient during the early phases may not only impede short term physical progress, but may also be speculated to result in negative affects which may prevent return to pre-injury activity level. As such, continuous monitoring of patient pain tolerance during the early phases of rehabilitation is imperative.

Lastly, deeming success of recovery from ACL injuries is ultimately judged by comparing the postoperative activity level achieved by the patient to their pre-injury activity level. A study by Kvist *et al.*[87] found that 53% of patients returned to their pre-injury activity level. This was found by administering a battery of self-reporting questionnaires including the Tampa Scale of Kinesiophobia (fear of movement) to patients 3-4 years after their ACL reconstruction procedure. These results are in agreement with a 56% rate of return to pre-injury activity levels reported in a review of 15 studies.[88]

Summary of the Problem

In summary, the literature reported that the prevalence of ACL injuries is higher in the military compared to the general population. Mechanisms of injury and risk factors were identified with some risk factors predisposing women more than men to this particular injury. In addition, the literature reports that complications exist after an ACL injury consequentially inducing more time away from physical activity and potential inability to return to pre-injury activity level. As part of interventions, identification of those risk factors that are most easily modifiable may reduce injury incidence rate. As part of the rehabilitative process in those already injured consideration of the aforementioned risk factors may aid in design of individualized treatment regimes. Lastly, we consider the reported rate of returns to pre-injury activity levels to be troublesome, especially in the context of the armed forces, where there is a potential for loss of personnel in roles that may be considered essential. We argue that the fact that a large proportion of injured patients do not return to the same level of activity is attributed to difficulties in clinical decision-making. These difficulties arise primarily due to the multifactorial nature of the problem, which demands scrutiny of current assessment procedures.

Considerations in the Standardizing of Assessment Methods

This section elaborates on the considerations in the choice of methods and equipment to be uses in the patient assessment process. Attention is brought forth towards advantages of using isokinetic dynamometry for the assessment of knee joint musculature strength, as well as to the measurement of several psychological constructs arising due to the injury itself and due to exposure to the surgical intervention. In this respect, it should be noted that the current project does incorporate tests related to performance of functional movements; however these will not be reviewed here.

Use of Isokinetic Dynamometry for Assessment of Knee Muscular Function

Strengthening of the knee musculature following surgical restoration of the ACL is a mainstay of the rehabilitative process. In this respect, the most advanced method of evaluating musculature capabilities is by use of isokinetic dynamometers. As will be elaborated, these high-end machines offer numerous advantages over other methods of strength evaluation when considering theoretical and practical psychometric factors relevant to the selection of outcome variables.[89]

Ensuring Patient Safety during the Assessment Process

The first factor to take into account is ensuring patient safety during the assessment process. In this respect, measurement of muscular strength using isokinetic dynamometry offers several distinct advantages.[90] First, the clinician is able to control several testing parameters in a manner that diminishes patient discomfort and minimizes chances of re-injury. These parameters relate to choices of testing range of motion and muscular contraction type, positioning within the device, as well as the angular velocity at which efforts are performed. Clinical decision-making regarding manipulation of these aspects are aided by several biomechanical studies that provide a quantitative estimate of forces at the knee as a function of knee range of motion during isokinetic testing.[91] In addition, dynamometers currently used by the CF are supplemented with a specialized attachment designed to eliminate the anterior translation of the tibia relative to the femur during knee extension movements, and hence minimize ACL strain during performance. Utilization of

these specialized attachments has the added advantage of allowing training through full knee extension at an earlier time point in the rehabilitative process. Lastly, perhaps the greatest advantage offered by isokinetic dynamometry with respect to patient safety relates to performance of movements at a predefined angular velocity. This, in effect, ensures that throughout the majority of the tested range of motion there are no adverse acceleration or deceleration phases, and hence injury mechanisms associated with these are eliminated. Current dynamometers used by the CF also incorporate cushioning properties such that a gradual and controlled change in velocity is achieved at end ranges of motion.

Accuracy of Isokinetic Measurements

Use of isokinetic dynamometry offers advantages relating to the quantitative nature of the outputs obtained, especially for prescribing of individual rehabilitation procedures. For example, test data can identify specific portions of the range of motion where muscular force producing capabilities are diminished, as well as enable accurate identification of bilateral muscular strength asymmetries for both knee extensor and flexor muscle groups. Another example relates to the accurate quantification of functional strength ratios of the knee flexors and extensors in different contraction types. In brief, it is thought that knee flexors play an important role in protecting the knee from re-injury during knee extension movements, as the eccentric action of the knee flexors tends to limit anterior tibial translation produced by the concentric action of the knee extensors. It has been proposed that a ratio composed of the eccentric strength of the knee flexors divided by the concentric strength of the knee extensors provides important information in this regard.[92] To accurately quantify this measure, termed the "dynamic control ratio",[93] one needs the ability to measure in a controlled manner different contraction types. This capability is exclusively offered by use of isokinetic dynamometry. It should be noted that the term "accuracy", in this respect, is related to the ability of strength output data obtained from isokinetic testing to detect small changes in performance that simply cannot be identified using other strength testing techniques, and specifically those related to commonly employed Manual Muscle Strength Training (MMT). In specifics, MMT is a clinical technique developed for the evaluation of joint range of motion and muscle group performance acting against gravity and examiner applied manual resistance.[94] Although there are several scoring criteria proposed in the use of the technique, the basic construct involves scoring of performance on an ordinal

scale ranging from 0-5, where zero indicates no movement of the limb when the agonist muscle groups are not directly acting against gravity and there is no visual or palpable indication of muscle contraction.[95] A score of five indicates that the tested joint exhibits a full range of motion when moved against gravity and that maximal strength is attainable when efforts are exerted against both gravity and examiner applied resistance.[96] The use of MMT for the assessment of muscular function has been severely criticized primarily due to the crudeness of the measurement scale which classifies a large portion of muscular strength capabilities as a score of four.[97] In particular, it has been shown in different muscle groups that the percentage of muscle strength needed to overcome gravity ranges between 4-20%.[98] Such efforts are given, by definition, a score of three on the MMT scale. As noted above, a score of five is given to maximal muscular strength capabilities. Thus, the vast portion of the strength capabilities of the muscle being tested lies somewhere within the scoring range 3-5, and is extremely influenced by the examiners subjective opinion. This subjectivity leads to an inability to detect clinically relevant changes in performance, especially if improvements are less than 25% of pre-intervention values.[99] This limitation is highlighted in specifics to recovery from ACL injury, where bilateral deficits of 25%-30% have been reported.[100] In addition, the reliability of MMT results, especially among different examiners assessing the same individual, is considered to be poor.[101] The poor inter-examiner reliability of MMT may be partially attributed to the lack of standardized testing procedures and also to differences in examiner experience. Although MMT limitations are well documented, this technique is still the most prevalent in clinical settings outside the research realm or highly funded public or private medical centres. The reasons for the continuous usage of MMT are likely attributed to cost and time effectiveness. However, given that several CF bases do have the necessary equipment, knowledge and practical experience related to the assessment of muscular strength using isokinetic dynamometer (see below); these may be harnessed to considerably improve upon current best practice.

Reproducibility of Isokinetic Measurements

Another important psychometric consideration relates to the issue of issue of reproducibility of measurements, and specifically to the magnitude of the inherent measurement error. The estimation of the measurement error is achieved using a test-retest experimental design, and the importance of this factor is due to the fact that it directly affects the establishment of the

confidence levels at which changes observed as result of intervention may be considered to be "real".[102] In addition, the current project necessitated the consideration of variations in scores that may arise from testing at different locations and by different personal. With regards to testing of the knee joint, several studies have been performed to address these issues, with general indications that variations in scores across testing sessions are small enough for detection of expected changes in muscular strength following intervention in healthy participants.[103] A smaller number of studies have evaluated the issue of performance reproducibility in patients following anterior cruciate ligament reconstruction,[104] with results indicating that the measurement precision would be sufficient to detect changes following rehabilitative intervention. To our knowledge no studies have been undertaken to evaluate the reproducibility of isokinetic obtained strength measurements in ACL deficient patients prior to surgical intervention.[105] In addition, the majority of studies listed have utilized isokinetic dynamometers that are not in current usage by the CF. On a related point, reproducibility measures reported upon in previous studies are based on specific testing protocols that may not be of direct relevance to the current project aims. Clearly, this mandates particular short term project goals associated with establishment of protocol specific reproducibility indices. However, it should be noted that even in light of the fact that only indirect and incomplete evidence is provided in support of acceptable reproducibility strength indices obtained using isokinetic dynamometry; these are still considered to be far superior in comparison to other methods used for the assessment of muscular strength.[106]

Practical Use of Isokinetic Dynamometry

In considerations of use isokinetic dynamometry and the standardization of measurement procedures it is of vital importance to assess whether these may be practically implemented. Such appraisal is specifically concerned with the availability of testing equipment in CF physical therapy units as well as whether the equipment is simple to operate and accepted to a degree that it is routinely used in clinical practice. In addition, associated costs need to be taken into account.[107] In addressing these issues, informal focus group meetings and communications with current CF physical therapy unit personal revealed that the same dynamometer type (Biodex System 3, Biodex Medical Inc., Shirley, New York, US) is present in 10 of the 26 service points: Cold Lake, Kingston, Valcartier, Halifax, Ottawa, Gagetown, Edmonton, St-Jean, Petawawa, and Trenton. This point is of because performance scores across different

dynamometers have been shown to be incompatible.[108] It was also revealed that that use of isokinetic dynamometry is used on occasion in some of the locations for the assessment and conditioning of knee musculature following various injuries (as well as other joints), and that clinicians are familiar to a some degree with operating procedures and the interpretation of test results. In terms of data storage, the particular dynamometer used by CF implements a standardized, accessible database using a commercial software program (MS Access, Microsoft Corporation, Redmond, WA, US). Exploitation of the underlying structure of this database may aid in reducing development cost for establishment of an inter-base strength database.

To conclude, establishing the use of isokinetic dynamometry for the assessment of thigh musculature function prior and after ACL surgical intervention is conceivable within the CF given the availability of equipment in several locations; current knowledge related to operational procedures; and the use of outputs for assessment of patient status. Given the advantages in the use of isokinetic dynamometry for objective quantification of relevant muscular strength parameters, standardization of assessment protocols using this specific device may potentially allow to establish clinical prediction rules for return to duty in a timely manner.

Rationale for the Assessment of Psychological Factors

In a recent review concerned return to sport following ACL reconstructive surgery, it was concluded that there is a need for understanding the role of contextual factors, such as fear of re-injury, in the decision-making process.[109] The need for assessment of such factors stems from potential negative mental consequences that may be developed as a result of the injury itself, as well as due to the preferred treatment option composed of surgical intervention. With regards to the latter, it is well documented that hospital patients admitted for surgery often find themselves in a personally threatening situation.[110] In particular, the anticipation of harm during surgery and the anticipation of pain and disability postoperatively may give rise to a variety of negative thoughts or feelings. As such, even surgeries categorized as minor interventions may be perceived as a major distressing experience by the patient.[111] In part, such patient perceptions may arise due to entrance into the highly regimented, technologically advanced health care system where they have little experience, and little control over their care. It has been suggested that when the average patient has such experiences, emotional responses of distress such

as feelings of fear or helplessness often follow.[112] Psychological stress of surgery may vary depending on factors such as preoperative psychological characteristics, the type of surgical procedures involved, overall prognosis, and feelings that events are out of one's control.[113] These latter feelings, in combination with the actual and unavoidable short term physical insult inherent to invasive surgery, may be contributing to the documented postoperative pain experienced in the first two or three days after the operation.[114] In specifics to ACL surgery, data has shown that 24-hour postoperative pain measures assessed while resting may reach an average score of 6/10, and pain while moving may reach an average score of 7/10. Pain while resting at 48-hours postoperative may reach an average score of 5/10 and pain while moving a score of 5.5/10.[115] In considering these data, it is important to note that patients were not restricted from post-operative pain medication usage.

Concurrent with the distress that may be experienced due to the surgical procedure; the injury itself often leads to individual negative consequences. That is, consideration of post-injury affective distress is important to consider in the rehabilitation process, as research findings have suggested that 5-13% of athletes report clinically significant levels of psychological distress, including feelings of separation and loneliness, following sport-related injury.[116] These data may have important implications for recovery from ACL reconstruction because post-injury disturbances in affect have been associated with poor adherence to physical rehabilitation protocols.[117] Research examining individual differences in recovery rates from surgery shows that an individual's interpretation of his/her life-events and how he/she affectively responds to such evaluations (i.e., anxious or depressive mood states) are associated with variations in recovery indices (e.g., range of motion) from ACL reconstructive surgery.[118]

Of the affective variables associated with pain, research has shown that individuals experiencing high levels of depression are likely to experience more intense pain.[119] Indeed, depression is significantly associated with heightened pain intensity in clinical and experimental pain populations.[120] Research has also shown that individuals experiencing high levels of anxiety are likely to experience more intense pain.[121] Further, specific research examining anxiety and pain following surgery has shown that individuals experiencing higher anxiety are likely to experience both higher pain and use greater amounts of postoperative medications.[122] Current surgical data shows that anxiety

in the postoperative period is a significant factor in predicting pain during recovery.[123]

There is also a growing body of research suggesting that catastrophizing may be of importance to recovery from surgery. Catastrophic thinking has been associated with slower and more complicated surgical recoveries,[124] and has been suggested to be the most significant single predictor of overall healing.[125] Pain catastrophizing has been defined as "an exaggerated negative mental set brought to bear during actual or anticipated painful experience".[126] Catastrophizing is viewed as comprising three separate but related dimensions: rumination ("I can't stop thinking about how much it hurts"), magnification ("I'm afraid that something serious might happen"), and helplessness ("There is nothing I can do to reduce the intensity of the pain"). A relationship between catastrophizing and subjective pain report has been demonstrated in experimental pain models and in several clinical populations.[127] Catastrophizing has also been shown to be associated with emotional distress states such as anxiety and depression, analgesic intake, duration of hospitalization, and occupational disability.[128]

In specific to post ACL reconstruction pain, Pavlin *et al.*[129] found that in line with predictions, pre-surgical pain catastrophizing scores were significant predictors of maximum pain scores and duration of time spent in the Post Anaesthesia Care Unit (PACU) when pain exceeded 3/10. In clinically meaningful terms, the maximum pain score in patients with high pain catastrophizing (PCS) scores (above the median) was 33% greater in PACU and 38% greater at 24 hours compared with pain scores in patients with low Pain Catostrophizing (PCS_ scores (below the median). Pain scores reported at rest (following discharge) did not differ between high and low PCS groups. However, pain with activity (walking) was 116% greater at 24 hours in patients with high PCS scores. The latter observation suggests a potential relationship may exist between PCS score and a patient's ability to perform rehabilitation manoeuvres. These findings suggest a case could be made for the inclusion of a measure of catastrophizing in the preoperative evaluation of patients prior to surgery and out into rehabilitation.

In sum, the surgery and sport-injury literatures have identified pain, affective distress, feelings of losing control, and catastrophizing as significant individual difference variables associated with increased postoperative pain and acute postoperative disability in general, and with reference to ACL surgical reconstruction. Other contextual constructs that were not discussed include

kinesiophobia (fear of movement) and confidence to return to sport, although they are concurrently assess with the latter factors. Several investigators have also shown that catastrophizing is associated with subjective and objective indices of disability outside of the acute postoperative period. These data may have important implications for the rehabilitation that follows the distressing acute in-hospital period of ACL surgery.

Work Done to Date

Several preliminary investigations were undertaken by our research team in preparation for implementation of the proposed standardized assessment procedures. These were accomplished simultaneously with testing of pre-surgical patients. At the time of submission, nearly 100 individuals have been tested. Of these, about half were healthy participants whose data was used for the establishment of a normative data base to which patients may be compared prior and following surgery, as well as for establishing between-day reproducibility of various strength indices. In addition, data from healthy participants were used to test basic assumptions related to use of strength scores in clinical settings. These include establishment of decision rules for ascertaining the type and level of effort produced during testing. A complete methodological description of the protocols utilized and additional results are provided elsewhere.[130] Lastly, initial patient data gathered prior to surgery were explored the robustness of pain catastrophizing scores within a testing session. Note that all procedures were approved by the relevant institutional review boards, and written informed consent was obtained from all participants prior to testing. In addition, it should be noted that we present in certain cases only a partial analysis of data, due to time constraints associated with the publication process.

Establishment of a Normative Strength Database and the Reproducibility of Relevant Isokinetic Derived Strength Measures

A common procedure in the assessment of patients' status is that of comparisons of individual strength measures to those obtained from individuals of similar demographic characteristics and who have not sustained injury. In addition, knowledge regarding the ability to reproduce results is a critical aspect of any test; as such information permits the clinician to declare with a certain level of confidence whether changes observed are reflective of measurement

error, or attributed to a "true" enhancement or deterioration in muscular force developing capabilities.[131] In this respect, variations in strength scores within and between testing sessions should be expected, as these are partially reflective of a healthy human motor control system.[132] However, procedures for muscle strength testing, and particularly using isokinetic dynamometry include several other systematic and random components that may contribute to increased measurement error. For example, unfamiliarity with movement at a constant velocity may result in consistently higher strength scores in repeated performance due to the participant learning to execute the movement correctly. With regards to random errors, these may occur, for example, due to differences between sessions in the alignment of the biological axis of the knee with the mechanical axis of the machine, as well as inconsistent stabilization of the body within the device. Thus, the effects of these and other sources of error need to be quantified, as they may influence outcomes measures upon which decisions are based.

For establishment of the normative database, we recruited a convenience sample who had no previous musculoskeletal injuries of the lower extremities or spine (26 men, age 22.8 ± 3.5 years; weight 81.2 ± 15.2 kg., height 180 ± 6 cm and 20 women, age 22.4 ± 2.3 years; weight 66.7 ± 9.1 kg., height 169 ± 6 cm). The participants were involved, on average, in 5 hours of weekly physical activities in a variety of individual or team sports performed at the intramural or competitive university level. None of the participants had previous experience with isokinetic dynamometry. Measurement reproducibility was established in this sample by performance of a 2nd testing session which took place on average 10 days following the first one. The procedures and set order emulated those performed in the 1st testing session, and testing was performed at the same time of day. Recordings of the physical setup used in the 1st testing session (i.e. chair distance from the dynamometer, seat height, seat pan depth, back rest angle, and lever arm length) were used to standardize the participant's posture within the device across the two testing sessions. The same investigators provided all instructions and performed all measurements in both testing sessions.

Following familiarization and practice, the concentric and eccentric muscular strength of the knee extensors and flexors of the dominant limb were measure using a non-reciprocal of three repetitions each, at testing velocities of 30 and 120 degrees per second. It should be noted that the participants also performed submaximal effort sets, which were used for other purposes (see

below). Ample rest of 2-3 minutes was provided in between testing of each muscle group and in between testing at different preset angular velocities. The Peak Strength Value (PM) for each repetition was extracted, and these were averaged across the three repetitions to yield representative individual strength scores.

Three aspects of reproducibility were explored:[133] the first is the assessment of bias between scores obtained in the two test sessions. This was achieved by calculation of the differences in mean scores and accompanying 95% confidence intervals.[134] The differences are reported either in the original units of measurement, or as percent changes in data log transformed to adhere to normality and uniform error of measurement assumptions). The second aspect assessed was the precision of measurements. This was done using the Typical Error (TE),[135] and by Limits of Agreement (LOA) method.[136] Based on the data used (original or log transformed), the TE is expressed either in the original units or as a coefficient of variation (TEcv, in %). Similarly, the LOA are expressed in either absolute or ratio form (i.e. ratio limits of agreement, RLOA). The third aspect explored is the assessment of relative reliability. This was achieved using Interclass Correlation Coefficient (ICC).[137]

Average peak moment scores for knee extension and flexion efforts for men and women are presented in Table 9.1 and 9.2, respectively. Percent differences in PM scores for both genders and for all efforts ranged between 0.1% and 2.9%, and were not statistically significant. The precision of measurements, as assessed using the TE, ranged between 3.8% and 6.1% for both genders and all efforts. Corresponding RLOA values indicate that for knee extension PM scores in both genders, it can be expected with 95% confidence that differences in test retest scores will be between 12.3% and 14.4% of each other. For flexion efforts, RLOA values obtained for concentric PM scores were slightly higher; ranging between 15.3% and 16.3%. For flexion eccentric efforts, RLOA values were the highest of all other efforts; ranging between 18.2% and 19.0%. ICC scores for males were above 0.90 irrespective of effort type. For females, ICC scores were above 0.85 for all effort comparisons.

Extension	**Day 1**	**Day 2**	**% Diff (95% CI)**	**TE (95% CI)**	**LOA**	**$ICC_{2,1}$ (95% CI)**
Ecc 120°/sec	269 ± 34	271 ± 36	0.8% (-1.8% to 3.6%)	4.0% (3.1% to 5.6%)	×/÷1.129	0.90 (0.79 to 0.95)
Ecc 30°/sec	269 ± 36	270 ± 38	0.1% (-2.4% to 2.7%)	3.8% (3.0% to 5.4%)	×/÷1.123	0.92 (0.84 to 0.96)
Con 30°/sec	200 ± 32	202 ± 33	1.1% (-1.9% to 4.2%)	4.6% (3.6% to 6.5%)	×/÷1.135	0.92 (0.83 to 0.96)
Con 120°/sec	162 ±33	164 ± 33	1.4% (-1.6% to 4.5%)	4.5% (3.5% to 6.4%)	×/÷1.134	0.95 (0.89 to 0.97)
Flexion	**Day 1**	**Day 2**	**% Diff (95% CI)**	**TE (95% CI)**	**LOA**	**$ICC_{2,1}$ (95% CI)**
Ecc 120°/sec	140 ± 34	144 ± 38	3.0% (-1.0% to 7.1%)	6.0% (4.6% to 8.4%)	×/÷1.186	0.92 (0.83 to 0.96)
Ecc 30°/sec	134 ± 31	138 ± 34	2.6% (-1.7% to 6.5%)	5.7% (4.4% to 8.0%)	×/÷1.182	0.91 (0.82 to 0.96)
Con 30°/sec	117 ± 36	118 ± 34	1.4% (-1.9% to 4.9%)	5.1% (3.9% to 7.1%)	×/÷1.160	0.96 (0.92 to 0.98)
Con 120°/sec	103 ± 29	105 ± 28	2.1% (-1.4% to 5.7%)	5.3% (4.1% to 7.4%)	×/÷1.163	0.95 (0.89 to 0.97)

Ecc = Eccentric; Con = Concentric. Diff = Difference; CI = Confidence Intervals. TE = Typical Error of Measurement. Note expressed as coefficient of variation where appropriate. LOA = Limits of Agreement. Note data is expressed in ratio form; ICC = Intraclass Correlation Coefficients.

Table 9.1: Men's mean (±SD) knee extension and flexion scores (Nm) for each contraction mode and testing velocity. Also presented are percent differences between days and accompanying 95% confidence intervals (CI); correlations between absolute difference scores and mean values of both testing session; LOA and ICC (95% CI). Partially adapted from Almosnino *et al.*[138]

Extension	Day 1	Day 2	% Diff (95% CI)	TE (95% CI)	LOA	$ICC_{2,1}$ (95% CI)
Ecc 120°/sec	191 ± 24	194 ± 28	1.0% (-2.5% to 4.6%)*	4.6% (3.5% to 6.9%)	×/÷1.144	0.89 (0.74 to 0.95)
Ecc 30°/sec	188 ± 20	192 ± 23	2.5% (-0.8% to 5.9%)*	4.3% (3.2% to 6.3%)	×/÷1.132	0.85 (0.65 to 0.93)
Con 30°/sec	139 ± 15	142 ± 16	1.9% (-1.3% to 5.1%)*	4.2% (3.1% to 6.1%)	×/÷1.128	0.86 (0.69 to 0.94)
Con 120°/sec	108 ± 12	110 ± 13	1.8% (-1.4% to 5.1%)*	4.2% (3.2% to 6.2%)	×/÷1.129	0.86 (0.69 to 0.94)
Flexion	**Day 1**	**Day 2**	**% Diff (95% CI)**	**TE (95% CI)**	**LOA**	**$ICC_{2,1}$ (95% CI)**
Ecc 120°/sec	94 ± 17	96 ± 19	2.4% (-2.1% to 7.1%)	6.0% (4.6% to 8.9%)	×/÷1.189	0.88 (0.74 to 0.95)
Ecc 30°/sec	91 ± 15	92 ± 16	1.2% (-3.4% to 6.0%)*	6.1% (4.6% to 9.0%)	×/÷1.190	0.86 (0.69 to 0.94)
Con 30°/sec	74 ± 15	76 ± 15	2.5% (-1.4% to 6.7%)*	5.3% (4.0% to 7.8%)	×/÷1.163	0.90 (0.76 to 0.96)
Con 120°/sec	67 ± 13	68 ± 12	1.8% (-1.9% to 5.7%)	4.9% (3.7% to 7.3%)	×/÷1.153	0.93 (0.85 to 0.97)

Ecc = Eccentric; Con = Concentric. Diff = Difference; CI = Confidence Intervals. TE = Typical Error of Measurement. Note expressed as coefficient of variation where appropriate. LOA = Limits of Agreement. Note data is expressed in ratio form; ICC = Intraclass Correlation Coefficients.

Table 9.2: Women's mean (±SD) knee extension and flexion scores (Nm) for each contraction mode and testing velocity. Also presented are percent differences between days and accompanying 95% confidence intervals (CI); correlations between absolute difference scores and mean values of both testing sessions; LOA; and ICCs (95% CI). Partially adapted from Almosnino *et al.*[139]

This investigation reports upon the acquiring of normative strength values of the knee musculature using non-reciprocal test protocol meant at measuring concentric and eccentric strength of the knee extensors and flexors at two different testing velocities in a group of healthy young adults. These values will be used to compare patient status to prior and after surgical intervention. In addition, this investigation establishes the between day reliability of the most

common used strength index used in clinical setting, namely peak strength, using the same type of isokinetic dynamometer in use by the CF. For both muscle groups, and irrespective of gender, precision of measurement of PM concentric and eccentric contractions is deemed sufficient to detect expected changes in strength as a result of targeted intervention for the knee musculature, as well as for identification of relatively small diversions in strength from normative values. In addition, the utilized protocol was sufficient to eliminate any possible bias between test sessions, and thus a familiarization session may not be required in testing of participants with similar characteristics. It should be noted that this investigation also established the precision of measurement of commonly utilized strength ratios, and readers are referred to appropriate references for elaboration.[140]

Validity of Isokinetic Strength Scores – Decision Rules for Ascertaining Type of Effort Produced

During assessment of muscular strength in rehabilitative settings, it is essential to determine the type and level of effort exerted by the patient during testing, as these may influence the values of outcome measures upon which decisions are based. In particular, it is imperative to assure that maximal effort was produced by the participant for valid comparisons of strength scores attained from the uninjured limb, or for comparison to normative values. On the other hand, assertion of submaximal effort production may be of value, as performance of these types of effort may be suggestive of underlying psychosocial issues that may of clinical interest. Some of these causes may include the presence of injury or pain; apprehension to perform due to fear of injury or pain; misunderstanding of examiner instructions; anxiety; depression; post traumatic stress disorder; lack of understanding regarding the importance of the test; low self-efficacy, and motivation of secondary financial gain.[141]As such, there is a need to establish decision rules for ascertaining the type of effort produced during knee isokinetic testing.

For establishment of such decision rules, our research team exploited a well described phenomena related to very little variations in the shape and magnitude of strength curves obtained from succeeding maximal effort repetitions.[142] On the other hand, previous research and clinical observations suggest that the variations between successive repetitions during performance of submaximal efforts are considerably larger. These variations seem to be manifested in the relative magnitude of the strength exerted, as well as in

differences in the shapes of succeeding strength curves.[143] To quantify these aforementioned phenomena, we proposed use of time series analysis measures that have not been applied previously to the analysis of isokinetic strength-time curves. The first measure is the zero lag, normalized Cross Correlation (CC). This measure is computationally similar to that of Pearson's Product Moment Correlation coefficient, with a score range from -1 to 1. In terms of interpretation, a score closer to the upper limit indicates a high degree of curve shape similarity. The second measure, used for complementary assessment of differences in curve magnitudes is the Percent Root Mean Square Difference (%RMSD). A score closer to zero percent difference is indicative of minimal differences in strength magnitude outputs. Utilizing these two measures, we aimed at establishing probability based decision rules for declaration of efforts as being maximal or not.

We utilized CC and %RMSD scores obtained from the maximal and submaximal effort sets (see description in the methods of the normative strength database and reproducibility subsection) as inputs for prediction models estimated using logistic regression. The cut-off scores were set such that in no case would a maximal effort be misclassified as a submaximal one (i.e. test specificity set to 100%). When an acceptable level of corresponding test sensitivity was detected, we made efforts to generalize our results further to new or larger samples by way of Monte Carlo simulations. Practically, following performance of a set, the clinician inputs CC and %RMSD scores obtained into the prediction equations. If the equation results in a value above the prespecified threshold, efforts are declared as submaximal with a certain level of confidence. On the other hand, if the equation results in a value below the pre-specified threshold, the effort performed is declared to have being maximal.

Table 9.3 outlines the decision rules obtained for each muscle group in performance of efforts at the two angular velocities of 30 and 120 degrees per second. In addition, decision rule performance in terms of test sensitivity and number of misclassifications are also provided. Evidently, the decision rules for classification of extension effort types are superior to those obtained for the knee flexor muscle group, irrespective of testing velocity. The decision rules for the knee extensor muscle group are comparatively better than those reported in previous investigations.[144] With regards to the relatively low performance of decision rules obtained for the knee flexors, a possible methodological issue that may have contributed to the results is the fact that preset

strength thresholds needed to be exceeded in order to initiate movement of the dynamometer's lever arm. Optimal setting of these thresholds may enhance the ability to discriminate between effort types for this specific muscle group.

	#	Description	Decision Rule	Sn (%)	Number of misclassifications*
Extension 30°sec^{-1}	**1**	Cutoff set to maximize the sensitivity while maintaining 100% specificity in development sample	Declare maximal effort if: 29.73(CC) -0.51 (%RMSD) >12.92	92.4	7/184 (1/92-6/92)
	2	Cutoff set to maximize the sensitivity while maintaining 99.0% specificity in simulation study.	Declare maximal effort if: 29.73(CC) -0.51 (%RMSD) >11.47	90.2	10/184 (1/92-9/92)
	3	Cutoff set to maximize the sensitivity while maintaining 99.9% specificity in simulation study.	Declare maximal effort if: 29.73(CC) -0.51 (%RMSD) >9.07	84.8	14/184 (3/92-11/92)
Extension 120 °sec^{-1}	**4**	Cutoff set to maximize the sensitivity while maintaining 100% specificity in development sample	Declare maximal effort if: 22.39(CC) -0.324 (%RMSD) > 8.33	84.8	14/184 (9/92-5/92)
	5	Cutoff set to maximize the sensitivity while maintaining 99.0% specificity in simulation study.	Declare maximal effort if: 22.39(CC) -0.324 (%RMSD) > 6.55	77.2	21/184 (10/92-11/92)
	6	Cutoff set to maximize the sensitivity while maintaining 99.9% specificity in simulation study.	Declare maximal effort if: 22.39(CC) -0.324 (%RMSD) > 4.54	65.2	32/184 (18/92-14/92)
Flexion 30°sec^{-1}	**7**	Cutoff set to maximize the sensitivity while maintaining 100% specificity in development sample	Declare maximal effort if: 11.41(CC) -0.27 (%RMSD) > 0.70	56.5	40/184 (22/92-18/92)
Flexion 120°sec^{-1}	**8**	Cutoff set to maximize the sensitivity while maintaining 100% specificity in development sample	Declare maximal effort if: 22.65(CC) -0.13 (%RMSD) > 12.86	46.7	49/184 (27/92-22/92)

Sn = Sensitivity, expressed as a percentage. * Number in parenthesis are the misclassifications out of the total number of efforts in each testing day.

Table 9.3: Performance of decision rules for ascertaining maximal knee extension/flexion efforts. Adapted from Almosnino *et al.*[145]

Robustness of Pain Catastrophizing Scores during Isokinetic Testing of Anterior Cruciate Ligament Deficient Patients

Measurements of isokinetic knee musculature strength as well as pain catastrophizing behaviour prior to ACL reconstruction may serve as a baseline to which post operative patient status may be compared. For attaining maximal voluntary contractions during isokinetic testing, clinicians routinely employ various patient targeted psychological interventions meant to enhance motivation as well as reduce apprehension. However, these regular clinical practices may also influence immediate PCS behaviour, and hence confound baseline measurements of this psychological construct. As such, we aimed at assessing the robustness of PCS scores obtained during knee strength testing of unilateral ACL deficient patients.

Twelve men (age: 26±4 yrs) and ten women (age: 25±5 yrs) with unilateral ACL deficiency performed bilateral isokinetic knee musculature strength testing. The healthy knee was tested first, and testing of each leg encompassed 2 sets of 6 concentric extension-flexion repetitions at angular velocities of 60 and 180 degrees per second. During the warm-up phase and during testing, the examiner attempted to increase confidence and reduce possible fear of pain or injury aggravation by providing targeted verbal and visual feedback on performance. PCS scores were obtained using the PCS scale questionnaire prior to testing; between testing of the healthy and injured leg; and at completion of all efforts. The PCS Scale[146] consists of 13 items describing different thoughts and feelings that individuals may experience when they are in pain. The PCS yields a total score and subscale scores for rumination, magnification and helplessness. The PCS total and PCS subscales have been shown to have good to high internal consistency (Cronbach's alphas: total = .87, rumination = .87, magnification = .66, helplessness = .78).[147] Differences in PCS scores within the testing session were assessed using one-way ANOVA with repeated measures.

Omnibus test results indicate non significant statistical differences in PCS scores as a function of questionnaire administration occurrence (mean PCS scores 12.5, 11.9, and 11.2 for pre, mid, and post test occasions, respectively, $p = 0.26$). As such, we conclude that the construct of PCS was unaffected by psychological interventions regularly employed during muscle strength testing. From a practical perspective, the PCS scale questionnaire can thus be administered at a time of convenience during pre-operative isokinetic testing in this specific patient population.

Goals and Future Work

This section briefly elaborates on several methodological, administrative and practical questions that need to be addressed in the immediate future for successful implementation of the proposed assessment program. With regards to isokinetic strength measurements, our immediate goals involve establishing decision rules for ascertaining maximal effort production in pre-operative patients. As noted previously, this is a crucial aspect related to muscular strength testing in light of current practices related to use of strength scores in the clinical realm. In addition, we have identified a void in the literature with regards to reproducibility of strength measurements in the pre-operative ACL deficient patient population. Establishment of the margins of error associate with measurements expected in these patients would allow us to ascertain whether observed changes post surgery is in fact attributable to treatment. In addition, we plan on exploring data analysis techniques that would allow us to declare the presence of injury solely based on biological signals, such as those obtained using isokinetic dynamometry.

In close agreement with recommendations provided by Rowe and Hébert[148], we perceive a need to establish a centralized, robust database of assessment outcomes obtained from multiple sites. This database should be incorporated into the proposed national surveillance system,[149] as ultimately the success of the proposed methods would have to be assessed longitudinally in relationship to re-injury rates and types of activities performed after rehabilitation. In this respect, it is important to structure the database in a manner that allows researchers to access data without compromising patient privacy. In addition, standardizing patient assessment procedures requires agreement among stakeholders regarding their practically. After reaching a consensus on these matters, uniform clinician training in the proposed methods is imperative in order to reduce variations in outcomes resulting from testing at multiple sites. The training should incorporate both theoretical aspects of measurement, as well as hands-on experience in assessment procedures. In order to accomplish such training in a cost-effective manner, we propose use of instructional videos, or perhaps conducting an online class where clinicians from multiple sites are able to participate simultaneously. Such an approach will directly address another recommendation made by Rowe and Hébert related to increasing resources available to clinicians.[150]

In conclusion, this chapter has outlined the problems associated with injury to the ACL and a proposition to standardize assessment methods in order to enable construction of clinical prediction rules for safe and effective return to military duties. Our proposed approach is unique in the sense that incorporates both physical and psychological function measures, and this multidisciplinary approach has been advocated in light of the need to improve upon rehabilitative decision-making in this particular patient population.[151] We find the proposition to be suitable and feasible in terms of implementation within the CF, particularly due to the availability of advanced testing equipment and the current clinician expertise in its usage. Such implementation would optimize individual patient care in manner that complements the current high level of treatment offered within the CF.

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CHAPTER 10

High Level Mobility Measurement in Canadian Forces Amputees

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ABSTRACT

Pasquina & Fitzpatrick (2006) reported that military service members who have sustained traumatic lower extremity amputations often demonstrate physical capabilities beyond those measured by current outcome measures. For example, they reach maximum scores on a number of amputee-specific outcome measures shortly after being fitted with their initial prosthesis. As such, the Comprehensive High-level Activity Mobility Predictor (CHAMP) was developed by Gailey, Scoville and the CHAMP research team in the US.[1] CF members are often referred to as tactical athletes; our ill and injured members are no different. The CHAMP is an easily administered, clinically friendly measure free of a ceiling effect in highly functionally individual that discriminates between levels of amputation.[2] Findings from the CHAMP project, as well as findings in CF lower extremity amputee population are discussed and reviewed.

High-Level Mobility Measurement in CF Amputees

There are currently a number of outcome measures that can be used in the clinic to evaluate and/or track the functional progress of an individual rehabilitating after a lower extremity amputation. These measures include but are not limited to the Timed Up and Go, Two-minute Walk Test, Frenchay Activities Index, Amputee Mobility Predictors, and the Locomotor Capabilities Index. However, when applied to high-functioning individuals, these tests are often not sufficiently sensitive to measure clinically significant gains.[3] This lack of sensitivity resulted in the need for an instrument to measure: 1. The baseline functional ability of the individual with a lower extremity amputation; 2. The

physical limitations of this individual which need to be addressed in physical therapy; 3. How these abilities change over time; 4. The readiness to return to higher level activities; and 5. The readiness to return to the individual's previous activities and more specifically for CF members, the ability to return to active duty or combat.[4] This readiness could also be translated to other high-level occupations, such as a police officer or firefighter, or high-level recreational activities.

Pasquina and Fitzpatrick (2006) described the use of existing outcome measures for a population of young, athletic US military service members with lower limb loss during rehabilitation at Walter Reed Army Medical Center.[5] They observed that maximum scores on current outcome measures, such as the Amputee Mobility Predictor, were reached shortly after the service members were fitted with their initial prosthesis.[6] They concluded that there was a need to develop and improve outcome measures of high level mobility for this specific population. The development of a new outcome measure to determine current levels of performance and predict future performance of service members would be extremely useful to help guide rehabilitation, return to sport, and aid in discharge planning. To address this need, Gailey, Scoville and the CHAMP research group reviewed existing high-level mobility measures under the spheres of balance and postural stability, as well as coordination, power, speed and agility in order to develop a measure that could be performed by all lower limb amputees, that would demonstrate excellent inter-rater and test-retest reliability, be free of a ceiling effect, demonstrate concurrent and construct validity, as well as be responsive to change over time.[7] The CHAMP was created from a combination of performance-based assessment instruments from the amputee and able-bodied literature that measure the physical performance factors of high-level mobility.[8]

The CHAMP researchers report a strong correlation between the total CHAMP score and the Amputee Mobility Predictor ($r = 0.87$, $p < 0.0001$) and the Six-minute Walk Test ($r = 0.80$, $p < 0.0001$), respectively.[9] Study results demonstrated the inter-rater ($r = 1.0$; 95% CI: N/A) and test-retest reliability ($r = 0.97$; 95% CI: 0.95 – 0.98) of the total CHAMP score to be excellent.[10] They encourage readers to watch for future publications in the *Journal of Rehabilitation Research & Development* that will explain they project in greater detail.

The first item: Single Limb Stance (SLS), measures balance and proprioception. It has been found to be a strong indicator in the capacity to ambulate.[11] The client is asked to fold their arms across their chest and lift one foot 15.2 cm off the floor for a maximum of 30 seconds. Participants perform between 1-3 trials per lower limb. Once 30 seconds is achieved on one limb, no further trials are performed with that limb. If the raised foot touches the floor, the foot is not maintained above the 15.2 cm marker, arms come uncrossed or the stationary foot loses contact with the floor (i.e. hopping) the trial is concluded.[12] The best stance time of both limbs are combined into a composite time, maximum being 60 seconds between both limbs.

The Edgren Sidestep (ESS) test assesses lateral speed and agility. On a 4 meter open floor space with each meter separated by a cone, patients sidestep back and forth to the outside cones as rapidly as possible. Participants are given 10 seconds and may have up to two trials, with a 60 second rest period between each trial. A trial is concluded if participant fails to keep their trunk and feet pointing forward at all times, fails to reach the end lines or cross their legs.[13] The higher the score, or greater the number of meters covered, the better their performance.

The T-Test (TT) is a timed assessment of the individual's ability to move through a course shaped like the letter "T", covering an open floor area of 10 meters by 10 meters. Participants are asked to walk or run as fast as they can in forward, side-to-side, and backward movements. Participants have two trials, with a rest period of 60 seconds in between. If a participant fails to keep their trunk and feet pointing forward at all times, run the course as instructed, reach the end lines or complete the course as well as move any cones or cross their legs more than once the trial is concluded.[14] The lowest time is chosen representing their best performance.

Finally, the Illinois Agility Test (IAT) adds the assessment of the individual's ability to move from a prone-to-standing position, accelerate, decelerate and weave through obstacles. Participants begin the test lying prone on the floor with their arms at their side. They are asked to walk or run as fast as they can up and back, then weave up and back through four cones and again, walk or run up and back over 10 meter distance. Participants have two trials, with a rest period of 60 seconds in between. A trial is concluded should a participant fail to run the course as instructed, reach the end lines, complete the course or

moves any cones.[15] The lowest time is again chosen, representing their better performance.

The CHAMP team created a 0-10 scoring system for the four CHAMP test items. The scores for the four CHAMP test items are added together to produce a total CHAMP score. The total CHAMP score ranges from 0 to 40, with 40 representing the highest level of performance. A comprehensive manual complete with standardized tester instruction to the participant accompanies CHAMP. The CHAMP team encourage testing to be performed using this standardized manual.

In Canada, the CF Physical Rehabilitation Program has been collecting CHAMP scores in its actively rehabilitating or recovering ill and injured population since 2010. It is being used clinically, both as an assessment tool and a functional treatment program. CF members are not restricted in their use of a mobility aide or to a certain type of prostheses when being used clinically. CHAMP is also being used as a bi-annual, national CF Physical Rehabilitation Program performance measurement tracking tool. For this purpose, members are tested using their functional everyday prostheses, while those still using ambulatory aides are recorded as not being able to meet the testing requirements. Unfortunately, due to medical restrictions or scheduling and logistical issues, only approximately 50% of the still serving CF lower extremity amputee population has been assessed using the CHAMP. Despite the small sample size, similar results are noted between the US and Canadian military amputee populations.

Results and Discussion

During Phase I of the American research, the CHAMP items were evaluated on 97 uninjured US Service Members. In Phase II, the CHAMP items were evaluated on 118 active duty and retired US Service Members (43 from Brooke Army Medical Center, 39 from Walter Reed Army Medical Center, and 36 from Fort Bragg) with at least one lower extremity amputation due to trauma.[16] As per Table 10.1, the researchers were able to test a sample at the major levels of lower extremity amputation, including individuals with bilateral involvement.

	PHASE II	PHASE I
Total number of participants	118	97
Age (years)	29.1 ± 5.7	26.1 ± 5.5
Height (cm)	181.6 ± 7.1	177.9 ± 6.5
Weight (kg)	90.6 ± 15.6	82.3 ± 10.5
Unilateral Transtibial: n (%)	60 (50%)	
Unilateral Transfemoral: n (%)	32 (27%)	
Bilateral Lower Limb Amputee: n (%)	26 (23%)	
• Bilateral Transtibial: n	12	
• Bilateral Transfemoral: n	7	
• Unilateral Transtibial / Unilateral Transfemoral: n[17]	7	
Time since injury (years)	3.2 ± 2	
Military Status: n (%)		
• Currently in Rehabilitation	31 (26%)	
• Discharged from Rehabilitation	11 (9%)	
• Active Duty Non-Deployed	22 (19%)	
• Active Duty – Deployed	10 (8%)	
• Retired	44 (37%)	

Table 10.1: Phase I and II Results from Brooke Army Medical Center, Walter Reed Army Medical Center and Fort Bragg American Testing Sites. Printed with permission from Ignacio Gaunaurd from the CHAMP testing team.[18]

In Canada to date, 16 of the 33 currently still serving lower extremity amputees have undergone CHAMP testing. As far as data collection in the CF, we have kept all amputation levels distinct. As such, the sample tested to date includes: seven (44%) unilateral transtibial amputees, two (13%) unilateral transfemoral amputees, two (13%) bilateral lower limb amputees, one (6%) partial foot amputee, three (19%) knee disarticulation amputees, and one (6%) hip disarticulation amputee. With respect to the uninjured members' scores, we have relied on our US allies large sample size normative values. We acknowledge that this American sample may not be fully representative of the current CF population profile with respect to gender or age and hope to collect our own normative values in the near future. The average time since

injury for the Canadian sample was 2.04 years. Only one of the subjects tested thus far has met all the requirements for universality of service. Highly motivated CF members with lower extremity amputations who have redeployed, have yet to also be captured in our data.

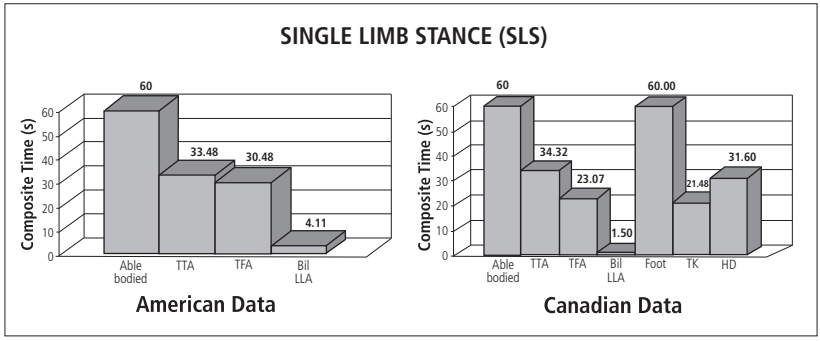

Figure 10.1: Single Limb Stance data. Printed with permission from Ignacio Gaunaurd from the CHAMP testing team.[19]

With respect to the CHAMP study, three unilateral transtibial US service members performed at the able-bodied range.[20] Of the 16 CF members measured thus far, only one partial-foot amputee performed at the able-bodied range. The ability to solely stand on an affected amputated lower extremity is a physical task military members may need to perform at any given point in their career. Military drill, navigating unpredictable military terrains, climbing ladders, getting in or out of military vehicles and donning or doffing protective Nuclear, Biological, Chemical equipment are but possible tasks requiring an independent single leg stance.

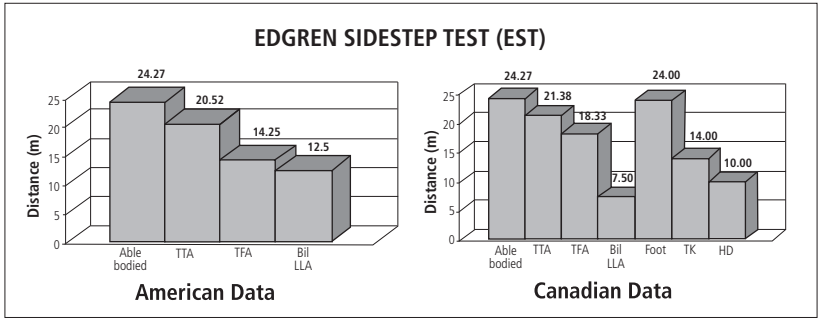

Figure 10.2: Edgren Sidestep Test performance. Printed with permission from Ignacio Gaunaurd from the CHAMP testing team.[21]

Our American colleagues report 53% of the unilateral transtibial amputees as well as 12% of the bilateral lower extremity amputees measured during their study performed at able-bodied ranges.[22] However, none of the unilateral transfemoral amputees were reported to have met the fresh hold. Again, the Canadian partial-foot amputee along with three unilateral transtibial amputees still serving in the CF were able to perform at the able-bodied range thus far. Due to the small size of our cohort, our results cannot be validated statistically, but we can affirm that the unilateral transtibial amputees' performance in both Canada and the US is superior to other amputation levels for the ESS.

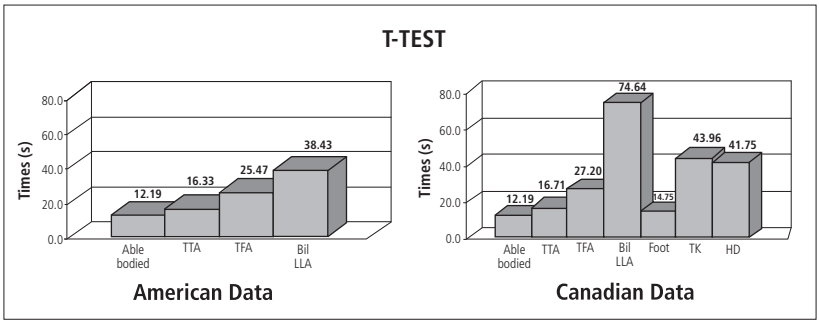

Figure 10.3: T-Test performance. Printed with permission from Ignacio Gaunaurd from the CHAMP testing team.[23]

Figure 10.3 demonstrates significant difference in performance between all amputation levels compared to the uninjured service members, via a clear step graphical representation. Of note, 54% of unilateral transtibial and 8% of bilateral lower extremity amputees were able to perform at able-bodied ranges in the US.[24] None of the CF unilateral transfemoral amputees were reported to have met the able-bodied range. The CF partial-foot amputee along with three CF unilateral transtibial amputees performed close to the able-bodied range. Of interest, the two unilateral transtibial amputees that almost successfully met able bodied time scores for the TT were not the same CF members performing the ESS Test at able bodied distances.

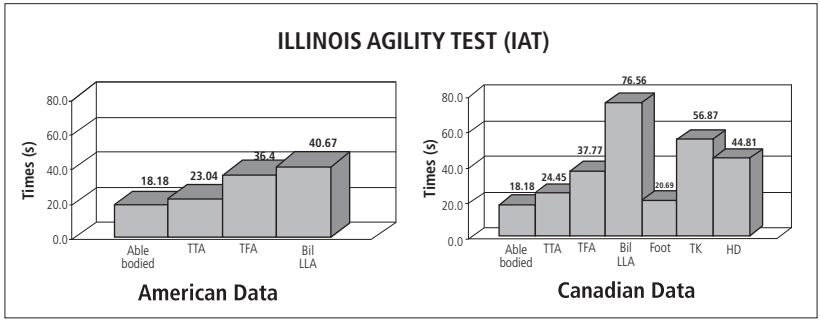

Figure 10.4: Illinois Agility Test performance. Printed with permission from Ignacio Gaunaurd from the CHAMP testing team.[25]

Finally, 58% of unilateral transtibial and 4% of bilateral lower extremity US service members participating in the CHAMP study performed at the able-bodied range.[26] Again, no CF unilateral transfemoral amputees reached the able bodied threshold. The CF partial-foot amputee along with two CF unilateral transtibial amputees performed close to the able-bodied range. One CF unilateral transtibial amputee, however, performed at the able-bodied range. When collecting CHAMP data on clients during the earlier phases of rehabilitation or amongst those with greater impairments, rehabilitation clinicians see significant variances in time scores likely due to the requirements for rapid changes in body position from prone to standing in the IAT.

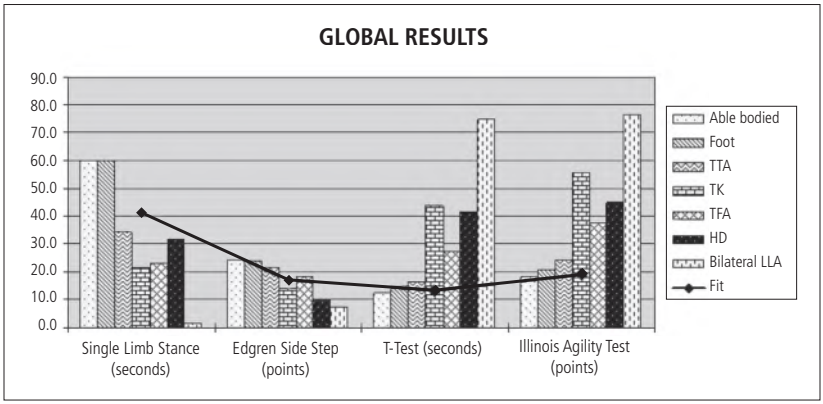

Figure 10.5: Graphical representation of CF members with lower extremity amputation CHAMP performance with an overlapping line graph representing results of a CF unilateral transtibial amputee having met universality of service requirements.

Of interest, only one of the few lower extremity CF amputees tested to date has met the universality of service requirements of being physically fit, employable and deployable. This member had never seen or heard of the CHAMP prior to participating in our data collection. He performed close to and at able-bodied ranges for both the TT and IATs respectively. Unipodal stance and quick lateral side stepping tasks, measured by the SLS, ESS and IAT tests, were tasks that rehabilitating CF members reported not routinely practicing or remember being exposed to during their rehabilitation. These are now elements incorporated into CF members' physical conditioning programs through CHAMP's detection of these relative performance shortfalls. None of the CF unilateral or bilateral lower limb amputees tested to date have performed at able-bodied ranges in all of the subsets of the CHAMP.

Conclusion

The CHAMP results presented here are relatively intuitive. One would predict based on clinical experience that higher levels of amputation would perform less well. Moreover, it appears that as a general rule, along with the results from our American colleagues, bilateral transtibial amputees are more functional than unilateral trans-femoral amputees.[27] Clearly, active knee-joint control has a significant impact on multi-directional activity. Although the CF Physical Rehabilitation Program has only been able to track small sample numbers, the CF results are similar to the US military results when one accounts for the minor discrepancies. The fact that few transfemoral amputees were able to perform in the able-bodied ranges may be representative of a floor effect, physical tasks may have been too difficult for them under the set scoring parameters. However, as military men and women constantly seek out challenges in fulfilling their need to compete and perform, CHAMP possesses the psychometric properties to measure functional progress and justify clinical interventions over time in high-functioning individuals. While clearly discriminating between amputation levels, CHAMP should assist in establishing realistic clinical prediction rules for lower extremity military amputees in the future. It will also be interesting to use CHAMP in future CF research initiatives. Identifying whether Computer Assisted Rehabilitation Environment (CAREN) training has any effect in balance, postural stability, coordination, power, speed and agility CHAMP measures being one example of future direction.

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17 Linberg, *et al.* "Reliability of Five High-level Activity Measures Established for Military Service Members with Traumatic Lower Limb Loss".

18 Gailey, *et al.* "The Reliability and Validity of the Comprehensive High-level Activity Mobility Predictor (CHAMP) Established for Military Service Members with Traumatic Lower Limb Loss."

19 Gaunaurd, *et al.* "Speed and Agility Testing of Military Service Members with Traumatic Lower Limb Loss."

20 Gailey, *et al.*, "The Reliability and Validity of the Comprehensive High-level Activity Mobility Predictor (CHAMP) Established for Military Service Members with Traumatic Lower Limb Loss".

21 Gaunaurd, *et al.* "Speed and Agility Testing of Military Service Members with Traumatic Lower Limb Loss".

22 Gailey, *et al.* "The Reliability and Validity of the Comprehensive High-level Activity Mobility Predictor (CHAMP) Established for Military Service Members with Traumatic Lower Limb Loss."

23 Gaunaurd, *et al.* "Speed and Agility Testing of Military Service Members with Traumatic Lower Limb Loss".

24 Gailey, *et al.* "The Reliability and Validity of the Comprehensive High-level Activity Mobility Predictor (CHAMP) Established for Military Service Members with Traumatic Lower Limb Loss".

25 Gaunaurd, *et al.* "Speed and Agility Testing of Military Service Members with Traumatic Lower Limb Loss".

26 Gailey, *et al.* "The Reliability and Validity of the Comprehensive High-level Activity Mobility Predictor (CHAMP) Established for Military Service Members with Traumatic Lower Limb Loss."

27 Gaunaurd, *et al.* "Speed and Agility Testing of Military Service Members with Traumatic Lower Limb Loss."

CHAPTER 11

Depression as a Precipitant to a Disability Following an Upper Extremity Work-related Injury: A Preliminary Investigation

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ABSTRACT

Little is known about the impact of depression on occupational injuries, particularly among workers claiming compensation benefits due to Musculoskeletal (MSK) injuries. Workers with MSK conditions who are depressed have sick leave durations that are twice as long as individuals with musculoskeletal conditions who are not depressed. With the objective of determining if depression preceded the injury, WSIB claimants with a work-related upper-extremity injury completed the Hospital Anxiety Disorder Survey (HADS). 104 patients completed the Disabilities of the arm, shoulder and hand (DASH) questionnaire, the SF36 Health survey, the Work Limitations Questionnaire and the Work Instability Survey. The cohort consisted of 71% shoulder, 18% hand and 11% elbow-injured patients. The depressed patients were significantly more disabled according to the DASH score than the non-depressed patients and had significantly worse physical and mental component scores on the SF36. Of the 19% of our cohort that reported being depressed, 69% of those reported being depressed before their work injury, which is double the Canadian national average. This finding lends credibility to the hypothesis that depression may be associated with, and possibly a risk factor for disability following upper extremity MSK occupational related injuries.

Introduction

The latest statistics from the Association of Workers Compensation Boards of Canada indicate that Ontario is responsible for 25% of all lost-time claim compensations following a work-related injury in Canada which amounts to millions of dollars for total benefit costs incurred[1] The Ontario WSIB statistics indicate that MSK injuries account for more than 50% of all reported injuries, with the upper extremity second only to the back in terms of body part affected.[2] MSK injuries are the most documented type of injury among military service members.[3] While the prevalence of upper extremity injuries in the military are not well-documented, those that have been reported, negatively impact military members' activities of daily living, leisure participation, and military duty readiness and moral.[4]

Depression is associated with work absences and lost productivity that persist even when the effects of socio-demographic, job and other health characteristics are taken into account.[5] Workers with MSK conditions who are depressed have sick leave durations that are twice as long as individuals with MSK conditions who are not depressed.[6] Recently published information examining depression among Canadian military members found depression rates of 7.6% for men and 11% for women, which is above the national Canadian average.[7]

Twenty years ago the hypothesis regarding depression as a risk factor for work injury began to emerge.[8] Before this time, the injury was seen as the precipitant of the depression in persons who were viewed as otherwise psychologically healthy.[9] Little is known about the impact of depression on occupational injuries, particularly among workers receiving compensation benefits due to MSK injuries. One study which examined depressive symptoms in the work disability process identified depression as a determinant of prolonged time on benefits for workers with MSK disorders.[10] They did not, however, examine or report on depression pre-injury.

The motivation for the current study stems from past work examining the health characteristics, work limitations and work instability of 460 WSIB claimants with upper extremity injuries.[11] We found that workers who were at high risk for work loss according to the Work Instability Scale had significantly greater difficulties with performance on mental tasks. These individuals also demonstrated significantly worse SF36 mental functioning scores

indicated that mental health, perhaps more than physical health may associated with their work instability. This led to the question of depression as a possible risk factor for work-related upper-extremity injuries.

Purpose of the Study

With the objective of determining if depression preceded or was a result of an injury, the HADS was added to the data collection in a clinic of WSIB claimants referred with a work-related upper-extremity injury. The preliminary results are presented.

Methods

Approximately 150 patients are annually referred to the Ontario WSIB Clinic in this study because they are in need of advanced assessment, investigations and treatment planning, and/or recommendations regarding return to work capabilities and prognosis. The clinic is staffed by specialty-specific medical experts, physiotherapists and occupation therapists. After their initial visit, many patients will return for a follow-up visit related to their initial assessment, and a few former patients may be visited again for re-assessment, as directed by the WSIB. In addition to collecting their demographic and medical information, each patient was approached by a research nurse and asked to provide informed consent allowing us to store their questionnaire data in a registry for WSIB research-related purposes. These questionnaires included the DASH questionnaire, the Visual Analogue Scale (VAS) for pain, and the SF36.[12] In addition, patients who were still active at their workplace were asked to complete the Work Limitations Questionnaire (WLQ) and the Work Instability Survey (WIS).[13] In late 2009, HADS was added to the battery of questionnaires for data collection.[14] Approval for this descriptive study was granted by our Institutional Human Ethics Review Board.

The DASH questionnaire is used to assess physical function and symptoms of the upper limb. Responses to the individual items are summed, averaged, and transformed to a standardized score of 0-100, with a higher score indicating greater disability. The SF36 is a generic tool which is used to assess physical and mental health which generates scores ranging from 0-100 for 4 physical health sub-scales and 4 mental health sub-scales; the greater the score the better the health in the specific area. Test items are scored and transformed in an algorithm to norm-based scores with a mean of 50 and a standard deviation

of 10 for PCS and MSC. The Visual Analogue Scale is a 0 to 100 mm horizontal line with bipolar anchoring labels: "no pain" (0) at one end and "worst pain possible" (10) at the other. Participants are asked to place a mark somewhere on the continuum showing the intensity of their pain. The VAS has ratio scale properties with high validity and reproducibility.

The 16-item version of the WLQ assesses limitations at work due to injury or associated treatment. The WLQ covers four domains; output demands, mental demands, physical demands and time management demands. Items are scored on a five-point scale, ranging from "none of the time" to "all of the time." The scores on the individual items are summed, averaged, and transformed to a standardized score of 0-100, with a higher score indicative of more limitations.

The WIS was developed as a screening tool for potential work loss. This survey contains 23 items (statements about the impact of the disease on working), derived from the patient interviews, each of which is affirmed as "true" or "false." The survey is scored by summing the 23 items, giving a range of 0 (low risk) to 23 (high risk).

Zigmond and Snaith developed HADS out of an existing need for a short, self-assessment mood scale specifically designed for use in non-psychiatric patients. The HADS contains 14 items consisting of two 7-item sub-scales assessing anxiety (HADS-A) and depression (HADS-D).[15] A clinically distinctive feature of the HADS, compared to other measures of affective disturbance, is the exclusion of symptoms that might arise from the somatic aspects of illness such as insomnia, anergia and fatigue. Each item is answered by the patient and rated on a four point (0-3) response category (0 representing absence of symptoms, to 3 representing maximum symptomatology). The scores range from 0 to 21 for anxiety and 0 to 21 for depression: a score of 0 to 7 for either sub-scale is regarded as being in the normal range, a score of 11 or higher indicates the probable presence of the mood disorder and a score of 8-10 being just suggestive of the presence of the respective state.[16] Several studies have reported on the demonstrated validity and reliability of the HADS.[17] Bjelland also reported that all studies of HADS in various translations which report data on internal consistency achieved the recommended Cronbach alpha coefficient (at least 0.60). HADS is also sensitive to change during the course of disease and in response to medical and psychological interventions.[18] In order to determine if the patient had the condition

pre-injury, the following question was added to the end of both the anxiety and the depression scales "Thinking back prior to your hand/shoulder/elbow injury, would you have answered the same way to these questions?" For the purposes of this study, patients were considered depressed or anxious if they scored 11 or higher on the HADS-D or HADS-A subscale.

Statistical analyses consisted of means, standard deviations, frequency counts and proportions to describe patients for the cohort. A residuals analysis was performed to determine whether the data met the assumptions of parametric tests (*i.e.*, normally distributed with equal variances). Differences in age and gender, between the depressed and non-depressed patients were compared using chi-square and independent samples *Student's t tests*. Independent *Student's t tests* were used to compare DASH, SF36, VAS and WLQ sub-scale scores, while differences between groups on instability risk was examined using non-parametric Mann-Whitney tests. All statistical analyses were performed with SPSS 17.0 (SPSS Inc, Chicago, IL, US). All tests were conducted at the 5% level of significance.

Results

At the time of our preliminary analyses, we had been collecting HADS data for 10 months. By this time, 104 WSIB specialty clinic patients had given their consent to allow data collection for research purposes. The cohort consisted of 71% shoulder, 18% hand and 11% elbow-injured patients. Fifty-seven percent sustained a right side injury and 88% were right hand dominant. The average age of the cohort was 47.3±14.8, and 58% of the cohort was male while 42% was female. The HADS scores for the entire cohort and by injury site are presented in Figure 11.1. Figure 11.2 presents the Canadian Community Health Survey proportions of national depression rates. All but one person in our case group who was found to be depressed was also found to be anxious according to the HADS-A. Two-thirds of the people reporting anxiety also reported depression. The proportion of men who were depressed was slightly higher than women (p=.63).

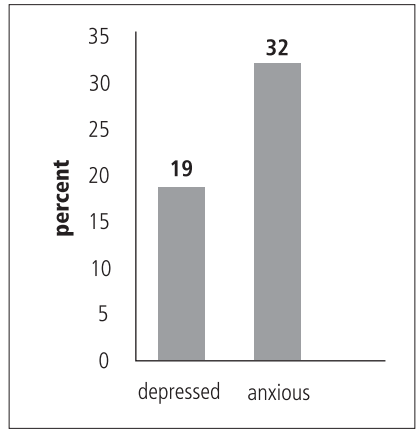

Figure 11.1a: Hospital Anxiety and Depression Survey Results

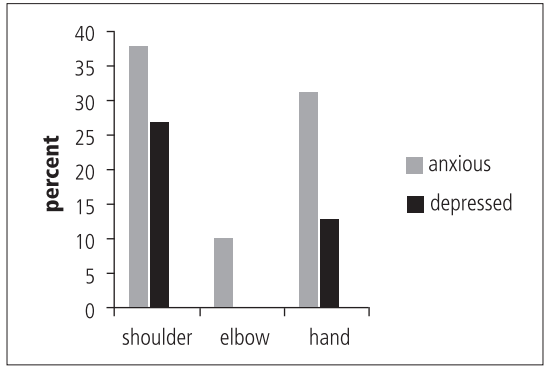

Figure 11.1b: Hospital Anxiety and Depression Survey Results by Injury Site

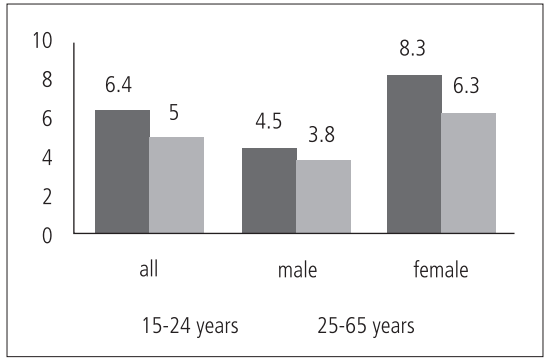

Figure 11.2: Canadian Community Health Survey Depression Rates

The depressed and anxious patients were significantly more disabled according to the DASH score than the non-depressed or non-anxious patients (p=.00), had significantly worse mental component scores on the SF36 (p=.00) and showed significantly greater limitations on mental and output tasks according to the WLQ (p=0.03; p=0.05). They were also at significantly higher risk for potential work loss. When excluding the anxious patients and comparing just the depressed to non-depressed patients, the DASH and SF36 mental scores continued to be significantly worse (p=.00); (p=.02) for the depressed group. In addition, the SF36 physical component scores were significantly worse (p=.03). However, the mental and output WLQ limitation subscale task scores were no longer different, nor was the risk of potential work loss.

The proportion of depressed patients and the sub-set of those reporting feeling depressed before their injury are shown in Figure 11.3. More males than females were depressed (56% versus 44%), and depressed before their injury (55% versus 45%). These differences were not statistically significant between genders (p=.80; .84). There were also no significant differences on age, DASH scores, SF36 scores potential work loss or work instability risk as determined by the WIS and WLQ scores between the depressed and depressed before injury groups (Table 11.1).

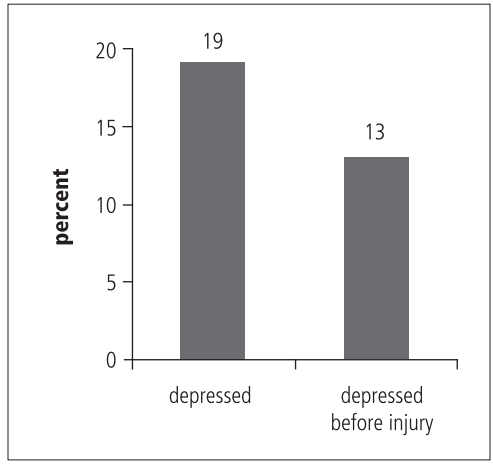

Figure 11.3: Depressed and Subset Depressed Before Injury

	Depressed mean (SD)	Depressed Before Injury mean (SD)	P value
Age	46.8 (10.0)	44.2 (7.2)	.58
VAS	39.8(20.3)	48.50(26.5)	.59
DASH	82.7(13.1)	68.8(17.9)	.22
SF36 PCS	34.1(4.1)	34.5(4.8)	.86
SF36 MCS	33.3(4.2)	27.4(8.5)	.17
WLQ Physical	46.8(18.4)	31.2(11.0)	.19
WLQ Time	50.0(21.2)	48.7(7.5)	.92
WLQ Mental	33.3(14.3)	40.2(8.0)	.43
WLQ Output	62.5(15.0)	41.2(20.9)	.15
WIS	17.7(2.5)	15.3(1.7)	.19

Table 11.1: Depressed and Depressed Before Injury Comparison

Conclusions

Much of the research in the area of mental health and work-related disability has focused on the effects of depression after an injury. This report examined depression as a risk factor for subsequent upper-extremity injuries in a cohort of Ontario WSIB claimants.

We found 19% of our patients reported being depressed. This rate is well above the average 6.4% for 15-24 year olds, and 5% for 25-65 year old Canadians who met all the measured criteria of major depressive episode.[19] The vast majority of these also reported being anxious reflecting how comorbid depression and anxiety is the rule rather than the exception in highly depressed persons.[20] Furthermore, the majority of the depressed patients (69%) were depressed before their work injury. Our analyses also revealed significantly greater limitations on mental and output tasks and higher risk for potential work loss for patients having both depression and anxiety. This finding disappeared when examining just the depressed patients, pointing to the possibility that anxiety more than depression could be responsible for perceived potential instability and limitations at work. Interestingly, in contrast to the common gender trend in populations of depressed individuals, we found that men reported higher rates of depression than women.

We saw significantly higher disabilities as measured by the DASH and SF36 in the depressed patients. These findings have been reported in other studies,

and likely have to do with the high correlation between depression and increased pain and disability.[21] As would be expected, due to the similarity in scores, no differences in disabilities as measured by the DASH and SF36 were noted between the depressed and depressed before injury groups.

One limitation to this study is that it was conducted among a group of workers that had an active claim with the WSIB for an upper extremity injury. Therefore, the findings may not be generalized to other non-claimant occupational groups such as military members with injuries beyond the hand, shoulder and elbow. Asking these patients to recall their mental state before their injury may have been a factor influencing the depression scores. Also, this was a preliminary investigation which left small numbers of patients in certain subgroup analyses. Despite these limitations, the number of people reporting depression before their injury was double the Canadian national average, lending credibility to the hypothesis that depression may be associated with, and possibly a risk factor for disability following upper extremity MSK work related injuries.

This study suggests that there is a need for more active involvement of mental health professionals in the care of injured workers. Physicians and surgeons contemplating interventions such as surgery should have heightened awareness of the importance and implications of possible associated mental health factors related to depression and anxiety. While larger prospective studies examining this relationship are required, employers and regulatory bodies may wish to implement measures designed to cultivate a workplace environment that assists in referrals. Future research may help to identify screening methods to assist in identifying workers or occupations at particular risk of disability in association with depression, anxiety and work related injury. Finally, considering the high rates of MSK injuries and depression amongst military members, this association should be explored in this unique occupational population.

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SECTION 3:
NOVEL TECHNOLOGIES

CHAPTER 12

Computer Assisted Mosaic Arthroplasty (Mosaicplasty)[1]

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ABSTRACT

Damaged articular cartilage in weight-bearing areas of the knee is not only painful for the patient, but also limits their Range of Motion (ROM). Because articular cartilage has limited self-healing potential, surgical treatment is necessary to restore the cartilage surface. The transplantation of multiple autologous osteochondral plugs (mosaicplasty) to the damaged site is one well-accepted surgical technique. During this surgery, small osteochondral plugs are retrieved from the periphery of the patellofemoral joint (or the margin of the intercondylar notch) and transplanted into damaged regions. The requirements for the long-term success of this procedure include reconstruction of the curvature of the articular surface with grafts, avoidance of graft protrusion or recession above or below the host surface and effective coverage (70-90%) of the defect. In order to help achieve high accuracy in these complex mosaicplasty procedures, researchers at Queen's University have developed a computer-assisted system to help obtain better outcomes. Currently, patients under the age of 50 who are undergoing mosaicplasty for their knee cartilage repair are being enrolled in a study comparing conventional to

computer-guided mosaicplasty. We will report on work done to date focusing on knee pain, stiffness and function as well as the accuracy of plug harvesting, placement and surface congruency as measured by Magnetic Resonance Imaging (MRI) technology.

Introduction

Knee dysfunction is an extremely widespread problem found in military populations.[2] Whether due to trauma or normal wear and tear, cartilage defects in knees are common. The result is pain and limited range of motion.[3] Due to its limited healing potential, surgical treatment is often necessary to restore the cartilage. The aim is to restore the biomechanics and biologic surface of the cartilage.

One surgical solution is marrow stimulation. This is done through subchondral bone penetration by drilling, abrasion, or microfracture. The end result is bone marrow stem sell fibrocartilage metaplasia, where stem cells transform into a mature differentiated cell type, resulting in new bundles of thick, clearly defined collagen fibres and intervening unicellular islands of cartilage arranged in small chains. While this procedure is relatively easy to perform and results in short term symptomatic improvement, fibrocartilage is not hyaline articular cartilage, and therefore tends to deteriorate with time.

A more successful surgical intervention involves the transplantation of bone and cartilage plugs into the deteriorated area. This procedure is referred to as mosaicplasty when multiple small plugs are used for repair, or Osteochondral Autograft Transfer (OATS), where the plugs are large enough so that only one or two are needed to fill the area of cartilage damage. Mosaicplasty or OATS is restricted to defects of 4 cm^2 or less, because of a limited source of plugs used for repair. A plug of normal cartilage is harvested from an area of the knee that is low-weight-bearing. Holes are drilled at the defect site and the graft plugs are inserted in the hole drilled into the lesion. While there are advantages to this method such as the recreation of the articular contour and better long-term results, this is a very technically challenging procedure with limited graft supply.[4]

The success of mosaicplasty depends largely on accurate reconstruction of the natural curvature of the surface with grafts. This requires avoidance of graft protrusion or recession > 0.5-1.0 mm and achieving effective coverage

(70-90%) of the defect. In order to implant these plugs with high precision and accuracy, a computer-assisted technique has been developed and is being tested by researchers at Queen's.

Computer-assisted mosaicplasty begins with a Computed Tomography (CT) scan of the damaged area. Computer 3D models of bone and cartilage are created from the CT datasets. Software is then used to position a mosaic of virtual plugs over the defect. At this stage, there is manual planning of the radius, size, position, orientation and rotation for each plug in the defect site. See Figure 12.1 and Figure 12.2.

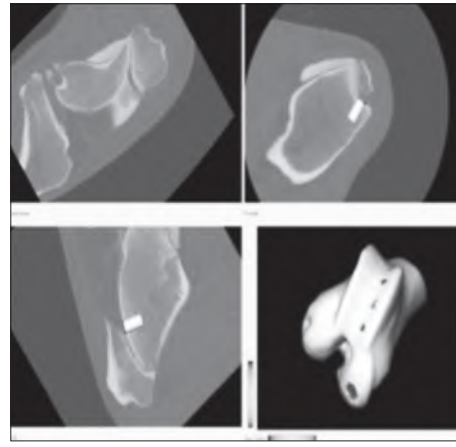

Figure 12.1: Planning Software

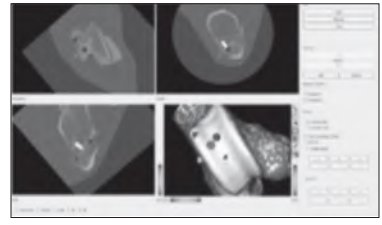

Figure 12.2: Planning of plug on recipient side (left) and harvest side (right)

We have also used template guided technology in conjunction with the computer-assisted mosaicplasty procedure. A rapid prototyping machine is used to create a patient-specific template which incorporates a mirror image of the

articular surface of the knee. The surgeon uses this mirror image to position the template on the knee. For each plug, two instrument guides are inserted into the template. On the retrieval side, the guide positions and orients the conventional plug cutting instrument with respect to the plan. To ensure the planned height of the plug, a predefined height mark on the cutting instrument is aligned with the top edge of the guide. The guide on the receiving side navigates tools for preparation and transplantation of the plug into the damaged area (Figure 12.3, Figure 12.4).

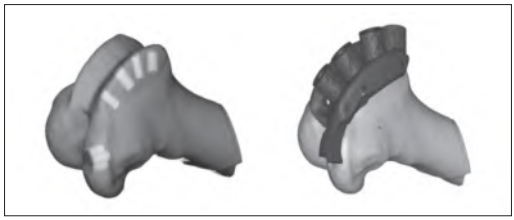

Figure 12.3: From the surgical plan to the guidance template

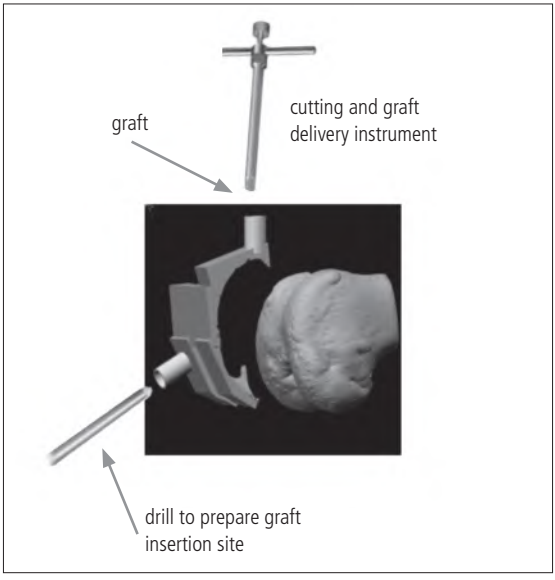

Figure 12.4: Tools for preparation and transplantation of the plug into the damaged area

In our research, we have tested for improved clinical outcomes of mosaicplasty in an animal model using two computer-guided systems, one with patient-specific instrument guides against the conventional technique.[5]

Fifteen sheep were randomized into three groups with impact cartilage defects created in each knee. After three months, the defect of one knee was repaired using the: (i) conventional approach, (ii) standard computer-guided tracking, or (iii) computer-assisted patient-specific instrument guides.

For both image-guided groups (ii, iii) harvest and delivery sites were preoperatively planned using custom-made software. During opto-electronic guidance (group ii), instrument position and orientation were tracked and superimposed onto the surgical plan. For the patient-specific instrument guides (group iii), plastic templates were manufactured which incorporated mirror images of the articular surface to allow an exact fit between template and anatomy. Cylindrical holes within the template guided the surgical tools according to the plan.

Three months post-surgery, both knees were harvested and the curvature of the reconstructed cartilage was compared to the cartilage surface of a pre-defect arthrogram CT scan. For each repaired defect, macroscopic International Cartilage Repair Society (ICRS) and histological repair (ICRS II) scores were assessed. All results were statistically compared between the three surgical approaches using either non-parametric or parametric Analysis of Variance (ANOVA) tests.

There were no significant differences found in cartilage surface reconstruction and macroscopic scores between the computer-guided and the conventional surgeries. However, both computer-guided surgical approaches resulted in significantly better histology scores compared to the conventional approach (improvement by 55%, $p=0.02$). In terms of the curvature of the surface graft, computer-assisted template-guidance was significantly better than conventional, and there was a trend for better results in computer-guided compared to conventional (Figure 12.5a and Figure 12.5b). In addition, when the treatment effect on the tibial plateau after healing was examined, computer-assisted template guidance was significantly better than conventional ($p < 0.017$). These results suggest that computer-guided systems can improve the clinical outcome of mosaic arthroplasty for the repair of cartilage defects.

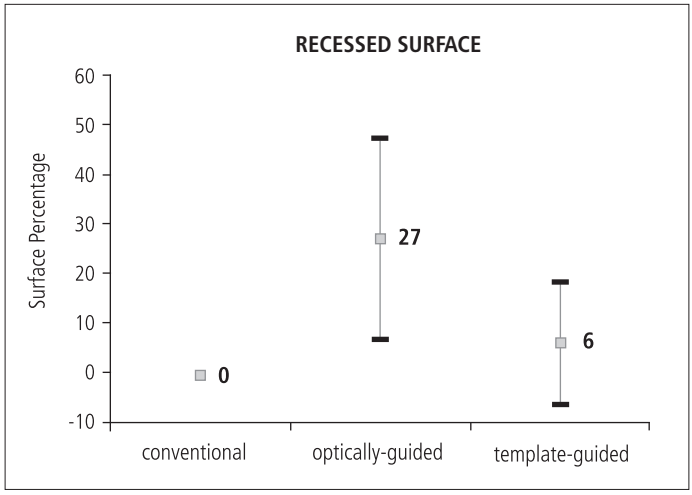

Figure 12.5a: Percentage of Recessed Surface after Repair

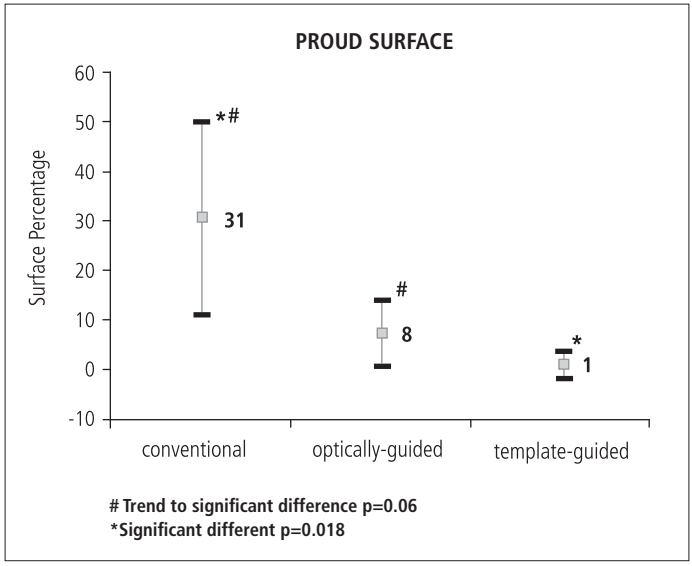

Figure 12.5b: Percentage of Proud Surface after Repair

Case Presentation

A 32-year-old woman is presented, with right knee pain and swelling following a skating injury. She is an avid soccer play, mother of two who works at a desk occupation. Her range of motion was 0/5/130 and her ligaments were stable with a grade II effusion. Radiographs showed osteochondritis dissecans. She was treated at our centre with computer-assisted template guided mosaicarthoplasty. Post-operatively, this patient has fully recovered. Although she has eliminated long distance running, she has returned to a level of pre-operative activity. Her ICRS score continues to improve from 65.5 at 3 months to 83.4 at 12 months post surgery. Her International Knee Documentation Committee (IKDC) knee grade is A/B signifying the border between "normal" and "nearly normal".

Future directions for our mosaciplasty research involve in vivo autologous cartilage implantation to repair critical-sized cartilage defects using large-sized, scaffold-free constructs. For this method, cartilage cells are removed from the damaged site for culture. Cells are multiplied in culture and these cells are then injected at the defect site. From here, we hope to move to developing and surgically implanting patient specific cartilage implants.

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1 This research is supported by funding from the Natural Sciences and Engineering Research Council (NSERC). The authors wish to acknowledge Heather Grant for her assistance.

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CHAPTER 13

Development of Immune-Modulating Therapeutics Delivery Vehicles Using Natural Polysaccharides

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ABSTRACT

Curdlan polysaccharides have been of growing interest due to their ability to form unique single and triple helical structures and a range of immunomodulatory properties including antitumor activity, infection resistance, and wound healing. A new core-shell nanoparticle containing the chemotherapeutic drug doxorubicin was formulated via amphiphilic graft copolymer self-assembly using a Curdlan-*graft*-poly (ethylene glycol) (Curdlan-*g*-PEG). The graft copolymer was synthesized through the dicyclohexylcarbodiimide ester linkage of carboxylated polyethylene glycol (PEG) to the hydroxyl groups of the curdlan backbone. Curdlan and Deoxyribonycleic Acid (DNA) were also used as building blocks to create a hybrid liquid crystalline gel systems at various length scales using ionic gelation with calcium chloride. These systems were studied to understand the dependence of morphology and size of structures on the concentration of curdlan and DNA using light microscope and transmission electron microscope. Thus, new drug delivery systems were synthesized by utilizing the natural polysaccharide, curdlan.[1]

Introduction

Minimizing preventable death is a primary focus of combat casualty care. In this study, we report a lightweight powder-based medical formulation that can be used for wound care management outside of theatre hospitals.

Nanoparticle drug delivery systems seek to deliver therapeutic substances in a targeted fashion while increasing efficacy and reducing undesirable side effects. Curdlan polysaccharides have been of growing interest due to their ability to form unique single and triple helical structures and range of immunomodulatory properties including antitumor activity, infection resistance, and wound healing. Curdlan has been utilized in drug delivery applications for its ability to form helical complexes with bioactive molecules and its usefulness as a water stabilizer in a variety of derivative forms. 1,3-β-glucans are glucopyranose polymers with 1,3 glycosidic linkages and varying molecular weights, solubility and degrees of branching. These β-glucans have been used in a variety of research areas due to their unique ability to form single and triple helical structures that may form gels upon heating.[2] 1,3-β-glucans have various pharmacological properties and have demonstrated anti-tumor activity,[3] wound healing[4] and infection resistance.[5] 1,3-β-glucans impart these properties by activation of the alternative complement pathway[6] and interaction with lymphocytes and phagocytes[7] leading to stimulation of the production of cytokines, phagocyte and lymphocyte proliferation, oxidative burst, and phagocytosis of opsonized tissues.[8]

Curdlan is a linear, high molecular weight 1,3-β-glucan that has been explored for drug-delivery applications due to its ability to form a gel under thermal or ionic stimuli.[9] Curdlan sulfates have found application in imparting viral resistance[10] and are under continued investigation for applications in inhibiting Human Immunodeficiency Virus (HIV) infection.[11] Curdlan has the capability of self-assembling to form nanoparticles when its backbone is modified with hydrophilic PEG chains. These core-shell nanoparticles can be used to encapsulate hydrophobic drugs such as doxorubicin in the core while maintaining biocompatibility due to the PEG shell. Curdlan can also form complexes with DNA for creating Liquid Chrystalline Gels (LCG) structures.[12] These structures can be self-assembled at various length scales ranging from nanometers to centimeters. The incorporated DNA can be used to enhance the immune modulating effects of curdlan, especially if CpG DNA is used.[13]

Methods

Materials and Equipment

Curdlan (~90,000 Da) was obtained from Wako Pure Chemical Industries. Sodium hydroxide was purchased from Caledon Laboratory Chemicals.

Calcium chloride anhydrous salt, Phosphotungstic Acid (PTA), trisodium citrate salt, Amicon filtration units (molecular weight cut-off, MWCO of 10,000 Da) and dialysis membrane (Flat Width 45mm with12,000 to 14,000 Da MWCO and 3,500 Da MWCO) were purchased from Fisher Scientific. Monofunctional carboxylated PEG (~5,000 Da) was purchased from NanoCS. Dicyclohexylcarbodiimide (DCC), Dimethylaminopyridine (DMAP), DNA sodium salt from salmon testes and anhydrous Dimathylsulfoxide (DMSO) were purchased from Sigma Aldrich. Doxorubicin HCl was purchased from IntaTrade Chemicals GmbH, desalted using 2 molar equivalents triethylamine, and extracted using Dichloromethane (DCM) to obtain a hydrophobic form of doxorubicin. Formvar coated Transmission Electron Microscopy (TEM) grids were purchased from Canemco & Merivac (100 mesh copper grids). Linear polarizer sheets (2" x 2") were purchased from ThorLabs, Inc. and used to create the crossed nicols effect.

The visible light images of the macroscopic gels were taken using a Sony Cyber-shot DSC-P150. Spherical gels were imaged using Olympus BX51-P Polarizing microscope using a 5x objective and 10x eyepiece and linear polarizer filters. Philips CM10 Transmission Electron Microscope was used for studying micro- and nano-structures. Particle size was measured by Dynamic Light Scattering (DLS) using Brookhaven 90Plus Particle Size Analyzer at 90° and room temperature.

Curdlan-g-PEG Doxorubicin Nanoparticles

Curdlan (500 mg) was dissolved in 50 mL of stirring anhydrous DMSO under nitrogen bubbling for 1 hour. Simultaneously, carboxylated PEG (1 g) was dissolved in 30 mL of stirring anhydrous DMSO at 60°C under nitrogen bubbling for 20 minutes and DCC (600 mg) and DMAP (400 mg) were dissolved in 20 mL of stirring anhydrous DMSO under nitrogen bubbling for 20 minutes. DCC activated carboxylated PEG was formed by addition of the DCC/DMAP solution to the carboxylated PEG solution under stirring for 15 minutes. The activated carboxylated PEG solution was added to the curdlan solution and stirred for 15 hours at room temperature. The final solution (100 mL) was added to 3.5 kDa MWCO dialysis tubing and dialyzed against 2 L of distilled water for 72 hours with water changed every 6-12 hours to remove unreacted PEG. The precipitated product was obtained by centrifugation with the water suspended over-grafted portion discarded. The product obtained from centrifugation was lyophilized overnight to remove water and washed

10 times with diethyl ether to remove DCC, DMAP, and dicyclohexyl urea. Residual ether was removed by desiccation to a dry powder consistency.

Curdlan-*g*-PEG was dissolved in DMSO at 7.5 mg/mL and varying volumes of polymer solution and 6 mg/mL Doxorubicin-DMSO solution were mixed at drug loading percentages (weight of doxorubicin/weight of polymer x 100 %) of 10, 20, and 40% each with a volume of 3.2 mL and a final polymer concentration of 3.5 mg/mL. One milliliter of each solution was added in a slow drop-wise manner to 10 mL of stirring distilled water with a mild vortex. The polymer droplet was allowed to disperse completely before addition of the next drop.

The suspension of doxorubicin loaded Curdan-*g*-PEG nanoparticles was concentrated in Amicon filtration units at 4000 rpm for 20 minutes to remove water and free Doxorubicin. Then, the encapsulation efficiency and mass yield of doxorubicin were determined by measuring the absorbance at 480 nm.

$$\textit{Encapsulation Efficiency (\%)} = \frac{\textit{Concentration of encapsulated drug}}{\textit{Concentration of drug in initial feed}} \times 100\% \quad (1)$$

$$\textit{Mass Yield (\%)} = \frac{\textit{Concentration of encapsulated drug}}{\textit{Concentration of polymer}} \times 100\% \quad (2)$$

Figure 13.1: Measure of the encapsulation efficiency and mass yield of doxorubicin

Eleven milliliters of nanoparticle suspension in distilled water was added to a 3,500 Da dialysis tube and dialyzed against 1.75L of distilled water for 3 hours to remove free drug. One milliliter of the washed nanoparticle suspension was added to 12.5 mL of distilled water and read in triplicate (100 μL) in a 96 well microplate at 480 nm to determine the 100% release condition. The remainder of the suspension in the dialysis tube (10 mL) was added into 125 mL of distilled water stirring at 37°C. Samples were collected at various time intervals and absorbance was measured at 480 nm to determine the concentration of doxorubicin released.

Micro and Nano Structures of Curdlan-DNA

Solutions of curdlan (10 mg/mL and 30 mg/mL) and DNA (0.1 mg/mL 0.5 mg/mL and 2.5 mg/mL) were prepared at various concentrations in 0.4 M sodium hydroxide and deionized water respectively. These solutions were mixed in a 1:1 ratio and this mixture was then slowly added to magnetically stirring solution of 10 wt % aqueous calcium chloride in a drop-wise manner. The solutions were allowed to stir for 1 hour. Transmission Electron Microscopy (TEM) samples were prepared by extracting a drop of sample onto the TEM grid and letting the polymer absorb for 3 minutes followed by filter paper blotting to remove excess solution. Staining was performed by exposing the samples to 2 wt % aqueous PTA for 30 seconds followed by filter paper blotting. The samples were dried in ambient conditions overnight and imaged the following day. Most representative images were presented.

Spherical Gels of Curdlan-DNA

In order to synthesize spherical gels of Curdlan-DNA in the millimeters length scale, curdlan was dissolved in 0.4M sodium hydroxide at a concentration of 15 mg/mL and DNA was dissolved in deionized water at a concentration of 15 mg/mL. These two solutions were mixed in various proportions to obtain samples of 0%, 25%, 50%, 75%, 100% DNA. This mixture was then slowly added to calcium chloride solution as mentioned in the nanostructure formation section. Gels were formed in the presence of DNA, with decreasing rigidity as DNA concentration decreased. Pure curdlan sample did not produce any visible structure. These samples were sandwiched between a microscope slide and a cover slip and then imaged under 50X magnification with and without crossed polarizers.

Macroscopic Cylindrical Gels

Curdlan was dissolved in 0.4M sodium hydroxide solution at a concentration of 70 mg/mL. DNA was dissolved in deionized water at a concentration of 15 mg/mL. Aqueous DNA solution was mixed with curdlan solution at different volume ratios to obtain 5 wt %, 10 wt % and 20 wt % DNA/curdlan samples. Thereafter, 12 mL of these solutions were inserted into a dialysis membrane (12,000-14,000 Da MWCO), which was molded to form a cylindrical shape using two caps of diameter 29.6 mm. The dialysis tube was then immersed in

100 mL of 10 wt % aqueous calcium chloride solution for 3 days. The gels were extracted by cutting out the dialysis membrane and cross-sectional slices of 5 mm were obtained for imaging. Polarized images were obtained by sandwiching the gel cross-section between two polarizer sheets placed orthogonal to each other and placing the setup on a light source. This setup created a crossed nicols effect.

Results

Curdlan-g-PEG Doxorubicin Nanoparticles

Particle size analysis on empty and doxorubicin loaded curdlan agglomerations and Curdlan-*g*-PEG nanoparticles formed by nanoprecipitation gave insight into the relative populations of particle sizes and the effect of PEGylation. Number weighted DLS analysis of the Curdlan-*g*-PEG system revealed that PEGylation yielded stable nanoparticles with a size of 93.1 nm (Figure 13.2A) when Curdlan-*g*-PEG was loaded with 20% Doxorubicin compared to the empty particle size that averaged 53.3 nm. This increase in nanoparticles size has been observed previously upon drug loading as demonstrated in systems of cholesterol-conjugated carboxymethyl curdlan nanoparticles.[14] Intensity (Figure 13.2C) and volume (Figure 13.2D) weighted analysis revealed the presence of some larger aggregations among the nanoparticles with particle sizes as high as 392.4 nm but these larger particles were not visible on TEM micrographs, suggesting they represent a minority in the population. The log-normal number population density (Figure 13.2B) provides the nanoparticle size distribution with a mean particle size of 109.9 nm. The nanoparticle architecture is hypothesized to consist of a doxorubicin nanoparticle upon which the curdlan backbone experiences hydrophobic interactions and PEG grafts align outwards to provide a water stable shell.

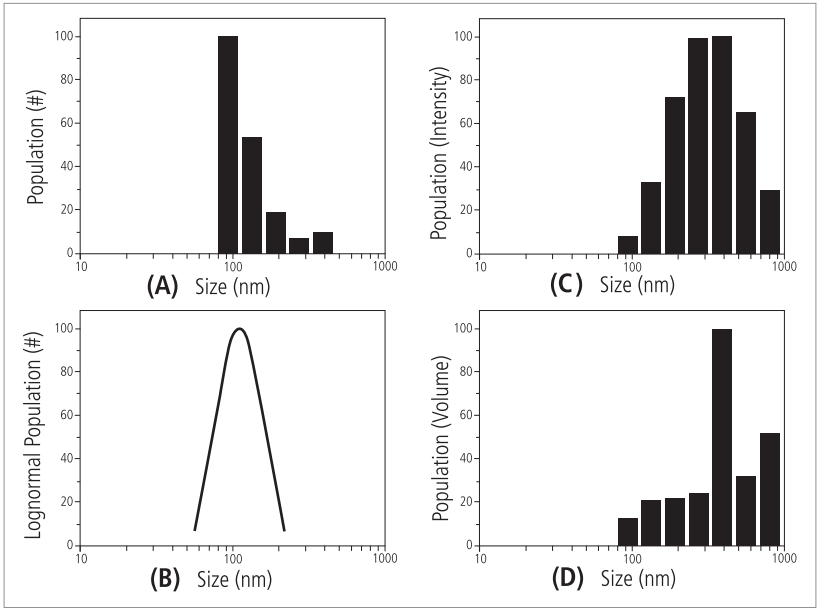

Figure 13.2:

(A) Number weighted population density for Curdlan-*graft*-PEG loaded with 20% Doxorubicin.

(B) Lognormal number population density.

(C) Intensity weighted population density.

(D) Volume weighted population density.

Using TEM analysis, the particle size and morphology of doxorubicin loaded curdlan-*g*-PEG nanoparticles were verified. Since the negative stain, PTA, used in the analysis is highly hydrophilic and electron dense, the hydrophilic PEG portion of the nanoparticles should appear darker due to increased electron density and doxorubicin and curdlan portions of the nanoparticles should appear lighter. It was found that the presence of the doxorubicin centre was clearly visible as bright white spots with a coating of a darker material (Figure 13.3a). No presence of bright white spots without such coating were visible on TEM samples, suggesting high encapsulation efficiency. Upon closer inspection of the nanoparticles the outer darker layer was found to consist of two layers itself, with an inner lighter layer postulated to be tightly packed curdlan backbone around the doxorubicin centre and the outer darker layer fully extended PEG chains that provide water stability (Figure 13.3b).

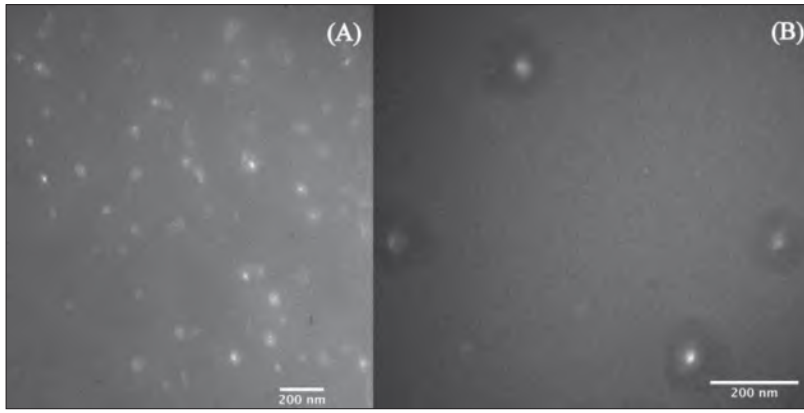

Figure 13.3:

(A) 20% Doxorubicin nanoparticles of Curdlan-*graft*-PEG appear as a bright Doxorubicin centre with a coating of more electron dense material.

(B) The coating is revealed to be multi layered with a compressed inner layer consisting mostly of Curdlan backbone and a looser outer layer consisting of extended PEG chains.

The drug concentration in nanoparticles was determined and compared to the ideal concentration. This provided the encapsulation efficiencies for the varying drug loading percentages for pure curdlan and Curdlan-*g*-PEG (Figure 13.4a). The Curdlan-*g*-PEG system attained similar encapsulation efficiencies as pure curdlan. Therefore, PEGylation allowed for stable nanoparticle formation while maintaining the inherent drug encapsulating capability of pure curdlan. Encapsulation efficiency is inherently dependent on the initial drug loading value and as such, this data was normalized by the drug loading percentages to determine the mass yield, a measure of the percentage of drug to polymer attained in the final suspension (Figure 13.4b). *In vitro* release was carried out in distilled water at 37°C. The nanoparticles showed a release of nearly 50% of the loaded drug within 24 hours (Figure 13.5).

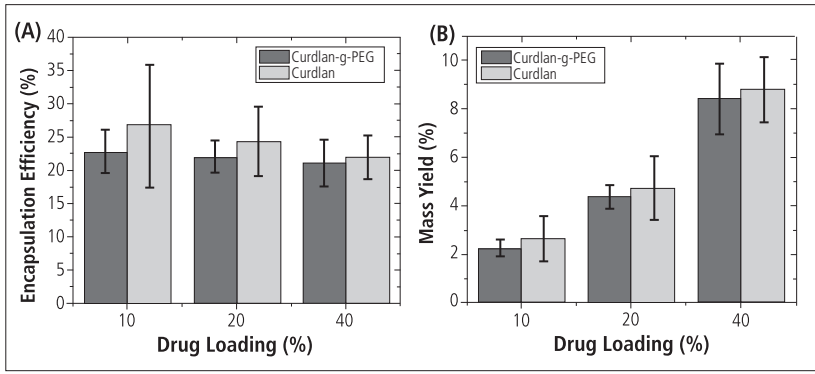

Figure 13.4:
(A) Encapsulation Efficiencies of Curdlan-*graft*-PEG and Pure Curdlan.
(B) Mass yields of Curdlan-*graft*-PEG and Curdlan polymer systems determined by normalizing the encapsulation efficiences by the drug loading percentage.

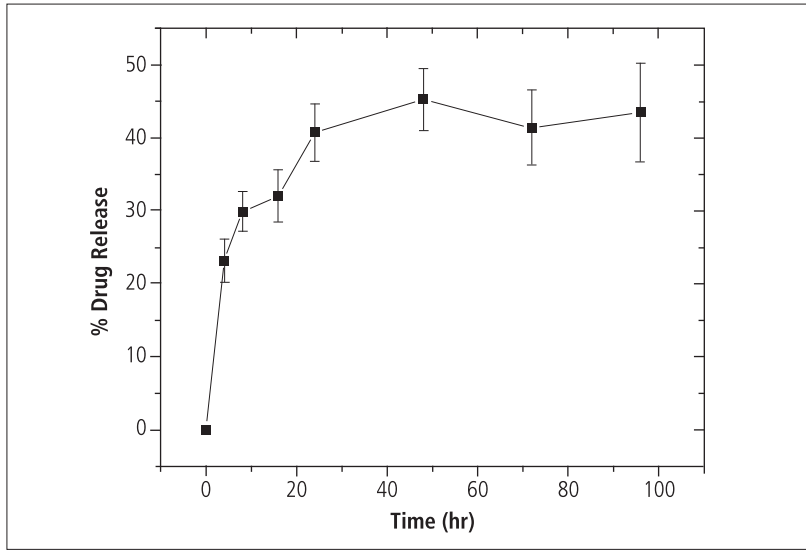

Figure 13.5: Release profile of Doxorubicin from Curdlan-*graft*-PEG nanoparticles that had settled in the distilled water release medium.

Curdlan-DNA Self-assembled Structures

Concentrations of DNA below 3 mg/mL allow the formation of nano- and micro-structures with curdlan using ionic cross-linking. These structures are

observable through TEM when stained with PTA. Equal volumes of curdlan concentrations (0, 10, and 30 mg/mL) and DNA concentrations (0, 0.1, 0.5, and 2.5 mg/mL) are mixed and added drop-wise to stirring 10% aqueous calcium chloride. This allows the formation of the structures shown in Figure 13.6. At the 30 mg/mL curdlan level, TEM reveals the presence of a fibrous network of curdlan with a fiber width of 20 nm. When repeated with 0.1 mg/mL DNA mixed with curdlan before addition to calcium chloride, 1.75 μm core-shell microparticles are observed with a white centre and a dark outer ring. The white centre is postulated to be a solid core of amorphous DNA and outer ring is thought to be more crystalline curdlan due to the presence of fibrous striations on the periphery. Introduction of higher concentrations of DNA causes a characteristic increase in the average microparticle size to 4 μm and upwards to 9-10 μm. At the 10 mg/mL curdlan level the pure curdlan system shows a similar fibrous network with smaller features and a fiber diameter of 5-10 nm. Incorporation of DNA typically yields the formation of particles and in the case of 0.1 mg/mL DNA, the presence of globular spheres within the fiber network is observed. Further increases in DNA concentration cause the formation of discrete nanoparticles with a fibrous nature and eventually the formation of a rigid rod-like structure wherein individual rods have a hydrophilic periphery and a hydrophobic core as observed by the contrast from phosphotungstic acid staining. Without curdlan, DNA initially forms small particulates (200 nm). Higher concentrations of DNA cause the formation of highly crystalline structures beginning with hexagonal crystallites and evolving to DNA crystallites forming fractal patterns.

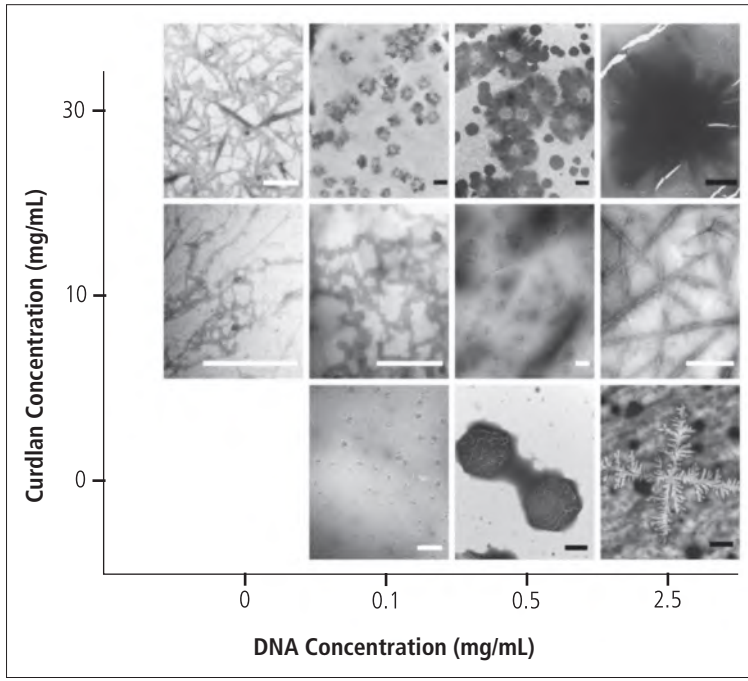

Figure 13.6: TEM of Curdlan and DNA nano- and micro-structures:
These were formed from addition of equal volumes of Curdlan and DNA at different concentrations. White scale bars are 500 nm and black scale bars are 2000 nm.

When the concentration of DNA in solution is increased, curdlan and DNA can self-assemble into elastic spherical LCG on the millimeter length-scale. Mixing different ratios of curdlan solution and aqueous DNA causes the formation of different structures. The drop-wise addition of 100% DNA to the aqueous calcium chloride causes the formation of spherical precipitates. When DNA/curdlan mixture are added drop-wise, larger spherical gels form that appear to have a white centre similar in appearance to the pure DNA and a semi-transparent outer coating of curdlan. The 100% curdlan system is not capable of forming spherical gels. Figure 13.7 shows the spherical gels under visible and polarized light. Gel system composed of 100% DNA forms a highly dense, optically opaque spherical gel. Under crossed nicols, the system is revealed to be amorphous due to the lack of birefringence patterns. The structure is markedly different when 25% curdlan is incorporated. No longer optically opaque, the gel now shows the characteristic isogyre pattern representative of an anisotropic crystalline structure. The centre of the gel

under polarized light shows a blurring of the orthogonal isogyres, representative of a more isotropic, amorphous core. This unique Curdlan-DNA structure suggests DNA acts as a nucleating centre for the formation of the spherical gel as the pure curdlan samples could not adequately hold their shape. Further incorporation of curdlan in the 50/50 sample shows a darkening of the isogyre pattern and more definition in the central region, characteristic of an overall increase in crystallinity. Therefore, it is concluded that spherical gels are formed with DNA/Curdlan mixtures with a tendency for amorphous, isotropic DNA to localize to the center and increasing levels of curdlan increases the overall crystallinity.

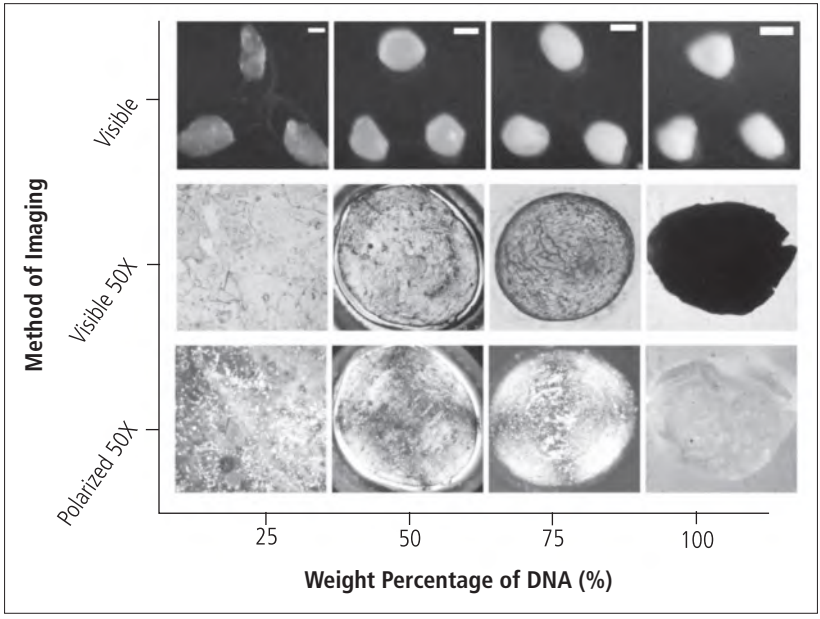

Figure 13.7: Curdlan and DNA Spherical Gels: Various ratios of curdlan and DNA observed under visible light (top) and polarized light (bottom). Scale bars are 1 mm each.

Further increasing the concentration of DNA and curdlan can create macroscopic cylindrical gels (Figure 13.8). The pure curdlan system shows characteristic concentric rings under visible light where the outer semi-transparent peripheral and inner semitransparent ring represents tightly packed LCG curdlan and the white ring represents amorphous curdlan, respectively.[15] When viewed under crossed nicols, the outer peripheral shows alternating colours characteristic of birefringence through an anisotropic crystal with the presence of orthogonal dark lines (isogyres) visible across the region.

Introduction of DNA into the macroscopic gels causes a partitioning of DNA into the amorphous and crystalline phases. Crystalline DNA forms a homogenous crystalline network with Curdlan along the periphery of the gels as seen by the darkening of the isogyre lines under crossed nicols, indicative of an anisotropic crystal. DNA is also present in an isotropic amorphous form as seen by darkening and expansion of the amorphous ring with increasing DNA concentration and loss of the small degree of crystallinity previously indicated by the isogyres in the centre of the gel. This behaviour of DNA partitioning into anisotropic crystalline and isotropic amorphous has been observed in pure DNA LCG[16] and this remains in co-gelation with Curdlan.

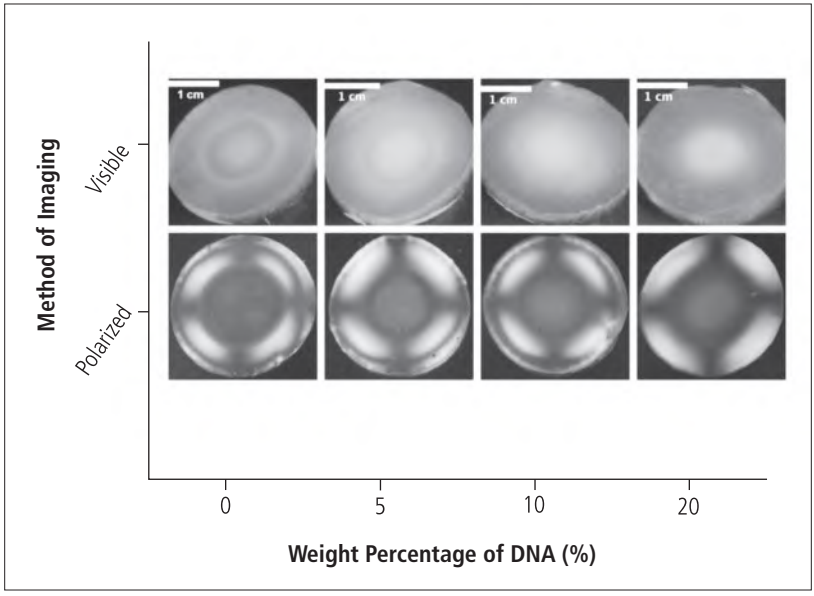

Figure 13.8: Curdlan and DNA Cylindrical Liquid Crystalline Gel: Cross-sections with 100% Curdlan, 5% DNA, 10% DNA, and 20% DNA as seen under visible light (top) and crossed nicols (bottom). Scale bars are 1 cm each.

Conclusion

The present study demonstrated the feasibility of curdlan-based structures for drug delivery applications. A Curdlan-*g*-PEG copolymer was successfully synthesized by DMAP mediated DCC-ester formation using a monofunctional carboxylated PEG. Doxorubicin was loaded in these Curdlan-*g*-PEG based nanoparticles. Additionally, the co-gelation of Curdlan and DNA in the

formation of unique structures ranging from nano- and micro-particles to millimeter scale spherical gels and macroscopic cylinders was controllable by concentration. Using the macroscopic cylinders, the nature of the system as a LCG is verified. Since similar behaviour is observed at the millimeter scale, it is believed that even the nano- and micro-scale systems are LCG's. In light of current Curdlan research into polynucleotides inclusion complexes this represents a new means to combine polysaccharides and polynucleotides. The systems developed here have the potential of creating an enhanced delivery device for bioactive molecules such as DNA as well as doxorubicin.

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1 This work was financially supported by Natural Sciences and Engineering Research Council of Canada (NSERC).

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CHAPTER 14

Factor V Degradation by *Acinetobacter baumannii:* Part of a Novel Virulence Mechanism to Attenuate Blood Coagulation

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ABSTRACT

Acinetobacter baumannii is a leading cause of infection in soldiers in combat war zones. It causes numerous disorders including: pneumonia, wound, respiratory tract, and bloodstream infections. These infections are difficult to treat because of resistance of *A. baumannii* to all antibiotics used clinically. Despite its clinical significance, *A. baumannii* virulence factors remain poorly understood. Methods: Our research has demonstrated coagulation Factor 5 (FV) cleavage by a novel virulence factor released from clinical isolates of *A. baumannii*. Conditioned media from sixteen isolates of *Acinetobacter* spp. from Canadian hospitals were analyzed by immunoblotting for their ability to cleave FV in normal human plasma. Eleven of sixteen isolates (69%) cleaved FV. Secretome analysis after Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis (SDS-PAGE) and silver staining revealed a Mr 60kDa protein present exclusively in strains that degraded FV. Identification and characterization of this protein is underway. Compared to unconditioned media, eleven of sixteen isolates (69%) significantly prolonged the activated partial thromboplastin time of normal human plasma. Virulence factors released from *A. baumannii* attenuate blood coagulation to enhance bacterial growth, survival, and transmission. Increased understanding of *A. baumannii* virulence factors will lead to development of new diagnostics, treatments, drug design, and vaccines to improve clinical outcome in war zones.[1]

Acinetobacter baumannii Infections Are a Clinical Concern in Combat War Zones

Acinetobacter baumannii, a Gram-negative rod commonly found in the environment, has been a major cause of hospital-acquired infections in immunocompromised individuals. Outbreaks in hospitals have been reported from various geographical areas,[2] such that is it now considered a problematic, multidrug resistant (MDR), nosocomial and community-acquired pathogen. *A. baumannii* can cause a multitude of infections that include pneumonia, bacteremia, meningitis, urinary tract infections, peritonitis, and skin and soft tissue infections.[3] The mortality rate associated with these infections is high. For example, the mortality rate associated with bacteremia is approximately 52% and that associated with pneumonia can range from 23-73%.[4] Risk factors for development of *A. baumannii* infection include alcoholism, smoking, chronic lung disease, and/or invasive procedures. Patients receiving mechanical ventilation are at special risk for hospital-acquired pneumonia caused by this organism.

The incidence of *A. baumannii*-mediated infections has been increasing consistently. For example, the National Nosocomial Infections Survey data for US intensive care units indicate that *Acinetobacter* spp. caused 6.9% of cases of hospital-acquired pneumonia in 2003, an increase of almost 5-fold from 1975.[5] Similarly, rates of bloodstream infection, surgical site infection, and urinary tract infections have also increased during this period.[6] It is accepted that the predominant species associated with these infections is *A. baumannii*.

Acinetobacter spp. infection in war-related injuries is now well documented.[7] Casualty statistics from the 2003-2005 military operations in Iraq and Afghanistan show an increase in the ratio of wounded to fatal casualties compared to previous operations in the Persian Gulf, Vietnam, and Korea.[8] *Acinetobacter* spp. constitute the most frequently recovered Gram-negative isolate from war wounds in soldiers, with *A. baumannii* yet again being the predominant species.[9] *A. baumannii* is known to cause osteomyelitis and/or wound infection in soldiers serving in Iraq and Afghanistan with many of the isolates being found to be multidrug resistant. The transmission of this organism among hospitalized soldiers is believed to be nosocomial.[10] Due to the prolonged hospitalization of injured soldiers in Iraq, there is adequate antibiotic pressure and environmental contamination to establish a reservoir of MDR organisms that can be transmitted to other soldiers. The incidence

of MDR *Acinetobacter* spp. among soldiers from Iraq and Afghanistan have prompted some army medical centres to place all injured soldiers in contact isolation until colonization with MDR *Acinetobacter* spp. is ruled out,[11] thus leading to a tremendous economic cost as a result of these infections.

The antibiotic resistant nature of *A. baumannii* infections is proving to be very challenging for clinicians. The organism is resistant to many classes of antimicrobial drugs including β-lactams, first and second generation cephalosporins, aminoglycosides, chloramphenicol, and tetracyclines.[12] A rapid increase in the resistance of *A. baumannii* to fluoroquinolones has also been documented in the US.[13] Resistance of this organism is attributed to either intrinsic mechanisms or to acquisition of genetic resistance factors. Lately, emergence of MDR strains of *A. baumannii* is becoming a major concern in hospital settings.

Although *A. baumannii* is typically of low virulence, the MDR phenotype makes treatment of infections very problematic, especially in vulnerable hosts.[14] A recent study found that >90% of isolates from healthy personnel were susceptible to amikacin/sulbactam, ciprofloxacin, gentamycin, imipenem/cilastatin, and piperacillin/tazobactam. However, susceptibility to the same drugs was less than 50% in isolates from inpatients,[15] which underscores the role of antibiotic pressure in the emergence of drug resistant phenotypes.

Resistance is increasing for the current regimen of drugs used against *Acinetobacter* infections. Drugs of choice have traditionally been β-lactams, aminoglycosides, and quinolones.[16] Enzymatic modification of drugs (ex. Extended Spectrum Beta-Lactamase (ESBL)-mediated resistance for β-lactams)[17] or modifying enzyme-mediated resistance to aminoglycosides,[18] reduced permeability (resulting in resistance to β-lactams),[19] and target site mutations (ex. mutations in DNA gyrase leading to resistance to quinolones)[20] have been reported as resistance mechanisms in *Acinetobacter* spp. However, energy-mediated efflux of antibiotics is now being recognized as a major mechanism of resistance in *Acinetobacter* spp, responsible for the MDR phenotype of this organism. In spite of an increasing clinical importance of this organism, its virulence factors remain largely unknown. In this study, we show that interference with the blood coagulation pathway could be part of a virulence mechanism utilized by *Acinetobacter* spp.

Deregulation of Blood Coagulation and Fibrinolysis by Bacterial Virulence Factors

The blood coagulation system and fibrin formation stops blood loss in response to injury and prevents the spread of bacteria between tissues and transmission to other hosts. Gram negative and Gram positive bacterial infections lead to sepsis, a systemic inflammatory condition when the host immune system becomes hyperactive. The immune response to bacterial infection involves fibrin formation as a result of generation of Tissue Factor (TF) which activates the coagulation system via the Extrinsic pathway. Fibrin has a "barrier function" to block the spread of the invading bacteria within and between tissues and systemically in blood vessels. Certain pathogenic bacteria have developed ways to undermine and attenuate this process by secreting virulence factors that: 1) promote fibrin formation to block their destruction by white blood cells and/or 2) enhance fibrin breakdown to accelerate their growth and transmission.

Gram negative and Gram positive bacteria activate the coagulation system by accelerating TF production from monocytes and endothelial cells.[21] Coagulation may be initiated from bacterial infection by the Contact system of the Intrinsic pathway.[22] Bacteria activate Contact factors on their surface.[23] Lipolysaccharide (LPS) from Gram negative bacteria activates the Contact system by activating Factor 12 (FXII). Proteases secreted from bacteria activate Prekallikrein (PK), kininogen, or FXII resulting in production of bradykinin which increases blood vessel permeability.[24] This may represent a strategy employed by bacteria to facilitate their entry into and spread between tissues.

Coagulase is secreted from *Staphylococcus aureus* which activates prothrombin to a thrombin-like protease without proteolysis.[25] Coagulase/prothrombin converts fibrinogen to fibrin. The bacterial outer membrane Omptin proteases inactivate Tissue Factor Pathway Inhibitor (TFPI) resulting in enhanced fibrin formation.[26] The formation of a fibrin clot around bacteria would isolate the invading pathogen by preventing its spread. Bacterial-dependent generation of a fibrin would promote survival and growth, because fibrin entrained bacteria are recalcitrant to destruction by host macrophages and neutrophils.[27]

Fibrin formation is a transient response to injury because the clot is not infinitely stable, but is eventually removed by the fibrinolytic system to promote

wound healing, tissue remodeling, and repair.[28] Fibrinolysis is activated by tissue Pathway Inhibitor (tPA) and/or urikinase Plasminogen Activator (uPA) released from damaged endothelial cells; which convert plasminogen to the fibrin clot degrading protease, plasmin.[29] Plasmin down regulates coagulation by inactivating FV[30] and Factor 8 (FVIII),[31] effectively dampening their cofactor and accelerating effect on fibrin formation. Plasmin promotes tissue remodeling at the site of injury by activating Matrix Metalloproteinases (MMPS).[32] Plasmin hydrolysis of fibrin is regulated predominately by α2-antiplasmin[33] while α2-macroglobulin appears to serve as an "overflow" inhibitor.[34] Plasmin is also indirectly regulated by PAI 1 which inhibits tPA- and uPA-dependent plasminogen activation.[35]

Bacteria release plasminogen activators. Streptokinase from *Streptococci* converts plasminogen to a plasmin-like protease without proteolytic cleavage.[36] Conformational activation of plasminogen by streptokinase protects the protease from α2-antiplasmin inhibition.[37] Staphylokinase released from staphylococci activates plasminogen to a plasmin-like protease without cleavage;[38] but, unlike streptokinase/plasminogen, staphylokinase/plasminogen is effectively inhibited by α2-antiplasmin.[39] Bacterial binding of plasminogen accelerates staphylokinase activation and protects staphylokinase/plasminogen from α2-antiplasmin inhibition.[40] Staphylokinase deregulates the innate immune response by inactivating neutrophil anti-microbial α-defensins.[41]

Yersinia pestis secretes the Pla protease which activates plasminogen to plasmin.[42] *Y. pestis*-bound plasmin promotes bacterial release from fibrin to promote pathogen spreading and transmission. Genetic knockout models have shown that *Y. pestis* infection of normal mice results in large numbers of bacteria and low numbers of white blood cells at infection sites.[43] Infection of wild type mice with *Y. pestis* deficient in Pla or *Y. pestis* infection of plasminogen-deficient mice results in large numbers of white blood cells at infection sites and increased survival. The benefits of *Y. pestis* deficient in Pla or host plasminogen deficiency are lost in mice that are fibrinogen-deficient.[44] Pla deregulates the inflammatory response by inactivation of complement C3 and C3b resulting in decreased phagocytosis.[45] The above research emphasizes the importance of plasminogen and fibrinogen, the primary fibrinolysis and coagulation proteins, respectively, in controlling the immune response to bacterial infections.

Bacteria bind plasminogen and associate with tPA or uPA resulting in plasmin formation.[46] Bacteria express two glycolysis enzymes on their surface: Glyceraldehyde 3 phosphate dehyrogenase (GAPDH) and enolase which bind plasmin and plasminogen.[47] GAPDH and enolase recruitment to the bacterial surface bind and activate plasminogen to plasmin by tPA or uPA and initiate fibrinolysis.[48] Bacterial invasion and adherence is accentuated by GAPDH binding and plasminogen activation.[49] *Streptococcus* pneumonia virulence is associated with enolase binding and plasminogen activation resulting in disruption of gap junctions to promote bacterial migration and spreading.[50]

Group A streptococcal M protein binds plasminogen which may be activated to plasmin by tPA or uPA to increase bacterial virulence.[51] *Heliobacter pylori bind* plasminogen and release NAP which down regulates fibrinolysis by enhancing the expression of TF and Plasmonigen Activator Inhibitor (PAI)-2.[52] This would accelerate coagulation and stabilize fibrin to protect bacteria from phagocytosis. Plasminogen activator-deficient mice generate more extensive fibrin clots upon LPS treatment compared with wild type mice; whereas PAI-1-deficient mice are protected from extensive fibrin formation upon LPS challenge.[53] Thus, fibrinolytic factors control the extent of fibrin formation upon exposure to LPS.

In summary, bacteria have evolved to activate plasminogen to the fibrin-degrading protease, plasmin to enhance their dissemination. Plasmin degrades components of the extracellular matrix[54] and promotes bacterial spreading by activating procollagenase[55] and inactivating collagenase inhibitors[56] to facilitate disruption of the extracellular matrix at the site of infection.

FV, a procofactor that is activated by thrombin to FVa, is critical for effective thrombin generation as part of the *prothrombinase* enzyme complex.[57] Activation of FV to FVa occurs initially by thrombin.[58] In the presence of thrombomodulin, thrombin activates protein C to APC which inactivates FV and FVa and down regulates coagulation.[59] NE[60] or plasmin[61] initially activate FV and subsequently inactivate FVa. Proteases from *Escherichia coli* inactivate FV.[62] FV has been shown to be preferentially consumed by 60% after 5 h during human endotoxemia.[63] Deficiency of plasma or platelet FV increased mortality of mice upon group A *streptococci* infection, indicating that depletion of plasma or platelet FV increases host susceptibility to infectious disease.[64]

One of the major challenges in the development of novel therapeutic options is the lack of understanding of virulence factors of *A. baumannii*. As the role of FV is relevant to *A. baumannii* infections in combat war zones, but its cleavage by virulence factors released by this bacterium in not known, the present study set out to determine the extent of FV cleavage in conditioned media from clinical isolates of *A. baumannii* collected from Canadian hospitals. The study also examined the conditioned media from the clinical isolates of *A. baumannii* on the Activated Partial Thromboplastin Time (APTT) in normal human plasma in order to obtain a "global" assessment of the effect secreted factors from this bacterium on fibrin clot formation initiated by the Intrinsic pathway.

Method

Acinetobacter spp. Clinical Isolates

A 2ml culture of each *Acinetobacter* spp. clinical isolate (Gift from Dr. George Zhanel, University of Manitoba) was grown for 16h at 37°C in Luria broth, pH 7.0 (LB) with shaking at 200rpm. Subsequently, 500µl of each 2ml culture was inoculated into 50ml of fresh LB media and grown to an OD_{600nm} of 1.0 at 37°C with shaking at 200rpm. The bacteria were removed with centrifugation at 10,000 x g for 30min at 4°C and the culture supernatants were filtered through a 0.22mM filter (Millipore, Millex-GS syringe filter, Billerica, MA). The culture supernatants were concentrated from 50ml to 3ml with centrifugal filtration at 1,800 x g at room temperature (Pall Life Sciences, 3kDa molecular weight cutoff, Ville St. Laurent, Quebec). The conditioned media for each isolate was stored in small aliquots at -70°C and thawed/refrozen samples were not used for study. Unconditioned LB media alone (50ml) without bacteria was similarly concentrated to 3ml and stored at -70°C in small aliquots to serve as a control.

Fv Immunoblotting

The conditioned media for each isolate, unconditioned media, or phosphate buffered saline (PBS; 10mM phosphate/137mM NaCl/2.7mM KCl, pH 7.4) (30µl) was mixed with normal human plasma (NHP, Precision Biologicals, Halifax, NS; 30µl diluted 5-fold in 20mM HEPES/0.15M NaCl, pH 7.4; HBS) and incubated for 30min at room temperature. Each sample was diluted 8-fold in HBS, pH 7.4; mixed with an equal volume of 2x loading dye (0.1%

bromophenol blue/37% glycerol/30% SDS/5% mercaptoethanol) and heated for 5min at 95°C. Samples were electrophoresed with prestained molecular weight standards (BioRad, Mississauga, ON) in 4-20% gradient polyacrylamide gels (BioRad, Mississauga, ON) at 150V constant voltage. The proteins were transferred onto Immobilon-P PVDF membranes (Millipore, Billerica, MA) according to Towbin *et al.*[65] Non-specific binding sites on the membranes were blocked with 120ml of 2% (w/v) bovine serum albumin (BSA; Fraction V, Fisher, Nepean, ON) for 1h at room temperature. The membranes were washed for 4 x 5mins in 150ml of PBS/0.1% (v/v) Tween 20, pH 7.4 (PBS/Tween). The primary antibody, sheep anti-human FV IgG (Haemtech, Essex Junction, VT) was diluted 37,000-fold in PBS/Tween and applied to the blots for 1h at room temperature. The blots were then washed for 4 x 5mins in 150ml of PBS/Tween. The secondary antibody, donkey anti-sheep IgG conjugated with horse radish peroxidase (Jackson ImmunoResearch, West Grove, PA) was diluted 25,000-fold in PBS/Tween and applied to the blots for 1h at room temperature. The blots were washed for 4 x 5mins in 150ml PBS/Tween and 1 x 5mins in distilled water. The blots were then exposed to the enhanced chemiluminescence reagents (Western Lightening Plus, Perkin Elmer, Waltham, MA) for 1min at room temperature according to the manufacturer's instructions. The blots were wrapped in Saran Wrap, exposed to Kodak XOMAT film (Kodak, Rochester, NY) for 2mins at room temperature with an intensifying screen, and developed with a Kodak XAR film developer (Kodak , Rochester, NY).

Sds-page and Silver Staining

For this technique, 25µl of conditioned media, unconditioned media, or PBS was added to 15µl of 2x loading dye (0.5% bromophenol blue/25% glycerol/4% SDS/5% mercaptoethanol). The samples were incubated at 95°C for 5mins and loaded into 4-20% polyacrylamide gradient gels (BioRad, Criterion gels, Mississauga, ON) with 5µl of pre-stained molecular weight standards (BioRad, Mississauga, ON) added to the outer well. The gels were electrophoresed at 150V constant voltage for approx. 1.5h in 25mM Tris/192mM glycine/0.1% SDS, pH 8.3 and stained with silver. The silver staining procedure was modified from Merril *et al.*[66] Briefly, 200ml prefix solution (50% methanol/10% ethanol in distilled water) was added to the gel and microwaved for 1.5min at 50% power. The gel was then incubated in the prefix solution at room temperature for 2mins with agitation. The prefix solution was decanted, replaced with 200ml of distilled water, and microwaved at 50% power for 2mins. The

gel was incubated in distilled water at room temperature for 2mins with agitation. The water was replaced with 200ml of 100μM dithiothreitol (DTT) solution in distilled water and microwaved for 2mins at 50% power. The gel was incubated in the DTT solution for 2mins at room temperature. The DTT solution was decanted and replaced with 200ml of 0.1% (w/v) $AgNO_3$ in distilled water and microwaved for 1.5mins at 50% power. The $AgNO_3$ solution was decanted and the gel was washed twice with 200ml of distilled water. The distilled water was decanted and replaced with 200ml of 3% (w/v) sodium carbonate/0.02% formaldehyde (Developer solution). The gel was incubated at room temperature with agitation until the protein bands of interest reached a desired intensity. The Developer solution was then decanted and replaced with 10ml of 2.3M citric acid and incubated for 1min at room temperature to terminate the reaction. The citric acid solution was decanted and gel was washed with 200ml of distilled water. The distilled water was decanted and the gel was stored in 0.03% (w/v) sodium carbonate for at least 1h prior to being photographed.

Aptt Clotting Assay

For this assay, 50μl of Normal Human Plasma (NHP) diluted 5-fold in HBS, pH 7.4 was added to 50μl of conditioned media, unconditioned media, or PBS, pH 7.4 and incubated for 30mins at room temperature in 8 well microplate strips (Nunc, Roskilde, Denmark). Then, 50μl of APTT reagent (bioMerieux, St. Laurent, QC) was added to the microplate wells, the samples agitated for 15s, and then incubated at room temperature for 5mins. Then, 50μl of 25mM $CaCl_2$ was added to the samples. After a 15s incubation at room temperature, the samples were agitated for 5s and the absorbance at 405nm was read every 5s for 8mins in a microplate reader (SpectraMax Plus, Molecular Devices, Sunnyvale, CA). The APTT clot times were determined as the time to reach the half maximal increase in absorbance at 405nm after $CaCal_2$ addition (Approx the inflection point of the sigmoidal absorbance vs time curve).

Results

Immunoblotting was used to assess the presence of potential virulence factors secreted from the *A. baumannii* clinical isolates that had the ability to proteolytically cleave FV, a key accelerator of fibrin clot formation, upon their addition to normal human plasma. Of the sixteen clinical isolates from Canadian hospitals studied, eleven (69%) were capable of secreting a protease activity

that cleaved FV from the Mr of 330kDa of the intact procofactor to a Mr of 150kDa of the proteolytic product (Figure 14.1, Panels A and B). FV cleavage by the conditioned media from the eleven clinical isolates was deemed specific because five of the clinical isolates did not support such an activity vs FV nor did non-conditioned but similarly concentrated LB media or a PBS buffer control. Further, the conditioned media from a non-pathogenic *A. baumannii* strain (ATCC 19606) also did not support cleavage of FV upon addition to normal human plasma. These results indicate that the majority of the clinical isolates of *A. baumannii* studied released a proteolytic activity that specifically cleaved FV upon addition to normal human plasma.

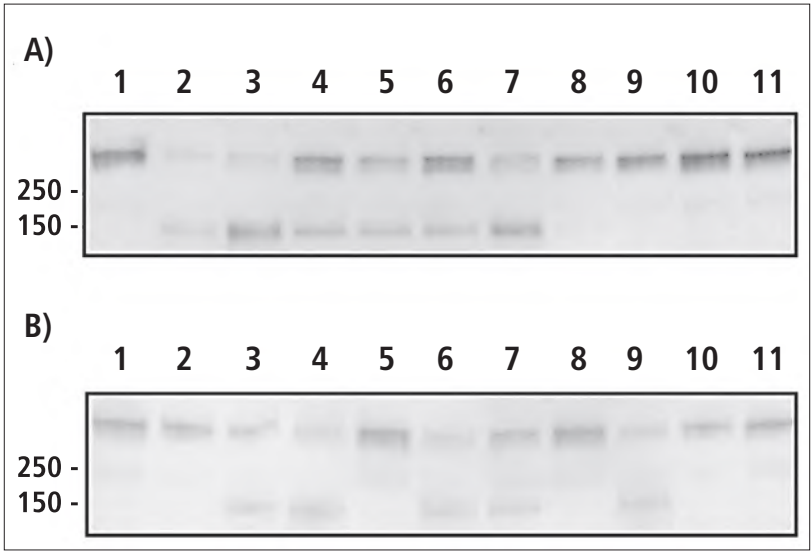

Figure 14.1: Cleavage of FV by *Acinetobacter baumannii* Conditioned Media.
Conditioned media from *A. baumannii* strains AB006, AB007, AB004, AB005, AB011, AB013, AB012, AB008 and ATCC 19606 (Lanes 2-10, respectively in Panel A) and AB009, AB010, AB014, AB027, AB028, AB029, AB030, AB031 and ATCC 19606 (Lanes 2-10, respectively in Panel B) were added to NHP and FV immunoblotting was performed as described in the text. Also shown is the effect of PBS, pH 7.4 and non-conditioned LB media on FV in NHP in lanes 1 and 11, respectively in Panels A and B. The migration position of the molecular weight markers (250kDa and 150kDa) transferred to the membranes is also indicated to the left of Panels A and B.

As an initial attempt to identify and further characterize the proteolytic activity released from the clinical isolates of *A. baumannii* which supported

FV cleavage, SDS-PAGE and silver staining of the conditioned media was performed. Secretome analysis of the conditioned media using this sensitive staining method indicated that a protein of Mr 60kDa was secreted exclusively from the eleven isolates that supported FV cleavage in normal human plasma (Figure 14.2, "Arrow" Panels A and B). Conversely, the Mr 60kDa was not present and secreted from the five clinical isolates that did not support FV cleavage upon addition to normal human plasma nor was this protein secreted from the non-pathogenic *A. baumannii* strain (ATCC 19606). The protein profiles of each of the conditioned media from the clinical isolates studied were deemed specific because negligible protein band staining was observed in both non-conditioned but similarly concentrated LB media and a PBS buffer control. The secretome analysis of the proteins secreted from the clinical isolates of *Acinetobacter* spp. studied represents the first attempt to identify the protease(s) responsible for mediating the cleavage of FV. Studies are underway to identify the Mr 60kDa protein by LC-mass spectrometry.

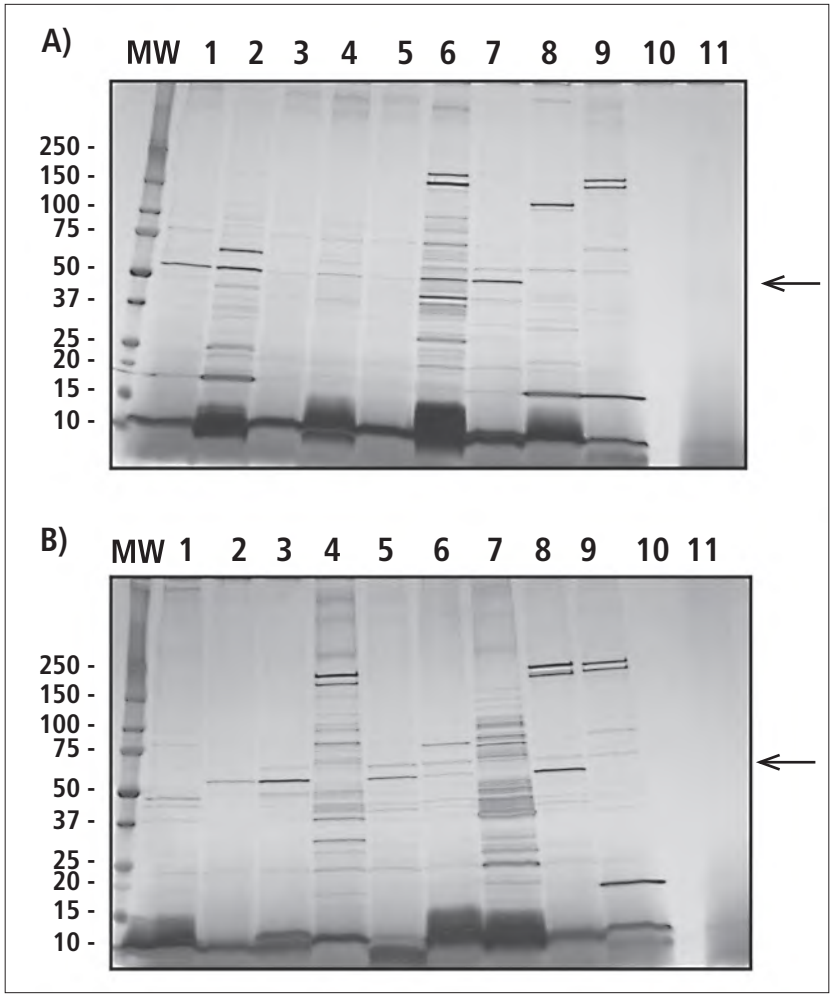

Figure 14.2: SDS-PAGE and Silver Staining of *Acinetobacter baumannii* Conditioned Media. Conditioned media from A. baumannii strains AB006, AB007, AB004, AB005, AB011, AB013, AB012, AB008 and ATCC 19606 (Lanes 1-9, respectively in Panel A) and AB009, AB010, AB014, AB027, AB028, AB029, AB030, AB031 and ATCC 19606 (Lanes 1-9, respectively in Panel B) were subjected to SDS-PAGE and silver staining as described in the text. Also shown is PBS, pH 7.4 and non-conditioned LB media in lanes 10 and 11, respectively in Panels A and B. The "arrow" to the right of Panels A and B indicates the migration position of the 60kDa protein. The migration positions of the molecular weight (MW) markers is also shown to the left of Panels A and B in kDa.

In order to assess the "global" effect of the conditioned media and the secreted proteins from the clinical *Acinetobacter* spp. isolates on the coagulation process initiated via the Intrinsic pathway, the activated partial thromboplastin time (APTT) clotting assay was used and the results are illustrated in Figure 14.3. Compared with the similarly concentrated non-conditioned LB media, eleven of sixteen isolates (69%) significantly prolonged the APTT while two of sixteen isolates significantly decreased this parameter. Further, four of sixteen isolates had no significant effect on the APTT compared with the non-conditioned LB media. These results indicate that the majority of the clinical isolates tested significantly attenuated the coagulation process initiated via the Intrinsic pathway. Of particular interest is that eight of the eleven isolates that supported FV cleavage also attenuated coagulation as assessed by the prolongation of the APTT.

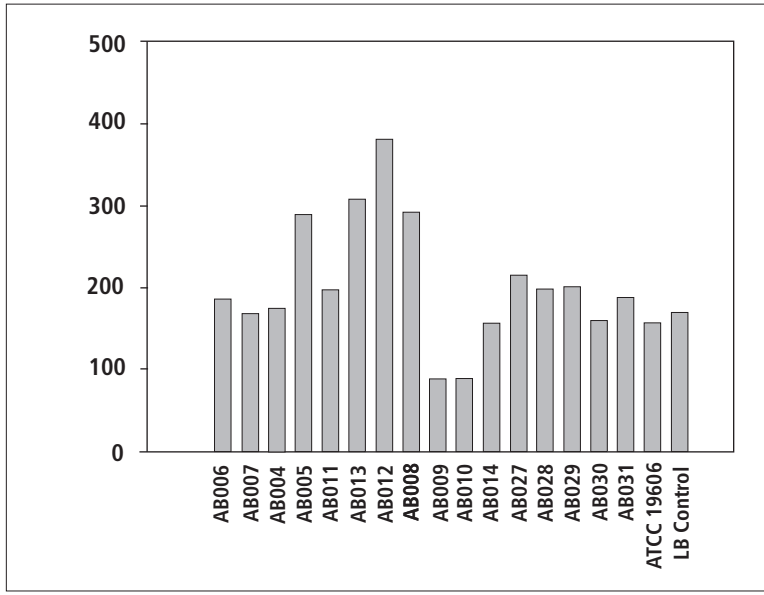

Figure 14.3: Effect of *Acinetobacter baumannii* Conditioned Media on Activated Partial Thromboplastin Time of Fibrin Clot Formation in Normal Human Plasma. Conditioned media from the *A. baumannii* strains or non-conditioned LB media were added to NHP as described in the text and the effect on the APTT clot time was determined and is shown.

Discussion

This research represents the first study to characterize virulence factors released from clinical isolates of *Acinetobacter* spp. in terms of their effect on

coagulation FV, a critical enhancer the process of fibrin clot formation. The results indicate that the majority of the clinical isolates tested (69%) secrete a proteolytic activity that cleaves intact FV from a Mr of 330kDa to a product of Mr 150kDa. Although such cleavage would be expected to inactivate the cofactor activity of this crucial coagulation factor and attenuate the blood coagulation process, this will need to be confirmed in future work using concurrent FV activity assays.

Secretome analysis of the conditioned media from the sixteen *Acinetobacter* spp. clinical isolates using SDS-PAGE and a sensitive silver staining assay indicated that the eleven strains which supported FV cleavage possessed a protein of apparent Mr of 60kDa. Since the five strains which did not support FV cleavage in normal human plasma did not secrete a protein of Mr 60kDa, the results suggest this protein mediated this cleavage effect on FV. Studies are now in progress to identify the Mr 60kDa protein by LC-mass spectrometry. Identification of this specific protein will shed further light on its function in the context of a role in inactivating the blood coagulation process.

The research has also indicated that eleven of the sixteen clinical *Acinetobacter* spp. isolates released a factor or factors that significantly prolonged the APTT clot time in normal human plasma. Such an inactivation effect on the Intrinsic pathway of coagulation would be expected to attenuate this process during *Acinetobacter* spp. infections in combat war zones and result in bleeding complications in affected soldiers.

In conclusion, our research has demonstrated that clinical isolates of *Acinetobacter* spp. from Canadian hospitals secrete virulence factors that attenuate the blood coagulation process by cleavage of FV as well as inhibiting fibrin clot formation via the Intrinsic pathway. Such novel virulence factors secreted from *Acinetobacter* spp. that inhibit fibrin clot formation would be expected to enhance bacterial growth, survival, and transmission. Further characterization of virulence factors released from *Acinetobacter* spp. is expected to not only reduce coagulopathies and improve the clinical outcome associated with these infections in soldiers in combat war zones, but contribute to the development of new diagnostics, treatments, anti-virulence drug design, and vaccines. Future discovery and development of novel diagnostics and treatments for *Acinetobacter* spp. infections in combat war zones will ultimately result from a greater understanding of the interactions of bacterial virulence factors with the proteins of the blood coagulation pathway.

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CHAPTER 15

Effects of the Explosive Compound Perchlorate During Early Frog Development

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ABSTRACT

Perchlorates are strong oxidizers used in components of military ordinance and have been measured in North American water systems over the past decade. Many studies have demonstrated that these anions negatively impact normal development across species due to their goitrogenic effects. This chapter examines the effects of potassium pechlorate ($KClO_4$) on thyroid gland-related gene expression during the larval development of *Silurana tropicalis* frogs. Larvae were exposed to four different concentrations of $KClO_4$ (0, 10, 100 and 250 ppb) over the course of embryogenesis and were sampled after 24 h in early pre-metamorphosis. Transcript levels of thyroid hormone receptor alpha (*tralpha*), thyroid hormone receptor beta (*trbeta*), type II deiodinase (*dio2*) and type III deiodinase (*dio3*) in whole larvae were measured using Reverse Transcription Polymerase Chain Reaction (RT-PCR). Transcript levels did not significantly change among treatments ($p \leq 0.05$). These findings provide further evidence that perchlorate exposure during embryogenesis has little effect on thyroid hormone-related genes during early vertebrate development.

Introduction

Environmental Presence of Perchlorate

Perchlorate has been released into the environment since the Second World War. Perchlorate salts are powerful oxidizers, and as a constituent of solid

propellants,have been used extensively in military applications for explosives and a variety of other munitions.[1] Military ranges, munitions depots and supporting factory facilities are prime point sources of perchlorate in the environment. Contamination tends to be most heavily concentrated surrounding these sites, with the environmental concentrations ranging from 12,500 to over 5,000,000 ppb.[2] For example, perchlorate concentrations at the Longhorn Army Ammunition Plant in Karnack, Texas ranged from 555 to 5,557,000 ppb in vegetation, 811 to 2038 ppb in aquatic insects and 207 ppb in fish.[3] In aqueous systems, perchlorate resides as an anion and rapidly moves through environmental media. It can be readily transported through runoff and accumulate in surface waters.[4] Thus, perchlorate's effects can be far reaching from the original point sources. Perchlorate anions have been detected in drinking water at concentrations ranging from 1 to 200 ppb and in North American waterways in concentrations exceeding thousands of ppb.[5] These concentrations exceed the majority of recommended perchlorate exposure levels for drinking water, which range from 3 to 14 ppb depending on the state and province.[6] In the US, studies have demonstrated that perchlorate anions can be detected in a variety of human bodily fluids including urine, breast milk, amniotic fluid, saliva and blood, in concentrations ranging from 0.5 to 92 ppb.[7] Due to the widespread presence of perchlorate in the environment and in bodily fluids and the potential health consequences of prolonged exposure, the ongoing use of this chemical is of growing concern.

Overview of the Thyroid Gland and its Associated Enzymes and Receptors

A major health concern regarding perchlorate exposure is its interference with normal thyroid gland function.[8] Many biological processes are under the influence of Thyroid Hormones (THs), including: metamorphosis in fish and anuran amphibians;[9] smoltification in fish;[10] neuronal development, metabolic regulation and sexual differentiation in mammals, fish and amphibians[11] and gonadal recrudescence in fish and avian species.[12]

The only known mechanism of perchlorate toxicity is the competitive inhibition of iodide (I-) binding to the Na^+/I^- symporter (NIS) in the thyroid gland.[13] The NIS actively transports and concentrates iodide in the thyroid follicle cell.[14] Iodide is critical for the biosynthesis of the iodine-containing THs, tetraiodothyronine (T4) or triiodothyronine (T3). The major form of TH released into the blood is T4, which has a longer half-life than T3.

However, T3 is a metabolite of T4 and is the more potent of the two hormones. T4 is converted to the active T3 by deiodinases.[15] The interplay between THs and deiodinases is essential to many physiological processes throughout development.

Deiodinases activate and deactivate THs via iodination and deiodination of their phenolic rings. Type II deiodinase (*dio2*) activates THs by converting T4 by outer ring deiodination to bioactive T3.[16] Type III deiodinase (*dio3*) catalyzes the inactivation of THs by inner ring deiodination of T4 and T3 to inactive metabolites 3,3',5'-triiodothyronine (rT3) and 3,3'-diiodothyronine (T2), respectively.[17] The expression of deiodinases is ultimately dependent on TH concentration requirements of a tissue, which in turn are dependent on the animal's stage of development. For example, deiodinases regulate circulating TH levels during brain development. In the brains of young rats, *dio3* is highly expressed at the end of the fetal period and just after birth to ensure TH levels are only present in high concentrations in brain tissue during development and growth.[18] Thus, coordination of the expression and activity of the deiodinase enzymes in individual tissues allows the body to regulate the concentration of active TH present, according to specific needs.

The primary mechanism of THs is via transcriptional regulation of target genes. The effects of THs at the genomic level are mediated by nuclear TRs, which are intimately associated with chromatin and bind THs with high affinity and specificity.[19] Hormone binding is associated with the conformational change of the receptor that causes it to function as a transcriptional activator. Like deiodinases, Thyroid Receptors (TRs) (*tralpha* and *trbeta*) have distinct patterns of spatiotemporal expression dependent on all the stages of development, TH concentrations and species.[20] Goitrogenic chemicals such as perchlorate can disrupt the coordinated activity of THs, deiodinases and TRs.

Consequences of Perchlorate Residues on the TH Axis

Perchlorate is similar to iodide in charge and size and is preferentially transferred into the cell by the symporter.[21] In sufficient concentrations, the anion inhibits the biosynthesis of the iodine-containing THs. Waterborne exposures to perchlorate have been demonstrated to reduce plasma TH concentrations, alter thyroid gland histology and affect developmental processes in fish, amphibians,[22] birds and mammals, including humans.[23] Three spine stickleback fish (*Gasterosteus aculeatus*) exposed to 100 ppm of sodium

perchlorate from early larval development up to sexual maturity showed impaired development, slower growth and smaller physical characteristics compared to controls.[24] Larvae and adult Chinese rare minnows (*Gobicypris rarus*) exposed to 50 ppb magnesium perchlorate experienced slowed growth and up regulation of *dio2* and NIS and down regulation of *dio3*.[25] In a number of amphibian species (*Xenopus laevis, Silurana tropicalis, Hyla versicolor, Rana sphenocephala, Spea multiplicata*), chronic exposure to 60 ppb of sodium or ammonia perchlorate was sufficient to reduce growth whereas concentrations greater than 100 ppb of sodium, potassium or ammonia perchlorate induce hypothyroid conditions and lead to changes in thyroid gland morphology, inhibit tail resorption, and prevent metamorphosis.[26] However, sodium and ammonia perchlorate concentrations exceeding 400 ppm result in high mortality in both amphibians and fish species.[27]

TH-related genes (*i.e.*, TH-receptors and deiodinases) are all expressed and functional starting in anuran premetamorphosis through to climax.[28] In this study, an amphibian model serves to test the effects of $KClO_4$ during early development. The semi-aquatic life history of amphibians makes them a relevant model to observe the effects of environmental concentrations of perchlorate. Moreover, THs are evolutionarily conserved among vertebrates and some invertebrates. This study evaluates the effects of $KClO_4$ on gene expression of TH-related genes (*tralpha*, *trbeta*, *dio2* and *dio3*) during early development in the African clawed frog (*Silurana tropicalis*). Gene expression analyses complement previous knowledge about developmental changes of thyroid activity and provide novel insights on a possible role of perchlorate in TH metabolism at the level of gene expression.

Material and Methods

Breeding and Maintenance of *S. tropicalis*

Adult *S. tropicalis* frogs were reared in dechlorinated and aerated water from the Queen's University Animal Care Facility (Kingston, ON, CA). Fertilized eggs were obtained from two pairs of frogs by injecting human chorionic gonadotropin hormone (hCG; 2500 IU/mL; Sigma Canada Ltd., Oakville, ON, CA) into the dorsal lymph sac of adult *S. tropicalis*. Both males and females received a priming injection of 50 µL hCG (10X dilution) followed by a boosting injection of 200 µL hCG (5X dilution) after 24 h. Amplexus began approximately 1 h after the second injection and eggs were present between 2 to 3 h post-injection.

Developmental stages were determined following the Nieuwkoop and Faber (NF) developmental table.[29] Units of time assigned to each stage are in hpf. A 12:12 h light:dark cycle was maintained, where lights came on at 7:00 am. Water conditions were maintained between 24°C and 25°C. The care and treatment of animals used in this study were in accordance with the guidelines of the Animal Care Committee of Queen's University and the Canadian Council on Animal Care.

$KClO_4$ Exposure and Tissue Collection

Eggs were allowed to develop to NF 8, at which point they were collected and dejellied with 2% (w/v) L-cysteine (pH 8.0; Sigma). The eggs were washed three times with modified Ringer's solution (0.1 M NaCl, 1.8 mM KCl, 2.0 mM $CaCl_2$, 1.0 mM $MgCl_2$, 300 mg/L $NaHCO_3$). Following L-cysteine treatment, 50 embryos were placed in 125 mL glass jars containing 30 mL of modified Ringer's solution (1:9 v/v). Embryos were exposed from NF 12 to NF 48 (8 to 72 hpf) to nominal concentrations of $KClO_4$ (10, 100 and 250 ppb; Sigma) dissolved in Ringer's solution. Ringer's solution was refreshed daily. A concentration of 0.04 ppm of the antibiotic gentamycin (Sandoz Canada, Inc Boucherville, QC, CA) was administered for the first 24 h. Tadpoles were fed Sera Micron® (AmiDis, St. Laurent, QC, CA) twice a day from NF 46 to NF 48.

Whole NF 48 larvae were sampled from each treatment for gene expression (10 per pool; n = 8 pools). Tadpoles were anesthetized by immersion in 1% of 3-aminobenzoic acid ethyl ester (MS-222; Sigma), stored on dry ice and kept at -80°C until analysis.

RNA Isolation and cDNA Synthesis

Samples were homogenized using a sonicator (Ultrasonic Dismembrator-150T, Thermofisher, Ottawa, ON, CA). Total Ribonucleic Acid (RNA) was obtained using the E.Z.N.A. total RNA kit as described by the manufacturer (VWR International, Mississauga, ON, CA). DNase treatment was performed using a RNase-free DNase I set (E.Z.N.A. DNA/RNA Isolation Systems, OMEGA bio-tech, Victoria, BC, CA). Isolated RNA was resuspended in RNase-free water and stored at -80°C. Concentrations of RNA were determined using the NanoDrop-2000 spectrophotometer (Thermofisher, Ottawa, ON, CA). Total cDNA was generated from 1 µg of total RNA and 0.5 µg random hexamer

primers using reverse transcriptase. The cDNA products were diluted 80-fold prior to Polymerase Chain Reaction (PCR) amplification. Samples without the addition of Reverse Transcription (RT)- and No Temple Controls (NTC) were also run. RT- controls assess genomic DNA contamination whereas NTC control for reagent contamination.

Real-time RT-PCR

Specific primer sets used for *trαlpha*, *trbeta*, *dio2*, *dio3* and *rpL8* genes are described in Langlois *et al*., (2010).[30] Briefly, sequences are as follows:

trαlpha (forward: 5' -TAAGTTCTCTGTTCCCCTTTCCG-3';
reverse: 5' -TCCTCTGATCTTCTTGCTGCTC-3'),

trbeta (forward: 5' -ATCCAACACAGCAAAGGTATTTTC-3';
reverse: 5' GTAATGACTGCCCCACATTGC-3'),

dio2 (forward: 5' -GTGTTGCCGACTTTGTGTTG-3';
reverse: 5'-CGTTCTTCTTGGTTTCTGTGCT-3'),

dio3 (forward: 5' -TCGGAACTGAGGATGTGGT-3';
reverse: 5' -ATGCCCAAGGAGATGAGTG-3') and

rpL8 (forward: CCCTCAACCATCAGGAGAGA;
reverse: 5'-TCTTTGTACCACGCA).

For all real-time RT-PCR assays, primer concentrations were optimized to obtain a minimum threshold cycle and a maximum change in fluorescence. The reaction consisted of a 20-µL amplification reaction containing 4 µL of cDNA and 16 µl of GoTaq Master Mix (Promega, Madison, WI, US). Primer concentrations were optimized and varied according to the primer set, for use with 1 µg of diluted cDNA template. Primer concentrations used are as follows: *tralpha*, 0.25 µM; *trbeta*, 0.25 µM; *dio2*, 0.28 µM; *dio3*, 0.18 µM; and *rpL8*, 0.45 µM.

The thermocycler program included an enzyme activation step at 95°C (15 min) and 40 cycles at 95°C for 15 s, the gene specific annealing temperature for 5 s, 72 °C for 30 s and 80°C for 8 s. Gene specific annealing temperatures for *trαlpha*, *trbeta*, *dio2*, *dio3* and *rpL8* are 62°C, 58°C, 60°C, 60°C and 62°C, respectively. After this amplification phase, there was a denaturation step of 1 min (95°C) followed by 40 cycles starting at 55°C and increasing 1°C/30 s to generate a dissociation curve to confirm the presence of a single amplicon.

Primer and probe concentrations were optimized to yield an efficiency of 100 ± 10% and an R2 ≥ 0.99. The relative standard curve method was used to interpolate relative messenger Ribonucleic Acid (mRNA) abundance of target genes within each sample. The threshold for each target was automatically calculated by the MxPro software (MX3005P) and was only corrected when necessary. For the perchlorate exposure, equal parts of complementary DNA (cDNA) from each treatment were used to produce a standard curve. The standard curve was performed by serial dilution (1:4), with concentrations ranging from 0.048 to 50 ng.

Data Analysis

Data for the $KClO_4$ exposure is expressed relative to the control group and normalized to the housekeeping gene *rpL8* mRNA levels. Each gene's fold average was first divided by the fold average of the control. This is done for each gene of interest including the *rpL8* gene. Fold changes for *dio2*, *dio3*, *tralpha* and *trbeta* genes relative to the control were then normalized to the fold change of *rpL8*.

Water Chemistry Analysis

Water samples (20 mL) were collected in pre-cleaned, 100-mL amber glass bottles and stored at 4°C for 40 d. The Analytical Service Group of RMCC, in Kingston (ON, CA) performed the water analyses. At the time of analysis, water samples were warmed to room temperature, diluted if necessary with deionized water to ensure they fell within the calibration range, placed into 5-mL polyvials and closed with filter caps. Samples were analyzed by an ion chromatograph equipped with a conductivity detector and an ASRS Ultra suppressor (Metroh, Mississauga, ON, CA). A 1 mL aliquot of sample was injected directly into an Ion Pac anion analytical column (Dionex, Sunnyvale, CA, US) and eluted with 25 µM sodium hydroxide solution under isocratic conditions, at a flow rate of 1 mL/min. The run time per injection was 26 min and the perchlorate retention time was 19.1 min. The detection limit was 1 ppb. Routine quality assurance analyses (*i.e.*, deionized water blanks, matrix blanks, matrix spikes and duplicate samples) were conducted, as appropriate, with each sample set.

Statistical Analysis

Statistical analyses were performed using JMP Version 9.0.0 for Macintosh (SAS Institute Inc.). Data for all genes were first tested for normality and homogeneity of variance using the Shapiro-Wilk test and the Levene's test, respectively. Non-normal distributions and unequal variances were indicated ($p \geq 0.05$) and data was subsequently transformed using a Log10 transformation. When re-tested for normality and homogeneity of variance, all assumptions were met. A one-way ANOVA was used to evaluate the fold change of *dio2*, *dio3*, *tralpha* and *trbeta* genes between the four different $KClO_4$ concentrations.

Results

Chemical Analysis

The results of the analyses are presented in Table 15.1 and demonstrate that the actual perchlorate concentrations closely approximated the nominal values.

Perchlorate Concentrations (ppb)		
Nominal	**Measured**	
	Range	Mean (± SD)[a]
0	ND[b]	ND
10	6.5 -7.8	7.2 (± 0.9)
100	99.0 - 140.0	119.6(± 28.8)
250	130.0 - 330.0	220.0 (± 127.3)

[a]Standard Deviation

[b]Non Detectable; detection limit = 1 ppb

Table 15.1: Comparison of nominal and measured concentrations of $KClO_4$ (ppb). Mean and range represents all measurements within each treatment (n = 2).

Molecular Effects of Goitrogen Treatment during Early Development

Embryogenic larvae (NF 12-14) were exposed to $KClO_4$ throughout the course of embryogenesis and were sampled at the beginning of pre-metamorphosis (NF 48). Transcript levels in whole NF 48 larvae were measured afterwards using RT-PCR. For all of the genes evaluated, transcripts were detectable. The effects of $KClO_4$ on TH-related gene expression are shown in Figure 15.1. Transcript levels of *tralpha*, *trbeta*, *dio2* and *dio3* did not significantly change

between 0, 10, 100 and 250 ppb perchlorate treatments (one-way ANOVAs; $p \geq 0.05$).

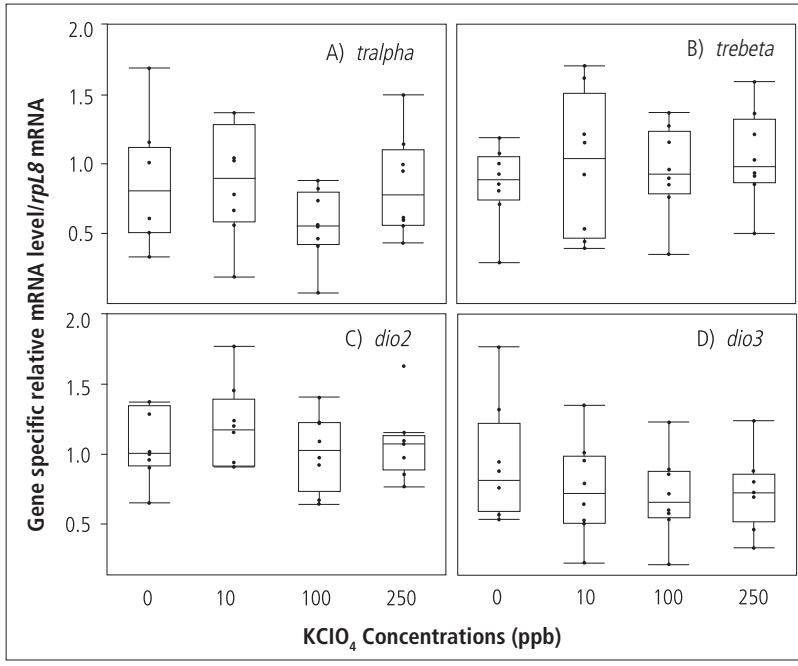

Figure 15.1: Effects of $KClO_4$ exposure (0, 10, 100, and 250 ppb) on TH-related gene expression during larval development (from NF 12 to NF 48) in *Silurana tropicalis*. Nominal concentrations are presented on the X-axis. Transcript level for *tralpha* (A), *trbeta* (B), *dio2* (C) and *dio3* (D) are shown. Levels of mRNA are expressed relative to the control and are normalized *rpL8* mRNA levels. Individual sample points are presented along with quantile boxplots.

Discussion

Effects of $KClO_4$ on Transcript Levels in NF 48 Whole Larvae

Treatment with $KClO_4$ (10, 100 and 250 ppb) during embryogenesis and early premetamorphosis did not affect the expression of TH-related genes *tralpha*, *trbeta*, *dio2* and *dio3*. These results suggest that perchlorate exposure during early development has little effect on thyroid gland function. In amphibians, the thyroid gland becomes functional during pre-metamorphic stages with iodide uptake commencing at NF 46.[31] When raised in water with a

temperature of 24 to 25°C, *S. tropicalis* larvae take approximately 24 h to reach NF 48. Thus, a 24 h window between initial thyroid gland functioning and stage NF 48 may not be sufficient for $KClO_4$ to competitively inhibit the Na^+/I^- Symporter (NIS) symporter or for changes in gene expression to transpire. Opitz *et al*. (2006) demonstrated that NIS activity only becomes significantly pronounced at NF 52.[32] This study suggests that the low activity of NIS in the thyroid gland coupled with the brief exposure to perchlorate does not interfere with TH-axis during embryogenesis and early development in *S. tropicalis* larvae.

Other studies have found similar results using different model systems. Sparling *et al*., (2008) found no differences in physical measurements of growth observed between *H. versicolor* embryogenic larvae exposed to $KClO_4$ concentrations spanning 2.2 to 50 ppm and the control group.[33] Comparable results were observed for exposures during thyroid gland organogenesis in mammals. York (1998) observed that maternal exposure to ammonia perchlorate during rabbit fetal development resulted in no significant changes in toxicity to offspring between the perchlorate exposure and control groups.[34]

Although the thyroid gland is not active during embryogenesis, this period is not devoid of thyroid signaling. The expression of *dio2*, *dio3*, *tralpha* and *trbeta* during amphibian embryogenesis has been previously examined.[35] Studies show that THs and TH-related gene expression are present as early as NF 2.[36] The present study is one of the few that examines TH-related gene expression during embryogenesis under the influence of perchlorate. During this period THs play an important role in development. Morvan-Dubois *et al*., (2006) evaluated the ratio of THs present in *X. laevis* eggs and embryos, and a significant increase was observed from the mean of T3 measured in eggs to that of NF 35-37 embryos ($p \leq 0.05$).[37] Increases in T3 concentrations indicate deiodinase activity during embryogenesis. Transcripts of *dio2* and *dio3* were present in NF 48 whole larvae tissues. The conversion of T4 to the bioactive T3 implies that THs are required for physiological processes during embryogenesis. Thus, TR gene expression should be observed in whole larvae samples. Indeed, *tralpha* and *trbeta* transcripts were also detected in early stage larvae. Developmental profiles examining *tralpha* and *trbeta* transcripts show that expression was relatively stable through early embryogenesis. Increases in *tralpha* and *trbeta* mRNA synthesis only occurred in late embryogenesis.[38] Thus, perchlorate does not pose a threat to amphibian thyroid signaling until later stages of development.

Studies have shown that chronic exposures to perchlorate starting at developmental stages NF 10 or less until metamorphosis resulted in significant changes in the thyroid gland. *X. laevis* larvae exposed to sodium perchlorate (ranging from 10 to over 1000 ppb) exhibited reduced growth and changes in thyroid gland morphology, including increased follicular cell height and colloid T4 ring depletion.[39] Effects on thyroid gland morphology and growth were also observed in Goleman *et al*., (2002) after *X. laevis* larvae were treated with 0.002 to 14.14 ppm.[40] Therefore, chronic exposure over later stages of development has significant implications on the life history of an amphibian.

In contrast, to embryogenesis the expression levels of NIS, *dio2*, *dio3*, *tralpha* and *trbeta* genes and circulating THs' concentrations peak in the prometamorphosis and climax periods (NF 54-66). The recognized symptoms of perchlorate exposure could be attributed to exposure over this intense period of thyroid gland activity. Studies with shorter exposure periods to perchlorate reported significant effects on the thyroid gland, as long as the period of exposure occurred between NF 50 and 66. *X. laevis* larvae exposed to 20 ppm of sodium perchlorate for 12 d resulted in developmental retardation and reduced expression of TH-regulated genes.[41] Furthermore, Opitz and Kloas (2010) conducted 5 and 10 d period exposures on NF 46 *X. laevis* larvae and a 5 d period was sufficient to significantly alter the expression of TH-related genes.[42] Perchlorate exposure is most detrimental when it occurs between NF 50 to 66, which corresponds to the period when the expression of TH-related enzymes and receptors is highest. The abundance of these genes in larval tissue reflects their importance to development during this period. Limb generation, tail resorption, body sculpting and sexual differentiation occur during this period, are governed by THs and thus are potentially susceptible to changes in TH. *X. laevis* larvae exposed to a range of ammonium perchlorate concentrations (2, 50 and 14,000 ppb) demonstrated significantly limited hindlimb growth, forelimb emergence and tail reabsorption over time.[43]

In conclusion, this study demonstrates that exposure to $KClO_4$ during early development (prior to NF 48) does not significantly affect TH-related gene transcription, which suggests that perchlorate does not interfere with normal thyroid gland formation and early function in *S. tropicalis*. The vertebrate embryo is not at risk of transcriptional TH-related gene disruption by perchlorate exposure until the thyroid gland is fully functional.

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SECTION 4: TRANSITIONS

CHAPTER 16

Pilot-Project on Incarcerated Former Military Personnel in Three Ontario Detention Centres

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ABSTRACT

There is limited research on incarcerated former military personnel in Canada. In March 2011, a pilot-project on this population was approved by the Ministry of Community Safety and Correctional Services (MCSCS) in three Ontario detention centres. The study objective was to determine over a one-year period (April 2011-March 2012) the number and characteristics of incarcerated former military personnel and identify factors associated with veterans' incarceration. Inmates reporting a military history volunteered to participate. Demographic variables and military history were obtained through a semi-structured interview. History of previous incarcerations, treatment of psychiatric problems, drug use and/or alcohol consumption were acquired by reviewing facilities' admission notes. Inmates' current offences were accessed through the Offender Tracking Information System. Preliminary data (April to October 2011) identified 18 male inmates in 3 provincial correctional facilities who reported military service. The timing of their first offence relative to their military service varied. All reported at least one risk factor for incarceration (e.g. previous incarceration, mental illness, substance abuse). Incarcerated veterans reported similar risk factors for incarceration as non-veterans. At completion, this study may assist correctional personnel in connecting offenders with services provided by DND and/or VAC.

Background

Research has shown that substance use disorders, severe mental illness, homelessness, past criminal justice system involvement and disadvantageous sociodemographic characteristics are risk factors for incarceration.[1] Certain

factors such as greater exposure to combat,[2] PTSD and other post-combat mental health disorders,[3] diagnoses of alcohol and drug abuse and dependence[4] and difficulty making the transition from the military to civilian society[5] may increase the risk of incarceration in the veteran population.

According to the U.S. Bureau of Justice Statistics 2004 Survey of Veterans in State and Federal Prison, 10% of State prisoners reported prior service in the U.S. Armed Forces.[6] There was little difference in mental health histories between combat veterans and non-combat veterans in State prison. Veterans were better educated and had lower incarceration rates than other prisoners.

In the United Kingdom, the Defence Analytical Services and Advice (DASA) of the Ministry of Defence and the Ministry of Justice estimated in September 2010 that 3.5% of all those currently in custody in England and Wales served in the Forces.[7]

In Canada, the only published data available on former military personnel in prison consists of a review extending a study undertaken by the Addictions Research Centre of the Correctional Services Canada (CSC) on the prevalence of veterans in CSC.[8] A total of 2,054 male offenders from the Atlantic, Ontario, and Pacific regions responded to questions about military service from February 11, 2009 to May 11, 2010; 2.8% of them reported having served in the Canadian military.

Presently there is no systematic identification of former military personnel at any level of the Canadian criminal justice system. Applying the 2.8% to the latest figures by Statistics Canada[9] on the number of people remanded or sentenced in provincial or territorial correctional facilities would mean that an estimated 668 incarcerated veterans would be sentenced or remanded in these facilities.

In March 2011, a pilot study on the number of ex-military personnel incarcerated in three Ontario detention centres in which the researcher works as a consulting psychiatrist was ethically approved by the Research Committee of the Ontario MCSCS. The study objectives are to determine the number and characteristics of incarcerated former military personnel over a one-year period (April 2011 to March 2012) and identify factors associated with veterans' incarceration. To our knowledge, this is the first study of its kind in Canadian provincial correctional facilities.

Methods

Participants

In order to recruit subjects, posters announcing that the researcher is doing a study on people who have done military service and now face legal problems were placed in the admission areas and health care units of the Niagara detention centre, the Hamilton-Wentworth detention centre and the Brantford jail as well as in each holding unit of each facility. A participant must self-identify as a veteran of any country's Armed Forces and sign a request to participate. Excluded are those who were less than 16 years old at the time of military service and those who provide unreliable or improbable information.

Data Collection

Once an inmate self-identified as having a military history and agreed to participate in the study, a semi-structured interview by the researcher explored the inmate's number of years in the military, the country for which they served, history of deployment to a war zone and/or involvement in an operational mission, rank, branch of service, time in the Reserves or Regular Force, nature of discharge, and reason for leaving the military. In addition, the Health Care Record or Health Assessment – Part A, completed on admission of the inmate to the facility by a nurse, was reviewed by the researcher for the following information: date of birth, history of previous incarceration, history of treatment for psychiatric problems and diagnoses, (current and past) street drug use and/or alcohol consumption and suicidal ideation reported on admission. The Offender Tracking Information System, the database system used by the Ontario MCSCS to record information about adult offenders,[10] was also reviewed by the researcher to obtain the inmates' offence history including current offence(s) and year of first recorded offence.

Results

Preliminary data collected from April to October 2011 indicated 18 male inmates self-identified as having served in the military. The number of years served ranged from 6 months (Basic Training) to 15 years; the average length of service was 4 years. The length of time between being released from the military to first recorded offence in Ontario ranged from 0 to 49 years. The length of time between being released from the military to current incarceration ranged from 5 years to 49 years.

Almost all veteran inmates studied had previous incarcerations. Those who had deployed to a war zone or been on operational missions were more likely to have received treatment for a psychiatric problem and/or been given a diagnosis of a psychiatric condition than those who had not deployed. Veterans in both groups described problems with (past and/or current) street drug use and alcohol consumption. Some spoke about their difficulties transitioning to civilian life. Most veterans reporting deployment to a war zone and/or involvement in operational missions had received Veterans Affairs services, but this group represented the minority of inmates studied.

Discussion

Incarcerated former military personnel in three Ontario provincial correctional facilities reported similar risk factors for incarceration as non-veterans. The incarcerated veterans' offending history could not be attributed solely to their previous military service. However, the nature of their military involvement (e.g. deployment to war zones and/or operational missions) was correlated with indicators of mental illness associated with combat.[11] The average duration of their military service was similar to that reported in the 2004 survey of veterans in U.S. State and Federal prisons.[12]

The timing of the incarcerated veterans' first offence relative to their military service varied. This means that it would not be possible to anticipate the arrival of former military personnel into correctional facilities once Canada withdraws from a given peacekeeping or combat mission. Screening all incoming inmates for military history would contribute useful knowledge in designing optimal correctional plans for incarcerated veterans. It would also assist in linking these offenders with services developed by the Department of National Defence and/or Veterans Affairs Canada and connect them to the proper community rehabilitative services upon release.

Limitations

This study relied on a convenience sample of volunteers with a self-reported military history. No validation with military records was performed. Detailed demographics and many risk factors for violence were not examined.

Conclusion

Incarcerated veterans reported similar risk factors for incarceration as non-veterans. The latency period between service and incarceration may be difficult to predict. Military history should be part of the intake screening process upon admission to all correctional facilities in Canada to aid custodial personnel in identifying needs and designing appropriate treatment for this population. Once completed, the results of this pilot study may help in connecting incarcerated former military personnel with services provided by DND and/or VAC.

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CHAPTER 17

Healthcare Leadership: Is Managing in the Hospital the Same as Managing in the Community or Does the Context Matter?

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ABSTRACT

Results from two national surveys demonstrated that healthcare leaders in the hospital and the community identified the same management competencies. The shift of the site of care from the hospital to the community/home and the increasing needs of an aging population suggest that leaders/managers can play an important role in the community. We conducted a national workshop to provide feedback on the survey findings and to further explore the meaning of the survey results. Workshop results demonstrated that there was agreement that the competencies are similar in the hospital and the community. However, the application of competencies varies due to the delivery setting, the experience of the healthcare worker and most importantly the needs of the client. This is an important message for those healthcare and social workers in the civilian sector that will, and do, provide services to Canadian veterans. Our veterans do not represent a homogenous population; they have diverse needs. The application of management/leadership skills/competencies will have to be dynamic, developmental and evolutionary – much like the Veterans Charter.[1]

Background

Healthcare managers and leaders are an important part of the healthcare team and are essential for the delivery of quality services and achieving health outcomes.[2] They are responsible for managing resources, facilitating communication between the different healthcare workers, and providing direction

to and commitment from individuals inside and outside of their organization.[3] Health administration and management programs have traditionally prepared and trained leaders/managers for the acute care setting within hospitals.[4] The shift of the site of care from the hospital to the community/home and the increasing needs of an aging population suggest that leaders/managers can also play an important role in the community.

Many medical services that have been traditionally delivered in the hospital are now being delivered in the community and/or the home.[5] Reasons for this shift in the site of care can be contributed to a number of factors; healthcare reform that supports post-acute home care services,[6] the decrease in the number of hospital beds,[7] technological advances[8] which enable care to be delivered closer to home outside of the hospital, and patient choice with the increasing emphasis on the quality of life.[9] At the same time, the incidence and prevalence of chronic disease is on the rise and an increasing number of individuals are now living with multiple chronic conditions outside of the hospital.[10] It would seem that now, more than ever, the expertise of healthcare leaders/managers are needed to organize the delivery of care in the community, and the home.

Why is this of interest to the CFHS? Lessons learned in the civilian healthcare sector can potentially provide evidence and direction for decision-makers in the CFHS. The relevance of such research is clear when it is recognized that the CFHS's personnel liaison with a variety of organizations, healthcare professionals and administrative leaders/managers in the civilian sector. As well, veterans will access care and/or potentially work in the civilian healthcare system upon retirement from military service.

Today's veterans are younger and will have different needs than previous generations of veterans.[11] VAC works with service providers and partners to support service delivery (e.g., supportive care, medical care, dental care, prescription drugs), residential care and devices to assist in living at home;[12] services primarily delivered in the community/home sector. Not only is there the potential that today's veteran will work longer in the civilian sector, following their military service but, VAC will need to be more flexible and responsive to the unique needs of this new generation of veterans. The enactment of the new veterans Charter in 2005 is reflective of this need as the charter is a living document, evolving to meet the needs of Canadian veterans.[13]

Policy Question

The changing and evolving needs of the Canadian population require healthcare managers/leaders to continually examine and evaluate the required skills/competencies needed to successfully lead/manage in today's healthcare system. We have conducted two national studies to determine the views of Canadian healthcare leaders/managers on the skills/competencies needed to lead in healthcare today. We surveyed the members of the Canadian College of Health Leaders (CCHL) (N=513) and the Canadian Home Care Association (CHCA) (N=109) during 2010 and 2011. The electronic questionnaire included variables related to demographics, education and employment history, previous experience with the healthcare system, and questions about leadership/management skills/competencies. Figure 17.1 provides the responses from the question, "What do you feel are the top five skills/competencies needed to lead/manage successfully within the next five to ten years?"

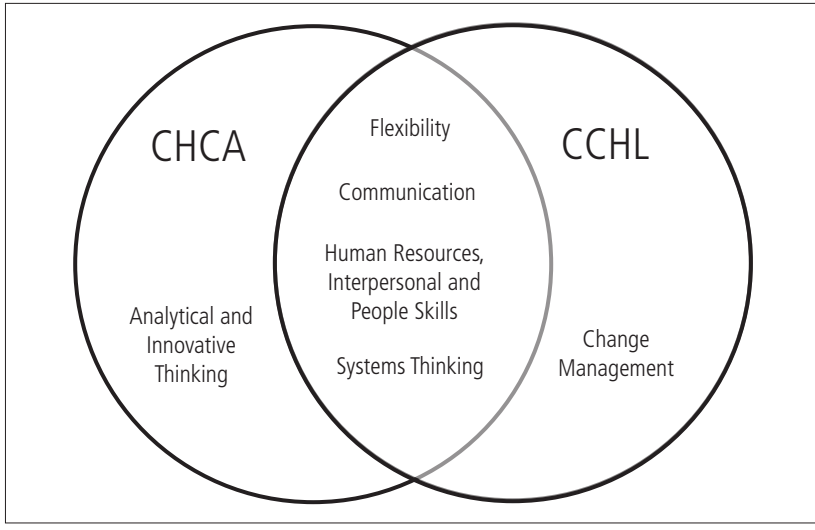

Figure 17.1: Competencies identified by CHCA and CCHL respondents

Results demonstrated that both hospital leaders/managers (as represented by the CCHL) and community leaders/managers (as represented by the CHCA) identified the same five top skills/competencies needed to lead in healthcare today. We are now conducting workshops with members from the CCHL and CHCA to collect feedback on the results and clarity on why the skills/competencies identified are similar. The results presented in this book are based on a workshop conducted in partnership with CHCA members.

Competency Frameworks

The goal of establishing a set of competencies is to "enable the learner to master those situations he will have to deal with in his professional and/or private life."[14] Competencies have also been identified as key resources to capture the knowledge, the skills, and the attitudes and behaviours required to be successful in any profession.

Views differ on the application of competencies.[15] Sparrow[16] identifies three approaches: management competency or the technical/functional approach; the behavioural approach; and the organizational competency approach. The management or the technical/functional approach relies on the functional analysis of roles to identify the standards for workplace behaviour.[17] The behavioural approach promotes and supports attitudes and beliefs that lead to good leadership/management.[18] The third approach focuses on the organization and how it promotes and supports good leadership/management opportunities.[19]

The healthcare literature defines a competency as the knowledge needed to perform a particular task.[20] However, a competency is more than just knowledge (i.e. technical/functional approach); a successful healthcare worker must also acquire additional behavioural skills (e.g., communication skills) to successfully fulfill their role.[21] In addition, the context, or the organization of the delivery of services, is important in terms of providing the resources needed to perform tasks. It is also recognized that the acquisition and application of competencies continues throughout the career of the healthcare worker whether it is during training or based on experience.[22] Competencies are not static but are dynamic, developmental and evolutionary – much like the healthcare system.

In reality, a combination of all three approaches is used to develop competency models for healthcare leadership/management. The NCHL has developed a NCHL Health Leadership Competency Model[23] to "provide the field with a comprehensive, validated competency model that will be suitable as the foundation for a breadth of leadership assessment and development applications." The model incorporates 26 competencies categorized into three categories; transformation, execution and people. Accredited graduate programs in healthcare leadership/management use this model across North America

for curriculum development and continuing education programs.[24] We used this model to map and to analyze the responses to the open-ended question, which asked for views on the top five skills/competencies needed to lead/manage in healthcare in the next five to ten years.

Method

The research design used in this study incorporates an integrative knowledge translation approach.[25] Central to this approach is the involvement of knowledge users and collaborators in the research design and to provide feedback on results and to assist in the interpretation of results.

We therefore conducted a workshop (N=30) at the CHCA's 2011 national conference held in Niagara Falls, Ontario to provide feedback on the survey findings and to further explore the meaning of the findings. Additional workshops are scheduled with hospital and institutional leaders/managers in June 2012.

We first presented a summary of the results collected from CCHL and CHCA surveys.[26] Next, groups were formed consisting of five to seven people. Based on the findings from the national surveys and informed by a systematic literature review we constructed a series of questions, which can be found in Table 17.1 in the results section. Note that each question was set within a specific context.

Each question was presented separately. Groups were then asked to discuss the question for approximately 10 to 15 minutes and then were ask to report back to all participants in the workshop. Time was then allocated for discussion between the groups in an open form. Detailed notes were taken to record the responses of each group. This data was analyzed to determine common themes. We report the main themes discussed for each question.

Results

In this section we present the main themes identified from the CHCA workshop data (Table 17.1).

#	Context	Question	Data – comments
1	CHCA respondents identified the following as the top 5 skills/competencies needed to lead/manage in healthcare within the next 5 years: human resources, interpersonal and people skills; systems thinking, communication; flexibility; and analytical and innovative thinking.	Do you agree or disagree? Which skills/competencies do you believe are important?	1. A critical component was missing cultural and religious background of the patient – care should be patient-focused 2. Context matters! 3. Applying competencies – are a continuum – how does one establish the ideal balance? 4. Accountability – a vision is needed for quality and continuous improvement 5. Educational model – skill acquisition – historically silo-based education; this type of culture is not well suited to developing the competencies/skills and knowledge necessary; rather need a more collaborative approach
2	Survey results indicated similar views on the skills/competencies needed in various sectors. However, it is believed different skills sets and competencies are needed to work in the community sector than the hospital sector.	Why do you think both groups identified the same competencies? In your opinion, are these skill sets and competencies the same regardless of the sector? Please explain why or why not.	1. Differences how the competencies are applied 2. Context matters! 3. Variation due to goals of treatment, types of treatment, regulation, 4. Resources – time constraints, funding models, delivery models 5. Involvement of family members more prevalent in the community setting 6. Leaders in the community more silo; funding model – services are contracted out in the community
3	Respondents indicated that interprofessional collaboration is both advantageous and necessary to succeed in a leadership or management position.	We would like to hear your ideas about IPC and how IPC enhances your role.	1. Applying team approach is better for both the patients and healthcare workers 2. Success depends upon the approach – patient centred care 3. Healthcare workers collaborating in a meaningful way – e.g., talk about the patient together 4. Important to consider who is part of the team 5. Cultural sensitivity – e.g., different belief systems; need to develop trust 6. Perceived role of the providers - e.g., First Nations and the role of physicians (who is credible?) 7. Education – IPE throughout one's career 8. Resources – funding, time

#	Context	Question	Data – comments
4	Based on the literature the ability to practice interprofessionally is enhanced by exposure to interprofessional education.	In your opinion are new graduates entering the workforce prepared to work interprofessionally? Do you have any recommendations on how to implement IPC?	1. Students are better prepared than in the past but improvement is needed 2. Educational programs need to: a. Include training in the community (e.g., medical students training) – practical experience is paramount b. Incorporate awareness of the role of other healthcare workers – role clarity is important 5. Training – learning together 6. Knowing the context

Table 17.1: Themes identified from the CHCA workshop

Discussion

Participants were not surprised that the members of CCHL and the CHCA identified the same competencies necessary to lead/manage in the next five to ten years. However, they agreed that survey respondents overlooked one very important element – the need to ensure care is client-focused. This includes the recognition of and respect for cultural backgrounds, lived experiences and beliefs of the client, as well as the context in which care is delivered. The community/home care clients do not represent a homogenous group but a diverse population with varying social and medical needs.[27] It was also noted, that the type of care delivered varies due to the goals of treatment, types of treatment and regulation.

Another salient point was the need to understand whom within the healthcare division of labour their clients would trust and respect. Clients in the community and the home come into contact with a variety of regulated, unregulated and informal caregivers.[28] It was noted that one of the challenges for community/home leaders/managers was that care was more "silo" due to the implementation of the competitive contracting model approach used by many regions. It was therefore difficult to coordinate care and for healthcare workers to work collaboratively when providing services to their clients.

Yet, there was agreement that interprofessional collaboration (IPC) benefits both clients and workers. The success of IPC is dependent on an approach that is client-focused and allows for the opportunity for healthcare workers

to have a meaningful discussion about the client. This is challenging in the community/home sector, as few opportunities exist for healthcare workers to communicate due to the fragmented approach to the organization and delivery of care.[29]

The workshop participants also identified that educational programs do not provide enough opportunities, or lack opportunities, for training in the community/home sector. In fact, it was the view of those present that all healthcare workers should gain some experience in the community/home sector during their training. For example, one suggestion was that medical residents should be required to complete a community placement (or rotation) prior to completing their educational program.

Experience was also viewed as important. It was through experience that leaders/managers learn how to fully utilize skills/competencies to successfully manage/lead.

Conclusion

Managing/leading in the community/home sector is not without it challenges. The fragmentation of the organization and delivery of care coupled with the diverse settings within which care is delivered calls upon a variety of skills/competencies. It was the opinion of those present at the workshop that leadership/management skills/competencies should be thought of as a continuum. Hence, leaders/managers have at their disposal an array of tools, which can be applied as the situation warrants. Training and workplace experience is essential for honing skills/competencies. The skills/competencies do not vary by sector but how those skills/competencies are applied varies due to the setting of the delivery of care, the experience of the healthcare worker and the client.

The views presented serve as a reminder that not all clients are the same. This is an important message for those healthcare and social workers in the civilian sector that will, and do, provide services to Canadian veterans as our veterans do not represent a homogenous population. Healthcare leaders/managers in the CFHS and the civilian sector providing leadership in the community/home sector will need to be cognizant of this diversity when planning and managing the delivery of care. The application of management/leadership skills/competencies will be dynamic, developmental and evolutionary – much like the veteran Charter.

1 We would like to than the following individuals for their invaluable contributions to the study. Any errors or omissions in this chapter cannot be attributed to them: The Canadian Home Care Association (CHCA); The Canadian College of Health Leaders (CCHL); Nadine Henningsen, Director of the CHCA; L. O'Rourke, Vice President of Professional Standards and Leadership Development, CCHL; Dr. M. Lemonde, Faculty of Health Sciences, University of Ontario Institute of Technology; Dr. W. Isaac, Director of the School of Health Services Management, Ted Rogers School of Management, Ryerson University; T. Smith, Program Director of the Department of Health Policy, Management & Evaluation, Faculty of Medicine, University of Toronto; Dr. R. Deber, Professor of the Department of Health Policy, Management & Evaluation, Faculty of Medicine, University of Toronto; CIHR Team in Community Care and Health Human Resources; The Centre for Academic and Faculty Enrichment at Durham College.

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CHAPTER 18

Barriers and Facilitators to Optimal Workplace Re-integration of Veterans with Mental Disorders

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ABSTRACT

This study is part of a larger project funded by the Canadian Institute for Health Research (CIHR) Catalyst Grant whose primary objective was to build a team of experts in civilian workplace reintegration of veterans with mental disorders. The focus of the larger project was team building and the development of a conceptual framework for understanding the interplay of workplace, legislation/policy, health care, and personal determinants in successful workplace reintegration. As an initial step, a comprehensive literature review of 5000 abstracts and 250 related articles was completed in 2009, which revealed ample research on return to work for persons with musculoskeletal conditions, on supported employment for persons with serious mental illness and on workplace mental health promotion and treatment. However, there were at that time no studies on work re-integration in veterans with mental disorders. The focus of this phase of the larger research program was on the identification of the experiences and perceptions of barriers and facilitators of workplace re-integration for veterans with mental disorders. Data was collected by means of semi-structured focus groups and individual interviews with veteran clients of VAC OSIC (n=6), their clinicians (n=7), vocational rehabilitation counselor (n=1) and clinical care manager (n=1), their VAC District Office case management staff (n=6) and the related VAC Regional Office mental health and rehabilitation consultants (n=3). The key data trends fell into those factors that facilitated workplace re-integration and those that presented barriers. The facilitative factors included having less severe mental

disorders, managed symptoms, peer support, information and preparation for civilian work, comprehensive and coordinated services, and positive employer attitudes. The barriers included severe mental illness symptoms, lack of relevant work-related skills, differences in military and civilian work cultures, range and timing of vocational rehabilitation services, limited team communication and collaboration, complex bureaucracies, underemployment and negative employer attitudes.

Introduction

Mental disorders and addictions are common in the Canadian population and have special significance in the Canadian military and veteran (former military) populations. Surveys show that 18% of regular CF members met criteria for mood disorder, anxiety disorder, or substance dependence.[1] A current Survey on Transition to Civilian Life found that 20% of veterans reported depression or anxiety and 11% had post-traumatic stress disorder.[2] Mental disorders in turn can have significant impacts on all areas of life including work. However, there is a paucity of research on mental health and workplace re-integration as it relates to veterans.

This study fits into a larger CIHR Catalyst Grant funded project whose primary objectives were to build a team of experts and develop a conceptual framework for understanding the interplay of workplace, legislation/policy, health care, and personal determinants in successful workplace reintegration for veterans with mental disorders. Up to that point, the work undertaken included a comprehensive literature review and a meeting of all the co-investigators and collaborators to draft a model. As part of the literature review, the 5000 abstracts gleaned from all relevant data bases were examined and yielded about 250 related articles which were read in detail by the research team. The team noted that there appears to be ample research on return to work for persons with musculoskeletal conditions, on supported employment for persons with serious mental illness and on workplace mental health promotion and treatment. However, there were no studies on work re-integration in veterans with mental disorders. The research team decided to supplement the literature review with the collection of primary data on this topic.

Context

Veterans Affairs Canada is the federal department that looks after the needs of veterans and their families. VAC's mission is to support and compensate

veterans, their families and other clients and to recognize their achievements. VAC is organized into three levels: Head Office in Charlottetown, four Regional Offices (Atlantic, Quebec, Ontario, Western) and thirty-eight District Offices (DO). The DOs are in direct contact with clients and provide case management and referral to services and benefits.

VAC has three business lines: compensation and financial support; health care and re-establishment and; remembrance. Compensation includes disability pensions/awards and related financial benefits. Access to health care and rehabilitation services includes referral and/or payment for a broad range of services such as OSICs (mental health clinics for veterans and others with PTSD, depression or anxiety), Clinical Care Managers (intensive case managers), the Operational Stress Injury Support System (OSSIS) (veteran peer support program) and vocational rehabilitation. Clients in the Rehabilitation Program are eligible for financial support to cover their loss of earnings. In addition, the CF provides an insurance program, Service Income Security Insurance Plan (SISIP) that provides long-term disability benefits and vocational rehabilitation/training to veterans who are released from the Forces due to medical reasons.

Study Objectives

The objectives of this study were:

To understand the experience of veterans with mental disorders with respect to the barriers and facilitators to optimal workplace reintegration.

To contribute to the enhancement of the existing interventions designed to assist veterans with mental disorders with workplace re-integration.

Methodology

Study Design

This study used a qualitative instrumental case design. A qualitative method is particularly appropriate for research that is exploratory, values context and setting and seeks a deeper understanding of the respondents' perceptions and lived experiences. An instrumental case study provides insight into an issue, in this instance, civilian workplace reintegration of veterans with mental disorders. This study focuses on one case i.e.: the OSIC clinic in one geographical

area and the clients, clinician, case managers and service providers associated with it.

Data Collection and Sample

Data was collected using focus groups with each of the following: OSIC clients who were employed CF veterans (n=4) and OSIC clients who were unemployed CF veterans (n=2), OSIC clinicians including psychologists, social workers, nurses and psychiatrists (n=7) and VAC district case management staff (n=6). Focus groups were appropriate for these cases as they provided a natural, real-life atmosphere and were thought to be less stressful for veterans than individual interviews. One facilitator led the focus group and the other took notes. The focus groups were also tape-recorded and transcribed.

Individual telephone interviews were conducted with VAC Regional Rehabilitation and Mental Health Officers (n=3), a vocational rehabilitation consultant (n=1) and a clinical care manager (n=1). As these respondents were located across the country, telephone interviewing was the most efficient strategy. All interviews used focused questions.

Data was collected along the four parameters identified in the Loisel *et al.*[3] (2005) Prevention of Work Disability Model to flesh out a model appropriate to veterans with mental health conditions returning to the civilian workplace. The Loisel *et al*. model developed for workers with musculoskeletal pain suggests that four types of factors impact on return to work i.e.: workplace systems, health care systems, personal systems and coping and legislative and insurance systems.

Based on the Loisel model the following six lines of questioning guided the four focus groups and five telephone interviews:

a. What is it like for veterans with mental disorders conditions to enter/re-enter civilian employment?

b. What are or might be the advantages and disadvantages for veterans with mental disorders entering/re-entering civilian work?

c. How do significant people influence the entry/re-entry to civilian work experience of veterans with mental disorders?

d. What makes it hard for veterans with mental disorders to enter/ re-enter civilian work? What are the challenges?

e. What makes it easier for veterans with mental disorders to enter/ re-enter civilian work?

f. Looking forward, what could be done to make entering/ returning to work easier?

Data Analysis

The summarized focus group and interview data was subjected to a qualitative thematic analysis. This analysis began with a "within group" analysis to identify the patterns and themes of each group of informants. This was followed by an "across group" analysis to identify over-arching common themes as well as differences. These were then grouped under the relevant categories of "facilitators" and "barriers" to workplace re-integration for veterans with mental disorders. The facilitators held a short joint de-brief session after each focus group and interview. The summarized notes and transcripts were used concurrently in the analysis to identify themes. When deeper review was necessary, the facilitator went back to the digital tape recordings for clarification. Two meetings were held to compare each facilitator's identified themes and check for inter-rater reliability.

Overall Results

Respondent Profiles

All veterans respondents were clients of one OSIC. The four employed veterans reported a variety of types of jobs and except for one, expressed satisfaction with their positions. Their length of service in the CF ranged from 6 to 23 years and their release from the military was between 7 and 30 years prior. Two reported that they had been discharged non-voluntarily and the other two left voluntarily.

The two currently unemployed veterans had initially been employed after leaving the military and before contacting VAC for assistance. Their length of military service ranged from 9 to 15 years and they had released from the CF between 13 and 29 years prior. One reported that his release was non-voluntary

and the other that his release was "mutually agreed on." It was not clear which veteran respondents participated in the VAC rehabilitation program.

The seven OSIC included two psychologists, two psychiatrists, a family therapist, and a clinical intern reported that about 50% of their clients were employed. The six VAC District Office case management staff including four case managers, one team manager and one District Medical Officer that some of their clients in vocational rehabilitation and few were employed.

Three VAC Regional Officers (RO) including two Regional Rehabilitation Officers and one Regional Mental Health Officer had worked for VAC for 4 years. The one Vocational Rehabilitation Counsellor had provided vocational services to the OSI clinic clients for VAC as third-party provider for three years and the one clinical care manager had a nursing background and had provided services for VAC for over 1 year.

Facilitators to Workplace Re-integration

The factors which facilitated workplace re-integration included having less severe mental health disorders, managed symptoms, peer support, information and preparation for civilian work, comprehensive and coordinated services, and positive employer attitudes.

1. Less Severe Mental Health Disorders and Managed Symptoms

Respondents noted that having less severe mental illness and fewer exhibited symptoms contributed to an increased likelihood of successful re-integration into civilian employment, as did absence of concurrent disorders and no recurrence of symptoms. The likelihood of vocational success was also increased when veterans had completed psychotherapy and had ongoing professional and social support during the transition to civilian employment.

2. Social and Financial Support

Social support was seen by respondents as critically important in helping to mitigate the impact of mental illness and facilitate work re-integration. Positive, supportive family relationships, peer support and financial security assisted veterans in seeking and completing treatment and in finding employment.

> *"Just by luck I've run into 3 people that have served in the military… there's a bit of camaraderie which has allowed me to very quickly understand what's available in town."*

Veteran respondents noted that using friends and allies was particularly helpful. They thought that peer support and mentorship, learning from those who had "been through it", had helped them find and keep a job. Additionally, veterans noticed that providing this kind peer support was rewarding for those veterans who offered to help.

3. Information and Preparation for Civilian Work

Veteran respondents felt that transition was easier when opportunities to prepare for civilian life were provided while they were still in the military. Veterans believed that if preparatory education for leaving the military was comprehensive, in-depth and addressed key aspects of civilian living, such as financial management, it would assist their transition to civilian life.

Professional respondents found that when vocational rehabilitation services provided veterans with work experience and time to practice in vocational skills, it facilitated successful reintegration to civilian employment. In particular, opportunities to identify transferable skills, rehearse workplace communication skills, such as interviewing or asking for a raise, and having a chance to practice work skills through work experience, were seen as helpful.

4. Comprehensive and Coordinated Services

Professional respondents emphasized the importance of comprehensive and coordinated services in facilitating return to work. They suggested that providing the veteran with a well-coordinated and comprehensive assessment of all the barriers (physical, psychological, social and vocational) to returning to his/her full employment potential was a key first step. Furthermore the provision of medical, psychological, counselling and vocational services and ongoing support once the veteran was employed was also seen as essential.

Interdisciplinary team meetings between OSI Clinic clinicians, VAC case managers and third-party providers were seem as key to facilitate individual case coordination and progress, thereby helping to return veterans to work. In addition, when decision-making authority was at the local VAC District

Office level as opposed to needing to take the considerable time to go to Head Office, it assisted the case to progress more quickly and smoothly.

VAC staff having the skills to recognize and respond to mental disorder symptoms also ensured targeted and appropriate case management and the provision of the support needed for successful re-integration.

5. Positive Employer Attitudes

Employers who valued veterans' military discipline and were accommodating to veterans' needs were seen as an important support to obtaining and maintaining employment.

Barriers to Workplace Re-integration

The barriers to workplace re-integration identified by the respondents included severe mental illness symptoms, lack of relevant work-related skills, differences in military and civilian work cultures, range and timing of vocational rehabilitation services, limited team communication and collaboration, complex bureaucracies, underemployment and negative employer attitudes.

1. The Severity of Mental Illness and its Impact on the Veteran's Functioning

According to professional respondents, severe levels of mental disorder symptoms often resulted in increased difficulties in achieving successful re-integration in civilian employment. Veterans who exhibited a high degree of re-experiencing, avoidance, numbing and hyper-arousal symptoms, had addiction problems, issues with trust, dysfunctional interpersonal relationships and struggles with their activities of daily living, were reported to have the most difficulty re-integrating into the civilian workforce. Veterans who had been medically released from the CF due to mental health issues faced larger challenges than those who had voluntarily chosen to leave the military. Pre-existing psychological problems and physical disabilities prior to military enlistment also increased the barriers to civilian employment.

The interplay of mental illness, personal functioning, and the individual's social environment also shaped the ability to overcome barriers to civilian work. Respondents noted that having severe mental disorder symptoms increased veterans' difficulties with interpersonal relationships, in obtaining medical help and social support.

In addition, veterans who were reluctant to seeking psychological treatment or who had a poor response to treatment faced greater barriers to success. External factors such as family members who discouraged seeking help, concerns about financial insecurity if took time away from work, and a lack of services nearby also dissuaded some veterans from seeking psychological help.

2. Lack of Relevant Work-related Skills

Veterans also experienced difficulties when they lacked knowledge and skills required in to undertake civilian job searches such as identifying transferable skills, completing application forms, writing resumes and job interview skills. These barriers were heightened when the veteran had little or no civilian work experience prior to military service In addition not having military training and skill formally recognized, credited or considered equivalent to civilian work certifications created a barrier for some.

> *"…they don't listen to you or recognize what skill set you have because they don't understand what we've been trained to do…"*

The barriers listed above were exacerbated by veterans' lack of knowledge and preparation for managing civilian systems in general including health care and financial services. Veterans indicated that the education provided by the military before their release to help them prepare for managing in civilian life was inadequate.

> *"Once you step out onto 'civvie street' you realize how much you really don't know. They don't train us for civilian needs but for military needs and they're not the same."*

3. Cultural Differences – Military and Civilian Workplaces

Veteran respondents talked about the cultural differences between the military and civilian work environment creating a major barrier to reintegration to civilian work. Difficulties arose for veterans when they were unprepared for the differences between military and civilian work customs such as differences in dress, time management and schedules, lines of authority, amounts of structure, supervision and direction, interpersonal communications, team spirit and work ethic.

> *"In the military, it was teamwork; everyone pulled together. In 'civvie street' no one wants to do it and they won't do it."*

> *"People are not on time; they don't do what they say."*

All professional respondents acknowledged that veterans often were surprised by and unprepared for the differences they found between the military and civilian workplace. Generally, veterans believed they had superior training, skills and work ethic to those found in the civilian workforce. In addition, although they were highly trained by the military, their training and skills were not recognized in the civilian workforce. Frequently they experienced no recognized equivalencies or transferable credentials. They, themselves, often did not recognize their transferable skills and limited themselves to jobs of equal "rank". As a result, veterans were often under-employed.

> *"You need to be educated that civilian life is different. (The military) need to communicate how different civilian employees are from soldiers."*

4. Vocational Rehabilitation Interventions: Range and Timing

The range and timing of interventions and their duration were seen as variables in the success of veterans return to work. The range of VAC and SISIP approved vocational rehabilitation intervention options were sometimes found to be restrictive. Consequently, many creative solutions that would have met veterans' needs such as job coaches or opportunities to practice these vocational skills were unavailable, when available were curtailed too quickly.

Barriers to successful civilian workplace reintegration arose when delays occurred in the vocational rehabilitation process. For example, a veteran's progress could be delayed by the complicated decision-making process regarding the need for and timing of particular physical and vocational assessments, the appropriate time to begin vocational rehabilitation, the duration of psychological and vocational support, and the implementation of a vocational plan. This in turn impacted the veterans' motivation, participation and success.

5. Case Management and Clinical Team Communication and Collaboration

Professional respondents felt that timely communication between relevant professionals working with the veterans acted as a facilitator to his/her

progress and success. Interdisciplinary communication and collaboration between VAC case management and OSIC clinicians was particularly valued. Many respondents, however, felt that there was limited communication and opportunities for clinical discussion and collaboration between VAC case managers and third-party providers.

6. Complex Bureaucracies and Lack of Awareness of Services & Processes

A number of respondents noted that VAC's lengthy decision-making processes could be frustrating. Further, the amount of work needed to complete the written forms required to fulfill VAC's policies and procedures was sometimes daunting to VAC staff and third-party providers alike.

Misinformation about whether working affects a veteran's VAC disability pension/award and confusion on when to begin vocational rehabilitation often acted as disincentives for veterans to begin vocational rehabilitation. Veterans and DO staff also noted that large lump sum disability awards deterred some veterans from seeking work. Professional respondents stated providing veterans with money alone did not ensure financial security as they also needed financial management skills.

The Operational Stress Injury Support System peer support program appeared not to be well-known or used by veterans or clinicians. It was mentioned only once by a veteran, who wondered if it existed, and once by a professional respondent who saw it as beneficial, but infrequently used.

7. Underemployment and Negative Employer Attitudes

All too often, the jobs that veterans did get were below their abilities and were personally unsatisfactory, but offered avoidance or numbing of their symptoms, and some financial security.

> *"I never did find a job that I liked. The situation I'm in now is called retirement. But the only reason I'm retired is because I got sick and tired of doing menial dead-end jobs."*

Negative employer attitudes toward hiring persons with mental disorders were also a barrier to workplace re-integration. One veteran noted that some employers were wary of veterans who had been deployed "*wondering if they might go postal*".

Study Limitations

Qualitative research should demonstrate "trustworthiness" measures like credibility, transferability or generalizability, dependability and confirmability.[4] This study demonstrates credibility through its accurate in-depth identification and description of the subject.

Transferability is less well demonstrated because the small numbers of veteran participants make it difficult to show that findings from this sample will be found in other samples of the same population e.g. other veterans who were OSIC clients or veterans with mental disorders as a whole. Also since most veteran respondents were still undergoing treatment, staff reported they had little knowledge of treatment outcomes for veterans and veterans' work experiences after receiving treatment.

Transferability can be greatly enhanced through the use of triangulation where multiple sources of data are brought to bear on a single point.[5] This study used multiple informants to corroborate and elaborate the data, thereby strengthening the transferability.

There may have been some sample selection bias as the OSI Clinic clinicians were asked to identify the clients who they thought met the inclusion criteria. In addition, focus group participants may also have been subject to the social desirability effect, in providing the answers that they think the researchers are looking for or the Hawthorne effect of providing positive answers in response to the attention provided by participating in the study.

Summary

The key data trends demonstrated the factors that facilitated workplace reintegration and those that presented barriers. Facilitative factors included less severe mental disorders, social support, information and preparation for civilian work, comprehensive and coordinated services, and positive employer attitudes. Barriers included severity of mental illness, lack of relevant work-related skills, differences in military and civilian work cultures, range and timing of vocational rehabilitation services, limited team communication and collaboration, complex bureaucracies, underemployment and negative employer attitudes. All of these factors can contribute to the

development of a conceptual model and be variables for further investigation on this issue of workplace re-integration.

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CHAPTER 19

Operation Gear Down: Re-integration of Military Personnel After Combat-related Health Challenges

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ABSTRACT

Based on a sample of testimonies collected from ninety service members in the combat arms, interviewed on three different military bases across Canada, this chapter aims at exploring which factors influence the way these military personnel achieve re-integration at home and at their regiment after each deployment. These factors are identified by the recourse to a bi-dimensional model that assesses, through a discourse analysis, soldier identity and organizational support for returning soldiers. Results tend to show that soldier's health challenges and their impact on post deployment re-integration at home and at the regiment, and combat readiness (ready to be separated again from family, ready to go back to war theatre) are often tied with organizational support. Once acknowledged, this tension is often resolved by re-adjustments in the soldiers' identification with their own soldier identity and warrior culture. It is this re-adjustment that determines the soldiers' ability to regain combat readiness. The notion of warrior identity, its development through indoctrination, and its questioning after multiple exposures to combat arms, followed each time by an often challenging return to the country, including re-integration at home and at the regiment to the point of preparing again to build-up towards a combat readiness level, are of critical importance to better understand the transforming Canadian culture of modern warfare with regard to health issues. This study aims at exploring the inner-workings, from re-integration to combat readiness, and the effectiveness of the CF training program when in theatre and upon return, through its impact on health challenges. *The opinions expressed in this article reflect the research of the author and do not necessarily represent the opinion of the Canadian Army, CF or DND.*

Testimonies from CF members in combat who have been to Afghanistan on multiple occasions allow for the exploration of new issues surrounding soldiers' identities (core soldiering values) and training in its full spectrum: from build-up (pre-deployment training) to reintegration, and build-up again. This chapter aims at examining how the CF can optimize the mission-critical outcomes, while determining the extent of the organizational and individual forces, as CF personnel face the challenges of transformations in military ethos and familial values in post-modern warfare. Most specifically, this chapter continues the exploration of a topic that began in chapter 19 of the book *Shaping the Future*.[1] This initial reflection came from reading a testimony regarding the experience of war on soldiers, on how a broken body and a broken soul bring efforts together to reconstruct the core soldier identity that has been weakened by an injury followed by a medical release. It was so rich in detail and value that it gave rise to an entire project. This project was based on interviewing 100 service members who were deployed to the ex-Yugoslavia in the 1990s and to Afghanistan between 2002 and 2009. The testimonies were collected at three different army bases across Canada, from October of 2010 to October of 2011. The present chapter aims at defining what it is to be a soldier in the CF in the combat arms, and at evaluating the impact on the mental health of these soldiers when they are unable to act upon the accepted ideals of a Canadian soldier.[2]

Methodology

The study of testimonies was first theorized by Jean Norton Cru, a French academic who participated to the First World War out of an ideological urge, inspired by his reading of romantic novels, to participate to a great event, war.[3] His enthusiasm faded as soon as he faced the reality of war, its horrors, its deaths, and its uselessness. He decided to publish a book relating the war experience of hundreds of French soldiers who went to war, so that people can "learn the truth from their experience" and "never embark in another war".[4] Not only did the study of his testimonies reveal the unreliability of the genre to relate the truth, but the reading of the so-called real experience of war did not stop humanity from entering into a Second World War a few decades later. [5] Nevertheless, testimony as a genre became a way of expressing oneself in the 20th century that transcends, at the dawn of the 21st century, all media of expression, from oral to written, from documentaries to internet tubes.[6] In a world where all is fragmented, where ideologies have faded after leading to too many atrocities and where the truth is relative, the study of

testimonies becomes the study of the identity of a culture. If one was to make an analogy with painting, a collection of testimonies could resemble Picasso's portraits, with the breast in the belly, the eyes like the Cyclopes, the limbs dismembered.[7] Each body part taken aside makes perfect sense, like each narrative, with their internal logic; but once they are all put together, it becomes impossible to extract, from the ensemble, a high-flown rhetoric. Similarly, it is no accident that the experience of the extreme, namely, the experience of war, is represented with the greatest accuracy not in a romantic novel, but through a collection of testimonies of the survivors who faced it; they return home with a broken, or at least transformed, soul, and a broken, or at least weakened, body. In this research project, each testimony is approached as the recollection of fragmented memories, and when put together the meanings extracted from their analysis form a composite ensemble at the image of the complexity and absurdity of the experience of war – a crippled three-headed anthropophagic monster.[8]

At first sight, there are many contradictions in the testimonies and it is difficult to extract a logical sense out of different quotes. For instance, the fact that the CF have a low number of casualties is proof, for some, that "they are doing their job well". But for others, the low number of casualties is proof that they are not fighting a "real" war: "At Normandy, you could lose 2000 people in a day; but now, the CF lose less than 250 soldiers a year in war". If each of these interviewees have recourse to the number of casualties as a referent to determine if the experience of war is positive or negative, the variable that is really determinant and that is not revealed in this quote, but later in their testimonies, is the impact of losing brothers in arms: for some, it is unbearable, for others, it is a justifiable tribute for a greater good. Hence, while narrating their own experience, interviewees tell the surface story, the discourse promulgated by the CF in the books they read, the discourse promulgated by some instructors during military training, or the discourse they heard from a war movie they have seen.[9] But as they deepen the expression of self by accumulating examples, anecdotes, analogies, they represent themselves in evolution; their story gets interiorized, individualized, better or worse. Sense does not arise as much from the aesthetical transformation of their experience, but from the gradual, sometime clumsy, always generous unveiling of an individual experience through discourse.[10] The narratological study of the experience of war told by the actors allows for an understanding of the debilitating and healing processes through which CF serving members go through as they are exposed under fire.

Defining the Soldier's Identity

While being interviewed, soldiers were asked what it means for them to be serving in the CF, and why they chose a trade in combat arms. The question was often commented as being a "tough one" before the participants even started trying to answer it. And the answer was never short. All of them first recited some variances of the regimental definition, "to defend the values of my country", after which they provided more explanations. The most common element that would come up in their answer was, "a good soldier is a soldier who does his job well".[11] And the second most popular definition was "a soldier's priority is to protect his buddies at war". These two elements seem to be the core of a soldier's identity.

Do Their Job Well

"Doing their job" is a vague expression that is always used to explain what it is to serve in the military. It seems that this expression is commonly used in the absence of any other words to describe what being a soldier truly entails. Interviewees relate being a soldier to being "fun", which is as far as they can go to describe the feeling that their duty gives them. They describe it as a feeling of euphoria; when asked what is euphoric about their job, they relate "it to being a part of the infantry and of battle groups". The circularity of the definition puts two things in evidence: infantry is cool because it is infantry, meaning it is the ultimate trade; being part of a battle group is euphoric because it allows to actively participate to missions, to be "over there", under fire: "There is no amount of money that is worth what we do over there.[12] There is no number that you can put… it is impossible. The guy who goes to Afghanistan, who goes into the battlefield, and wants money for it, is not in the right place. He is not in the right place. People realize that quickly enough, because nothing is worth the intensity of the effort". This intensity is linked with the feeling of being powerful, which is also mentioned in the vast majority of testimonies and is always linked with the soldier's weapon, or any other military equipment. For instance, one soldier explained that he was impressed to see how all the cars pulled over as he drove down the road with his armoured vehicle. This feeling of power is a great contributor to the satisfaction that many soldiers feel on the job. Being a figure of authority, and being respected and feared validates many soldiers. Being a symbol of power and authority is engrained into their moral fibre, and is a big cause of why soldiers love their jobs as much as they do. Of course, there are different

perceptions of the excitement of being at war: "You don't go there for the people, for the locals. You go there for the thrill, and for the paycheque. At the end, it is like a drug. Adrenaline is the greatest drug on Earth". Obviously, the person quoted above and the other interviewees express two different views: what defines both of these interviewees as soldiers is the high intensity of the combat; both of them talked about wildness and violence, in positive terms; for one, there is no dollar value for what he goes through. But for the other, the fact that the intensity comes with a paycheque is the best part.

What almost everyone in the military, young or old, irrespective of their reason for joining, agrees upon is the fact that being in the military is the best job they can have. The paycheque is rarely talked about by the people who hold higher ranks, as they are so used to receiving it. The lower ranks, however, are much more uncertain about the future, as they do not know if they will stay. Once they are released and try to find a job in the civilian world, they realize with bitterness in the tone and in the choice of words that they have to work just as much to get paid half of what they were getting paid in the forces, for a job they don't like: "Now, I didn't have a choice there. I wasn't really given a choice. So I had a good career, I was making good money, and I lost all that. All of that. I had to go and find myself another job, which pays a lot less. I work just as hard, but I get paid a lot less than what I used to get paid, and where's the justice to that? This is the problem. I lost my future. I was planning to serve until I couldn't serve anymore. So, I lost the next twelve years of my life. I lost everything I've ever done up to that point in time, because it's a profession, and I lost a lot". Like this one, soldiers, despite being unable to express what it is they actually do, often consider it to be the best job one can have. They have a sense of fulfillment that cannot be expressed in words. The belief that they are doing good, serving their country and helping others is often the best part of their job to many, and it is not something that they can place a value on.

But they do not only speak positively of their job; there are many tasks they do not appreciate as serving members: "To come back to the regiment, to do some cleaning after being under fire is close to impossible." When the soldiers are deployed, they feel as if they were superhuman (*übermensch*). They were allowed to do anything, and could handle equipment worth millions. The feeling of being powerful is intoxicating, and becomes a way of life for many. But when they return to the regiment, or worst, when they are forced to release due to a medical condition, they are only allowed to do what they consider as

the most menial of tasks, in which they find no dignity. Their sense of power and authority is expunged, and is replaced by nothing, leaving them with feelings of bitterness, or depression, or aggressiveness. Most find this impossible to cope with. They have great difficulties with living an ordinary life, where they have to clean floors at the regiment or appreciate other small tasks at home or in another job. It is no surprises that the vast majority of them, when asked what would they do if they were to become civilian, answered "I could not" or said they would become a policeman or a firefighter – a man in uniform doing a trade of service.

Adrenaline and Video Games

Interestingly enough given its very low probability of reflecting reality, almost none of the interviewees talked about watching TV, watching movies or playing video games. Only two specified games and TV, while they talked about how they coped with boredom. One interviewee was talking about the war, and what he did when he was waiting for action while deployed overseas. The other interviewee was referring to his time in the regiment, where he was constantly bored while waiting for another mission: "We don't want to be playing video games on our phones all day". Both referred to how much they hated not as much playing games and watching TV, but being portrayed as playing games and watching TV; as it was not something they associated with. Most interviewees were seeing their future with great fear of lack of purpose, after they learned that the mission in Afghanistan was winding down. Three of the interviewees were in the process of transferring to become military police, so that they could do their duty on a daily basis, instead of having to endure vast swaths of boredom. The soldiers either want to be preparing and training for a new mission, or be at war. They simply resent doing nothing at a regiment or, even worst, being released and suffer what they consider to be an ordinary job and an ordinary life. A large part of what defines a soldier's identity is comprised of very little of what actually transpires in a soldier's life. When asked, a soldier will explain their job in the most grandiose fashion, often recounting how they served their duty, how they exceeded their own limits as soldiers and how they helped many. But vast amounts of time are spent simply waiting – waiting for action when deployed, or waiting to be deployed. When asked what movie represents the best what they experience, most answer none of them, because no movie can represent, and still make the box office, the boredom that is underlying the excitement of their

experience: "Enemies don't always shoot at us, sometimes we have to wait long times between action". The constant boredom is something that many soldiers try to disassociate themselves from, but it is a harsh reality of being enlisted in the Forces. There is a constant struggle to cope with what they imagine a solder to be, what they wish they were doing, and what they actually have to do. This juxtaposition of activities weighs heavily upon the minds of many as they simply wait for their next mission, and while away their time with mindless video games and movies.

Cohesion

Group cohesion was often described in terms of the importance of protecting their buddies. "You fight and risk dying beside them; they become stronger than family". The expression "stronger" is quite interesting in this quote, as it is not just the random choice of a word, but the manifestation of a specific mindset. For all of the interviewees, all that is "strong", all that has to do with the "Force", the weapons, the hardship and hard work has a positive connotation. A relationship is positive, beneficial, not when it is gentle or soft or nurturing, but when it is "strong". Another element that is remarkable in this quote is the hierarchy: the group becomes more important than the family. The family becomes a place where they can enjoy some peaceful times, random barbecues with their partner's friends, soccer games with their kids, but it is never a long-term refuge. It is enjoyable as long as there is a sense of coming back to the regiment: "We get used to always seeing someone beside us. We need to isolate ourselves to do anything. But then we come back home and we miss the guys. We are happy to come back to the regiment, on the condition that they will promise us another mission". The prime importance given to the Forces, intensified by the use of the "we", referring to the brothers in arms, stresses the expectations they have towards the institution: the CF will reintegrate them back in, and send them again, to another mission. It is the core definition of being a soldier: do your job.

Regarding Mental Health

What happens when they cannot do their job anymore, when their chain of command keeps them at the regiment or posts them in some other province from where they are not likely to be deployed; when their families cannot live the stress of separation anymore; when their body or their soul is to broken to go back to the battlefield? Like so many heroes being raised not knowing

their real identity before they get to prove their divine strength while called upon to solve a conflict, such as Aeschylus, Hercules, or even king Arthur, many CF members in combat arms discovered their core identity in the battlefield, while confronted by hostile action. One of the soldiers interviewed was comparing his identity to a mask: it just happened to stick at his skin and he could not remove it without disfiguring himself. Take away this shield that covers them, and they become frail again, they become another self that they do not want to be.

Returning to Canadian Life

When soldiers make their returns, they find themselves in a peaceful country, much at odds with what they had become used to in a combat zone. Feelings of boredom are rampant in veterans, with many exclaiming that they are simply bored with the Canadian lifestyle. Part of this can be explained by the fact that they are forced to adopt a new role, which strips them of their power and sense of authority. But another large part is that the action that they had become so accustomed to in their lives is now simply missing. If they appreciate being in Canada because of the abundance of its goods and because of they don't need to fear to be shot at, the Canadian lifestyle is the very antithesis of what being a soldier is. The constant adrenaline, the rush of being at war, the sense of power, camaraderie and the sense of purpose that many of those enlisted in the armed forces experience simply vanishes when they return to their everyday lives as civilians. One third expressed feelings of aggressiveness and exasperation when it came to the whining they hear from their civilian acquaintances. Soldiers often struggle to cope with the fact that they now have to work twice as much to earn a living, and with the fact that they do not enjoy what they now do. They feel as though they have no purpose, and no power compared to what they had. Many wish the camaraderie, mentioning how they "miss the guys". The very image that soldiers create for themselves vanishes when they return from combat. They are left with no sense of identity, which is terrifying to confront. They also have residual feelings of guilt, which may come from a variety of sources such as the war, family or their own actions. Dealing with these feelings simultaneously proves to be a real challenge for a great number of those who return from war.

Families

One of the biggest parts of being enlisted in the Forces, after getting ready to be deployed and being deployed, is that one must come to terms with the effects this lifestyle will have on their families. Being deployed puts many away from their families, or puts them in unfamiliar areas where their family simply may not be able to fit in. Many have to make tough choices, as they want to do what is best for their family; but this is often at odds with them struggling to cope with every day, civilian life. One soldier for instance, who was not part of the interviews but whom I overheard speaking with a comrade at the canteen while buying a coffee, was conflicted between wanting to go back to a mission, and ensuring the safety of his child. He had been awarded full custody of his child in a divorce, but was debating whether he should ask for the custody to be switched back to the child's mother, simply so he could return to another mission. Personal debates such as this can take a huge mental toll upon the soldier, who simply cannot live in the civilian world but still wants, like any other person, what he believes is best for his child. Being enlisted also takes a huge toll on marriages of those in the Forces. Many married soldiers, when asked if they would deploy again, replied with "I cannot, my wife doesn't want me to". Beyond those who simply said they could not go back because their wife would not allow them to, two others talked in more details about the impact them being away on mission had on their wives' mental health, who could not deal with the anxiety of whether or not their husbands would survive the day. Two additional soldiers talked about the impact their deployment had on their daughters, whose anxiety reached the point where they had to be diagnosed with a medical condition. Another one talked about the impact, not of a deployment, but of a posting, as being detrimental to the special needs of his wife. In another study on Women in the CF, one interviewee came back to me two years after she did her testimony on the experience of war and explained that she chose to release given the pressure on her family. It is also the reality of the characters in the documentary *Sisters in Arms*, from Beth Freeman. The list of soldiers having to constantly cope with the guilt is very long.[13] They feel as though they are solely responsible for the pain that their families had to endure. Put against their own feelings of wanting to be deployed again, many have to endure overwhelming amounts of guilt.

Physical Injuries and their Toll

Apart from the mental toll that war takes, the physical toll is also prevalent. Being in the armed forces is what soldiers base their very identity and their future on. But when injuries strike, they are sidelined and forced to deal with many issues. For those enlisted, being a soldier is a job, and they pride themselves on doing it well. A soldier who was sidelined by injuries said "look, I can't sit on the fence on a medical category anymore. I've done everything everybody's ever asked me to do, so you either say I'm good to go, or you say I'm not good to go, because I have two offers. I can put my uniform back on and I can go to Afghanistan—which was where I wanted to go and what I wanted to do—or you tell me that you will never recommend me to deploy again, and I will take the uniform off and take the civilian job". They did neither. They said: "we'll leave you on category for another year," and I said no, that's not good enough. I'm a soldier and if I can't do my job, and my job is being a soldier—and I always said that, that if I couldn't do my job as a soldier then I wouldn't wear the uniform—so I took the uniform off". When they cannot physically serve their country any longer, the soldiers find themselves in a very unsettling position. Their very profession, and their livelihood, disappears as they are deemed unable to continue. Not only does this throw their future into turmoil, it also places their mind at great unease. Soldiers want to go and serve, no matter what the cost. But being told that they are unable to do so is a hard reality for them to face. Upon being hurt, many strive to be as healthy as they were beforehand. But the reality is that they simply cannot serve in the armed forces any longer, which shatters their self-esteem. They feel as though they have been spoiled, and are no longer the heroes and saviours they used to be. This is one of the hardest parts of being physically injured that a veteran of the armed forces has to encounter.

Conclusion

The toll that injuries take on the lives of veterans is incomprehensible. Apart from the mental aspects, their very future is jeopardized. Speaking of his injuries, one veteran said "all the sacrifices I've made. And my family's been through a lot, and so the VAC doesn't cut it. There's no compensation for any of that. How do you compensate somebody for something like that? It's pretty tough. But, that was my situation, right? I lost my livelihood". There is very little that a soldier in that position can do, as the sacrifices he had made were not for the paycheque, but were for a higher purpose. The paycheque

sustained him and his family, but now that he is hurt, he has neither the gratification of serving a cause, nor the stability of the pay. Injured veterans find themselves struggling to make as much as they used to, and on top of this, long to return to the battlefield to serve their country. The health related price they have paid is beyond understanding. Of the 100 members I interviewed, the vast majority (more than 80%) expressed difficulties to get adapted to the regimental and/or family life after deployment. A "natural" or "unchallenging" return to their home country is the exception. The difficulties are in most cases expressed in words that are anxiety related: increased level of intolerance, of aggressiveness, of lack of interest in anything that is not combat related. And yet, or maybe for this reason, when being asked, "if you had the choice, would you return back in Afghanistan", they almost all say "yes, in a heartbeat".

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1 S.A.H. Bélanger, "The testimony of a War Amputy from Afghanistan: Discursive Myths and Realities", *Shaping the Future: Military and Veteran Health Research*, (Kingston, ON: Canadian Academy Press, November 2011), 265-268.

2 This chapter would not have been possible without the precious help of Parth Bhowmick, Research Assistant and Queen's University student. The 100 testimonies collected in the last year have been recorded and taped under a Service Level Agreement between my university, the Royal Military College of Canada, and my sponsor, the Chief of the Land Staff – G1. The support of both my Principal, Dr. Joel Sokolsky, as well as of Lieutenant-Colonel Yvon Martineau, has been continuous and inspiring. A special thank you goes out to the staff of the Canadian Institute for Military and Veteran Health Research for their collegial support. To Mrs. Michelle Moore, MA Candidate at the Royal Military College of Canada, thank you for your continuous and generous support. *The opinions expressed in this article reflect the opinion of the author and do not necessarily represent the opinion of the Canadian Army, CF or DND.*

3 J.-N. Cru, *Témoins* (Paris: Gallimard, 1929), 727; J.-N. Cru, *Du témoignage* (Paris: Aléas), 118.

4 J.-N. Cru, *Témoins* (Paris: Gallimard, 1929), 52; See also J.-N. Cru, *Du témoignage*, (Paris: Aléas), 25-26 « Mon but est de donner une image de la guerre d'après ceux qui l'ont vue de plus près; de faire connaître les sentiments du soldat, qui ne sont pas des sentiments acquis par imitation ou par influence, mais qui sont sa réaction directe au contact de la guerre; de révéler toute une littérature, toute une classe de témoignages, une attitude d'esprit, une foi, un idéal, l'âme secrète de cette franc-maçonnerie des poilus… une répudiation énergique de pseudo-vérités millénaires ».

5 F. Rousseau, *Le procès des témoins de la Grande Guerre* (Paris: Seuil, 2003), 314; F. Rousseau, « Comment écrire la guerre? L'affaire Norton Cru », in C. Dornier and R. Dulong, Dirs., *Esthétique du témoignage*, (Paris : Éditions de la Maison des sciences de l'homme, 2005) : 3-17; J.N. Cru, Témoins: Préface et post-face de Frédéric Rousseau, (Paris: Presses Universitaires De Nancy, 2006), 1-80; C. Prochasson, « Les mots pour le dire : Jean-Norton Cru, du témoignage à l'histoire », *Revue d'histoire moderne et contemporaine* Vol. 48, No. 4 (Oct-Dec 2001) : 160-189.

6 A. Wieviorka, *L'ère du témoin* (Paris : Hachette, 1998), 186; T. Gomart, « Quel statut pour le témoignage oral en histoire contemporaine? », *Hypothèses* Vol. 1 (1999): 103-111.

7 C.A.J. Coady, *Testimony: A Philosophical Study* (New York: Oxford University Press, 2002, 1st ed 1995); H. Putnam, *Raison, Vérité et Histoire*, (Paris: Les éditions de Minuit, 2005, 1st ed 1981).

8 B. Richardson, *Unnatural Voices. Extreme Narration in Modern and Contemporary Fiction*, (Columbus : Ohio University Press, 2006), 168; D. Herman, *Story Logic. Problems and Possibilities of Narrative*, (Lincoln: University of Nebraska Press, 2002), 477; P. Ricoeur, *La mémoire, l'histoire, l'oubli*, (Paris : Seuil, 2000), 48-53 and 201-208; Phillipe Mesnard, « À l'articulation des points de vue » in C. Dornier and R. Dulong, Dirs., *Esthétique du témoignage*, (Paris : Éditions de la Maison des sciences de l'homme, 2005), 175-189.

9 J. Conrad, *What the Thunder Said. Reflections of a Canadian Officer in Kandahar*, (Kingston, ON: Canadian Defence Academy Press, 2009), 47 and *passim*, where the author compares medals received during WWI and during the war in Afghanistan, astonished by the great work of his contemporary compatriots; I. Hope, *Dancing with the Dushman: Command Imperatives for the Counter-Insurgency fight in Afghanistan* (Kingston, ON: Canadian Defence Academy Press, 2008), 157, where the author concludes by comparing his experience to a long war, giving to the war of Afghanistan the letters of nobles of WW1; etc.; Among the 100 military members in combat arms that were interviewed for this research project, very few said liking war movies when asked; the movie that was the most cited was *Saving Private Ryan.*

10 R. Wodak and M. Meyer, Eds., *Methods of Critical Discourse Analysis*, (London: Sage, 2008, 1st ed. 2001), 200; P. Bourdieu, *Langage et pouvoir symbolique*, (Paris: Seuil, 2001), 223; H. Wallenborn, *L'Historien, la parole des gens et l'écriture de l'histoire*, (Paris: Labor, 20060, 231.A. Honneth, *La lutte pour la reconnaissance*, (Paris : Cerf, 2008, 1st ed. 1992), more precisely « Reconnaissance et socialisation » 99-103; « Modèles de reconnaissance intersubjective », 136-158; « Identité personnelle et mépris. Les attentes liées à l'intégrité physique, juridique et morale de la personne humaine », 161-170; Dornier and R. Dulong, Dirs., *Esthétique du témoignage*, (Paris : Éditions de la Maison des sciences de l'homme, 2005), 388.

11 When the masculine form is used in this chapter, it is intentionally done so, as 95% of the interviewees were male and did refer to their experience using the masculine.

12 Interviewees who were in one of the other trades (artillery, combat engineer or armoured) would use the same type of expressions, but talking of their trade or of "combat arms" in general as the ultimate soldiering experience.

13 The guilt of soldiers who have failed in their mission found some expressions, during the 100 testimonies, that make it comparable to the guilt expressed in some other publications, such as L. Faulder, *The Long Walk Home: Paul Franklin's Journey from Afghanistan*, (Victoria, BC: Brindle & Glass, 2007), 184; A. Loyd, *My War Gone By, I miss it so,* (Toronto: Penguin, 2000), 322 (on the War in Ex-Yougoslavia). These expressions of guilt can even be compared to those of the victims of WWII, such as P. Levi, *Œuvre*, (Paris : Robert Laffont, 2005), 1132; A. Frank, H. Otto, *The Diary of a Young Girl – The Definitive Edition*, S. Massotty, trans., (London: Doubleday, 1995, 1st ed. 1947), 340; etc. This analogy is only at an exploratory stage and shall be the topic of another publication.

BIOGRAPHIES

OPENING REMARKS

Rear-Admiral Andrew Smith, CMM, CD, Chief of Military Personnel, entered the Collège militaire royal de St-Jean in 1979 and graduated from the Royal Military College in Kingston, ON, in 1984 with a bachelor's degree in Mechanical Engineering. He completed the Marine Engineering Applications Course at the Royal Navy Engineering College in Plymouth, UK, in 1985. Upon return to Canada, he completed further systems training and attained his Marine Systems Engineering Head of Department qualification in Her Majesty's Canadian Ship (HMCS) ATHABASKAN. Promoted to Lieutenant (Navy) in 1987, he was appointed the Detachment Commander of the Marine Engineering Technician Training Program in Rimouski, QC. In 1990, he undertook a two-year postgraduate program at the University of Michigan, and attained master's degrees in Naval Architecture and Marine Engineering, and Industrial Engineering. He was promoted to Lieutenant-Commander in 1991, and joined the Ship Repair Unit (Atlantic) in Halifax, NS, as the Industrial Engineering Officer in 1992. In 1994, he was appointed as the Marine Systems Engineering Officer in HMCS IROQUOIS. Following two years at sea, he was posted to the Canadian Forces College (CFC) in Toronto, ON, to attend the CF Command and Staff Course. Upon promotion to Commander in 1997, he was posted to National Defence Headquarters (NDHQ) on the staff of Director General Maritime Equipment Program Management (DGMEPM). In 2001, he was posted to the Canadian Fleet Atlantic Headquarters in Halifax, NS, as the Task Group Technical Officer, and subsequently spent six months deployed in Southwest Asia in support of Canada's contribution to the war against terrorism. Following his promotion to Captain(N) in 2003, he was appointed Commanding Officer of Fleet Maintenance Facility Cape Scott in Halifax, NS. Upon promotion to Commodore in June 2006, he was appointed Director General Maritime Personnel and Readiness. He was posted to the position of Assistant Chief Military Personnel on 16 April 2008. Following his promotion to Rear-Admiral in 2010, he was appointed Chief of Military Personnel on 24 June 2010.

Commodore H.W. Jung, OMM, CD, Surgeon General of the Canadian Forces and Commander of Canadian Forces Heath Services (2009-2012),

joined the CF in 1981. He completed his medical training at the University of Toronto and the Toronto East General and Orthopaedic Hospital. Commodore Jung has been posted to CFB Esquimalt and on HMCS PROVIDER as the ship's Medical Officer; to Lahr and Baden in Germany, as Base Surgeon; and as the Senior Medical Officer to the Canadian Air Task Group (Middle East) Qatar, serving through the air campaign of the 1991 Persian Gulf War. During his five-year tenure at CF Europe, he was a member of the NATO Tactical Evaluators. He also completed a tour as a medical Detachment Commander at National Defence Headquarters (NDHQ) Medical Inspection Room. In 1995, he was posted to Air Command Headquarters in Winnipeg. During his tenure at Air Command, he assumed multiple roles that included the posts of the Command Flight Surgeon and A1 Medical Operations. He was also posted to Maritime Forces Pacific Headquarters in Esquimalt as the Maritime Pacific Surgeon, and to NDHQ as the Maritime Command Surgeon and Medical Advisor to the Chief of Maritime Staff. Commodore Jung was appointed to the Order of Military Merit in 2001. Subsequently, Commodore Jung assumed responsibilities as Director Health Services Operations, Director Health Services Personnel and Deputy Surgeon General at the CFHS Group HQ. Commodore Jung was also the principle officer responsible for achieving Canadian Medical Association recognition of Physician Assistants as a health care professional in Canada. He was promoted to his current rank in June 2009 and appointed Surgeon General, Commander of the CFSH Group and Queens Honourary Physician. Commodore Jung completed his Masters of Arts in Leadership from the Royal Roads University in 2005. He is a graduate of National Securities Studies Program at the CFC.

Suzanne Tining, Deputy Minister, Veterans Affairs Canada. Prior to her appointment in January 2007, she was Associate Deputy Minister of Indian Affairs and Northern Development, and the Executive Director and Deputy Head of the Office of Indian Residential Schools Resolution Canada. From 2003 to 2004 she was a Visiting Executive with EnCana Corporation, Canada's largest oil and gas producer, through an innovative public-private sector exchange initiative. From January 2002 to December 2003, she worked with the Canada Economic Development Agency for Québec regions as the Assistant Deputy Minister, Policy, Planning and Information initially and then Assistant Deputy Minister, Operations. After a career spanning more than 20 years at Transport Canada, she left her position as Regional Director General for the Québec Region in November 1997 to serve as Director of Operations

in the Social Policy Secretariat and subsequently the Economic Policy Secretariat of the Privy Council Office. She then worked in the field of communications as the Assistant Executive Director of Planning, Research and Regional Coordination, from 1999 to 2001 at the Canada Information Office, later known as Communication Canada.

MENTAL HEALTH

Captain H. Christian Breede, CD, MA, PhD Candidate, joined the CF in 1998 and upon completion of a Bachelor's Degree in Political Science (Honours) from The Royal Military College of Canada, served with 2nd Battalion, The Royal Canadian Regiment as a platoon commander. In 2004, he deployed to Haiti, serving in Port au Prince with both Canadian and American forces. In 2005, he served as the Intelligence Officer for 2nd Battalion, The Royal Canadian Regiment and other staff appointments. In 2008, Captain Breede deployed to Kandahar, Afghanistan with the Provincial Reconstruction Team as the force protection company second-in-command. Upon his return to Canada, he completed the Army Operations Course in Kingston, Ontario. Captain Breede holds a Master's Degree in Political Studies from the University of New Brunswick, and is currently a full-time PhD Candidate in War Studies at The Royal Military College of Canada with a thesis topic on a reconceptualization of the analysis of state strength.

Susan L. Ray, PhD, RN, APN, is an Associate Scientist with the Health Outcomes & Health Services Group at Lawson Health Research Institute in London, Ontario, and an associate professor at the Arthur Labatt Family School of Nursing at the University of Western Ontario. Her research areas include psychological trauma on contemporary peacekeepers and their families, homelessness among Canadian and Allied Forces veterans and transitioning from military to civilian life, amongst others. Her research methodology is primarily qualitative using interpretative inquiry, hermeneutic phenomenology and grounded theory. At the University of Western Ontario, her teaching areas include violence and health, critical interpretative methodologies and mental health nursing. **Julie Salverson, PhD**, currently teaches at Queen's University in the Drama department. She has worked extensively across Canada as a playwright, producer, and community animator. Her first play was produced by Prairie Theatre Exchange in 1982 and she is the co-founder of Second Look Community Arts in Toronto. Her research, writing and performance interests include: Canada's involvement in the development of the atomic bomb

(continuing work from a Social Sciences and Humanities Research Council of Canada (SSHRC) funded project with Peter Van Wyck, Concordia University); the comedic and absurd as approaches to witnessing violence beyond an aesthetic of injury and spectacle; the relationship between aesthetics and ethics in translating stories of violence; Creative non-fiction and its place in scholarship; the role of the imagination in learning and development. *Contributors*: **Susan Del-Mei** is a 4th year Drama Major and History Minor at Queen's University. From Kingston, Ontario, she has participated in many theatrical projects both at Queen's and in the Kingston Community. With a passion for both the theatre and dance, and inspiration from this project, she plans to pursue a career in the theatre upon graduation. **Lauren Weinberg** is a 4th year student at Queen's University majoring in Drama. She hails from Richmond Hill, Ontario and has had a love for the arts since a very young age. She never thought it would become anything more than a hobby, but once she got to university, Lauren came to the realization that theatre was truly her passion. Upon graduation, she plans to pursue additional technical training in theatre production and then enter the industry. **Dustin Garrett** is a Drama Major in his final year at Queen's University. Born and raised in Kingston, Ontario, Dustin has always enjoyed the arts. He believes art has the ability to make a difference. Dustin wishes to continue making the kind of art that challenges audiences, create discussions, and acts as a catalyst for change. **Kylie Gilmour** is a 4th year Drama and Spanish student at Queen's University. Raised in Brampton, she has always been interested in telling important stories through drama and the therapeutic effect that drama can bring. She enjoyed the opportunity to work with such material and present it in a unique setting. **Smita Misra** completed her first degree in Life Sciences at Queen's University, and is currently working on completing a second degree in Drama. She is particularly interested in using drama and other art forms for education, empowerment and health. Smita has a strong knack for cross-cultural collaborations and is an Indian Classical Dancer (Kathak).

Peggy Shannon, MFA, graduated from the University of Washington (Seattle) with a Master of Fine Arts in the area of performance, and is completing doctoral studies at Royal Holloway, University of London, where her research examines the role of women in war, both in ancient Greek plays and throughout the world today. Demonstrating a strong commitment to both education and practice, Peggy has held positions as a Professor of Theatre at the University of California, Davis (UCD), as artistic director of the Sacramento Theatre Company, the Associate Vice-Provost for University Outreach and Engage-

ment at UCD, and appointments as the artistic director of A Contemporary Theatre in Seattle and associate producing director of L.A. Theatre Works, among others. She is the author of numerous publications and has delivered papers on topics such as the role of women in war, the relationship between stage directors and sound directors, and directing violence in today's theatre at conferences throughout the US, England, Canada and Greece. Peggy Shannon is currently the Chair of the Theatre School at Ryerson University and is the recipient of a Partnership Development Grant from the Social Sciences and Humanities Research Council of Canada.

Kate St. Cyr, MScPPH, is a research associate at the Parkwood Hospital OSIC in London, Ontario. She is also an Allied Scientist of the Lawson Health Research Institute in London, Ontario. She completed her academic studies at McMaster University in Hamilton, Ontario and Simon Fraser University in Burnaby, British Columbia. Her research interests include health-related quality of life, psychiatric epidemiology, and social determinants of health. She is also interested in comorbid psychiatric illness and suicidality amongst military personnel. **Maya Roth, PhD, C.Psych**., is a full-time clinical psychologist at the Parkwood Hospital OSIC, St. Joseph's Health Care London in London, Ontario. She is also an Allied Scientist of the Lawson Health Research Institute in London, Ontario. Dr. Roth completed her Bachelor of Arts Honours in Psychology at York University in 2002, her Master of Arts in Clinical Psychology at Queen's University in 2004 and her Doctorate in Clinical Psychology at York University in 2009. She completed a pre-doctoral internship at the London Clinical Psychology Residency Consortium and has been working at the Parkwood Hospital OSIC since September 2008. Dr. Roth recently received certification as a Prolonged Exposure therapist and supervisor through the Centre for the Treatment and Study of Anxiety at the University of Pennsylvania. Dr. Roth is interested and involved in research examining treatment outcome in post traumatic stress disorder and mood disorders among military and veteran personnel, treatment outcome in chronic pain, as well as the examination of pain and psychological distress at end of life. Clinically, Dr. Roth's practice involves the assessment and treatment of post traumatic stress disorder and other sequelae of military service, including depression, other anxiety disorders, and chronic pain. She provides both individual and group cognitive behaviour therapy for adults with anxiety and depressive disorders, and chronic pain.

Debbie L.Whitney, PhD, is an Assistant Professor in the Department of Clinical Health Psychology, Faculty of Medicine at the University of Manitoba. She is a staff psychologist and research officer for the OSIC, Winnipeg. She obtained a B.A. (Honours) degree in Clinical Psychology from the University of Winnipeg and then a Masters and Doctorate in Clinical Psychology from the University of Saskatchewan in Saskatoon. She has many years of experience dealing with problems of trauma and recovery. She has worked with adults, couples, families and children. As research officer, she wants to facilitate research activity within the clinic. Her own research interests include investigation of local norms for psychological assessment instruments, use of telehealth to expand access to service and the application of mindfulness to trauma recovery. **Jennifer C. Laforce, PhD, C.Psych**., is an Assistant Professor in the Department of Clinical Health Psychology in the Faculty of Medicine of the University of Manitoba. She is a registered psychologist who has worked clinically with military, veteran and RCMP populations since the Winnipeg OSIC opened in 2004, where she currently serves as the Clinical Coordinator. She obtained her PhD and MA in Clinical Psychology from Queen's University, and her BA(Hon) from the University of Alberta. Her research interests include PTSD, depression, and how people respond to service-related difficulties and treatment. She is particularly interested in applying research within clinical settings and populations. **Kristen Klassen, MSc**, is currently an instructor and a PhD Candidate at the University of Manitoba, in the field of Applied Health Sciences. In the past, she has obtained a MSc in Disability from the University of Manitoba, and a BSc in Kinesiology from Simon Fraser University. She has developed numerous courses at the University of Manitoba, notably "Principles of Fitness Training" and "Inclusive Physical Activity". She is the research coordinator at the OSIC, Winnipeg.

PHYSICAL HEALTH

Sivan Almosnino, MSc, PhD Candidate, received his Bachelor's degree from the Zinman College at the Wingate Institute for Physical Education and Sport Sciences, Israel. He is currently a PhD Candidate in Biomechanics and Ergonomics at Queen's University. He is also a member of Queen's University Ergonomics Consulting Program. His current research focuses on development of tools and methods for clinical decision making regarding readiness to return to activity following injury in a variety of work settings. **Marchiano Oh, BSc, MSc Candidate**, received his Bachelor's degree in Kinesiology from the University of Waterloo. He is currently a MSc Candidate at

Queen's University, where his research interests involve application of biomechanics principles to assessment of knee joint function. As part of his research, Mr. Oh has gained extensive experience in the testing and evaluation of Anterior Cruciate Ligament patients prior and following surgical reconstruction. **Dean Tripp, PhD**, is an associate professor in the Department of Psychology with cross-appointments at the Departments of Anaesthesiology and Urology at Queen's University. Within this department Dr. Tripp acts as a clinical consultant and active researcher. Dr. Tripp's research focuses on the psychological aspects of pain, and he has published specifically in the areas of Chronic Pelvic Pain Syndrome and recovery from surgery following Anterior Cruciate Ligament reconstruction. He also teaches courses in health psychology, interpersonal therapy, and pain. Dr. Tripp is a recipient of the Canadian Pain Society Early Career Award (2008), and the Frank Knox Teaching Excellence Award (2009) at Queen's University. He has also been nominated for several other province-wide teaching awards. **Zeevi Dvir, PhD**, received his PhD in Bioengineering from Strathclyde University in Glasgow. He is currently a full professor at the Sackler Faculty of Medicine, Tel Aviv University while serving as the scientific director of the Institute of Motor Functions at the Sheba Medical Center near Tel Aviv. He also holds an adjunct-professor position at Queen's University. Dr. Dvir is one of the foremost global authorities in the use of isokinetic dynamometry for evaluation of muscular strength capabilities in healthy and pathological populations. He serves as Editor in Chief of the scientific journal *Isokinetics and Exercise Science*, and is a senior editorial board member of several other scientific journals pertaining to biomechanics and physical rehabilitation. **Joan M. Stevenson, PhD**, is a full professor in occupational biomechanics within the School of Kinesiology and Health Studies with a cross-appointment to the School of Rehabilitation Therapy at Queen's University. She has served as head of department and is now serving as current Chair of the General Research Ethics Board and Coordinator of the Ergonomics Research Group. She is working with a number of different research teams on projects involving: design of personal protective equipment, development of ergonomic aids, assessment of cumulative loading in industrial jobs, and development of standardized testing strategies for military applications.

Captain Pauline Godsell, BSc(PT), has been the Rehabilitation Physiotherapy Coordinator for the CF Physical Rehabilitation Program since August 2010. She is responsible to Lieutenant-Colonel M. Besemann for establishing and developing a rehabilitation framework, developing standardized

operating procedures on patient care, establishing rehabilitation performance measures and conducting reviews and audits of the rehabilitation practices at the CF Centres of Excellence locations. She joined the CF in 2003 and received her BScPT from the University of Ottawa in 2007. **Lieutenant-Colonel Markus Besemann, BSc, MD, FRCPC,** has been at the helm of the CF Physical Rehabilitation Program since its inception in 2008. Lieutenant-Colonel Besemann was a General Duty Medical Officer (GDMO) in the CF prior to engaging in post-graduate training as a civilian in physical medicine and rehabilitation. For 12 years he was the Chief of Physical Medicine and Rehabilitation at the Regional Trauma Centre and the Regional Rehabilitation Centre in Gatineau, Quebec. He also holds a diploma in Sports Medicine from the Canadian Academy of Sports Medicine.

An internationally recognized surgical leader in orthopaedics and trauma, **David R. Pichora, MD, FRCSC**, is a pioneer in the use of motion analysis techniques for documenting patterns of disease in upper extremities. As a member of the Kingston General Hospital orthopaedic trauma service, he has undertaken extensive clinical outcome studies in the management of multiple traumas, and pioneered the world's first computer-assisted distal radius osteotomy. He is also a Professor cross-appointed in the Department of Mechanical and Materials Engineering at Queen's University. **Heather J. Grant, MSc,** graduated from the Queen's Community Health and Epidemiology program. She is currently the clinical research facilitator at the Human Mobility Research Center. For the past 17 years, Heather has worked in several research areas at Queen's including orthopaedics, psychiatry, stroke services, maternal health and injury surveillance. **Roumen V. Milev, MD, PhD, FRCPsych, FRCPC,** graduated medicine in Sofia, Bulgaria in 1983. He obtained Specialty in Psychiatry in Bulgaria; MRCPsych in England; and FRCPC in Canada. He defended his PhD in Forensic Psychiatry. Dr. Milev moved to Canada in 1995 and became Senior Psychiatrist/Medical Director at the Mental Health Clinic in Regina, and President of the Saskatchewan Psychiatric Association. In August 2001, he joined the Mood Disorder Research and Treatment Service in Kingston, Ontario, as a Clinical Director. Dr. Milev has a number of publications and presentations at national and international conferences. He continues close collaborative work with European psychiatric associations and international organizations. He has been a passionate researcher actively involved in clinical studies throughout his career. Dr. Milev is a dedicated teacher and lecturer and has received several awards in recognition of his

contributions. Dr. Milev is an expert in mood and anxiety disorders whose expertise has been sought throughout Canada and internationally.

NOVEL TECHNOLOGIES

Davide Bardana, MD, is an orthopaedic surgeon currently practicing in Kingston, Ontario. He is an Assistant Professor at Queen's University with an expertise in Sports Medicine, specifically knee and shoulder arthroscopy, as well as Orthopaedic Trauma. He completed his medical school at the University of Calgary in 1994 and went on to Queen's University for his orthopaedic surgery residency. After which, he undertook a Sports Medicine/Arthroscopy Fellowship in Salt Lake City, UT, followed by an Orthopaedic Trauma Fellowship in Melbourne, Australia. He has been in practice since 2002 and is also the team physician for the Queen's Gaels. His research interests include computer assisted ACL reconstruction and mosaicplasty, isokinetic and kinematic testing of the knee and shoulder, and arthroscopy skills teaching through virtual reality simulation. **John Rudan, MD**, is an Orthopaedic Surgeon at Kingston General Hospital, a Professor in the Department of Surgery at Queen's University Faculty of Health Sciences, and a Principal Investigator at the Human Mobility Research Centre. His research interests are in computer-assisted orthopaedic surgery and total joint replacement. Dr. Rudan performed the world's first computer-assisted knee surgery in July 1997. Since then he has pioneered many significant contributions in computer-assisted surgical techniques including: the first computer-assisted total knee replacement in 1998 and in 2001, the first uni-compartmental (half-knee) replacement and the first pelvis osteotomy. He currently holds three patents for new biomedical engineering products and he is the co-founder of a high-tech start-up company. He has authored numerous papers and has presented at many international conferences. He has received several awards from Canadian Orthopaedic Research Society. **Manuela Kunz, PhD**, is currently working as a researcher in the Human Mobility Research Centre at Queen's University. She received an MSc in computer science from the University of Hildesheim (Germany) and a PhD in Biomedical Engineering from the University of Berne (Switzerland). After working as a senior software developer for Stratec Medical in Switzerland, Dr. Kunz came to Queen's University in 2004 for her postdoctoral fellowship. Her research focuses in development, implementation and evaluation of computer-assisted orthopaedic surgery systems, primarily for joint replacement surgeries. Her work combines 3D medial imaging, computer visualization, tracking technologies, biomechanics and kinematics.

Mark Hurtig, DVM, is a Professor in the Department of Clinical Studies at the University of Guelph. He is also the Director of the Preclinical Core Facility of the Canadian Arthritis Network. He received a DVM from the University of Guelph and then a MVSc (Surgery) from the University of Saskatchewan before his appointment at the University of Guelph in 1984. His research is in the area of the repair of joint tissue injuries and the development of animal models for arthritis-based research. **James Stewart, PhD**, is a Professor in the School of Computing at Queen's University. He completed his PhD at Cornell University in 1992. His research program spans several areas within computer assisted surgery, including surgical interfaces, automatic planning of surgery, computation and visualization of uncertainty in surgery. Dr. Stewart leads a team that is working on Computer Assisted Mosaic Arthroplasty (CAMA), previously supported by an NSERC Strategic grant and now by an NSERC/CIHR Collaborative Health Research Projects grant. The team has established itself as a world leader in CAMA, having shown in an animal study that computer-assistance improves clinical outcomes in mosaic arthroplasty. The team has also developed methods for computationally predicting the repair surface over a cartilage defect and for automatically planning the entire CAMA surgery, and has developed patient-specific instrument guides that eliminate the need for complicated optical tracking equipment in the operating room. Dr. Stewart has supervised or co-supervised more than thirty graduate students. He is the recipient of several awards including Canadian Human Computer Communications Society Service Award in 2008 and the Howard Stavely Award for Teaching Excellence at Queen's University in 2005.

Frank X. Gu, PhD, graduated from Queen's University where he majored in chemical engineering and was awarded with Canada Graduate Scholarship from NSERC. During his doctoral program, he was awarded the Japanese Society the Promotion of Science (JSPS) summer fellowship to work under the Supervision of Professor Kazunori Kataoka at the University of Tokyo in Japan. In 2006, he was award with NSERC Postdoctoral Fellowship to join the Laboratory of Institute Professor Robert Langer lab at Massachusetts Institute of Technology (MIT). In July 2008, he joined Department of Chemical Engineering at the University of Waterloo. His current research interests are in the development of biomaterials for nanomedicine and biopharmaceutics applications.

Derek Tilley, MSc, is an instructor in the School of Engineering Technology and Applied Science at Centennial College, where he studies the development

of virulence-based assays for industrial/research applications. Derek received his Undergraduate honours degree in 2008 from Trent University; and MSc in 2011 from the University of Ontario Institute of Technology (UOIT). Veena Premjani is a MSc Candidate in the Applied Biosciences Program in the Faculty of Science at UOIT, where she studies the effect of bacterial virulence factors on the blood coagulation process. Ayush Kumar, PhD, is an Assistant Professor in the Faculty of Health Sciences at UOIT, where he studies bacterial pathogens exhibiting multidrug resistance and a protein family known as resistance-nodulation-cell division (RND) family. Efforts in his laboratory are focused towards understanding the mechanisms of function and regulatory pathways of these proteins in pathogens like *Acinetobacter baumannii* and *Pseudomonas aeruginosa* in order to aid in designing effective drug therapy. **John A. Samis, PhD**, is an Assistant Professor within the Faculty of Health Sciences at UOIT. Dr. Samis received both his Undergraduate honours degree in 1984 and PhD in Biochemistry in 1990 from Queen's University in Kingston, Ontario. He completed a postdoctoral fellowship at Harvard Medical School in Boston, Massachusetts from 1990 to 1993. His areas of specialization include protease biochemistry, blood coagulation, inflammation, and acquired blood disorders. Dr. Samis currently does ongoing research focusing on the role of proteases, either host or pathogen, in coagulation health and disease. His research is directed at using a number of protein-based functional approaches to characterize the temporal and biochemical changes in coagulation factors and proteases that occur during the pathogenesis of experimental and clinical sepsis-induced disseminated intravascular coagulation (DIC). Ultimately, this research will not only lead to a greater understanding of the biochemistry of coagulation factors and proteases in healthy individuals and those afflicted with coagulation disorders, but the development of compounds and diagnostic assays to improve the quality of life and clinical care of sepsis/DIC patients throughout the world.

Diana E.K. Flood, MSc Candidate, has a BSc with honours in Biology from Queen's University and is currently enrolled in the Graduate Studies program in the Department of Biology at Queen's University. Her MSc thesis investigates the effects of perchlorates on the male reproductive system in *Silurana tropicalis* frogs to provide further evidence for cross-talk between the thyroid hormone and androgen axes. **OCdt Abby Edmison, BSc Candidate,** is currently enrolled in a BSc with honours in Chemistry, and a minor in Life Science at RMCC. OCdt Edmison is studying the molecular mechanisms of action of potassium perchlorate in early frog development.

Valérie S. Langlois, PhD, received a BSc (Honours) in Environmental Sciences and a PhD in Chemical and Environmental Toxicology from the University of Ottawa in Canada. She is an Assistant Professor to the Chemistry and Chemical Engineering Department of RMCC and an Adjunct Professor to the Department of Biology of Queen's University, both located in Kingston, ON. Dr. Langlois is leading an Innovative Research Program in Toxicogenomics at RMCC. Dr. Langlois is training several high qualified personnel (HQP) in her laboratory, and part of the work of two of these HQP is presented here.

TRANSITIONS

Isabelle Côté, MD, CM, FRCPC, completed a degree in Medicine from McGill University, Montreal in 1985 and specialist qualifications in Psychiatry from the University of Toronto, Toronto in 1990. She has a private practice in general and forensic psychiatry in St. Catharines and Hamilton, Ontario. She currently holds the rank of lecturer in the Department of Psychiatry at the University of Toronto. She is a contractor psychiatrist at the Niagara Detention Centre, the Hamilton-Wentworth Detention Centre and the Brantford Jail (Ministry of Community Safety and Correctional Services). As a civilian, she is a contractor psychiatrist for CF Health Services Centre in Toronto. She is a psychiatrist-member of the Ontario Review Board. She has been retained as an expert witness for numerous criminal and civil cases. She has also written a number of articles related to forensic psychiatry. She has been a speaker at many medical and legal conferences.

Brenda Gamble, PhD, is an Assistant Professor in the Faculty of Health Sciences at UOIT. Dr. Gamble's research focuses on allied health professionals, healthcare leaders and the medical laboratory sector. She is Principal Investigator for the CIHR Meetings, Planning and Dissemination grant Quality and Safety: Canada's Medical Laboratory Sector. She is also a co-investigator on 3 other CIHR grants. As a co-investigator on the CIHR Team in Community Care and Health Human Resources, she partners with allied health Regulatory Colleges to study resource shifts of these health professionals across sub-sectors, with an emphasis on shifts from hospital to community; and to analyze the factors which are associated with retention of these workers, both within their profession, and within their sub-sector. As well, she has collaborated with the Canadian College of Health Leaders and the Canadian Home Care Association conducting national surveys to ascertain

the views of these stakeholders on educational requirements, leadership competencies and interprofessional practice as it pertains to healthcare leaders across professions. **Olena Kapral, BHSc, MA Candidate**, recently graduated from UOIT, completing a degree in Bachelor of Health Sciences, specializing in Kinesiology. During the course of her studies, Ms. Kapral has worked as a research assistant for the Faculty of Health Sciences. She has also worked on several projects with the CIHR Team in Community Care and Health Human Resources. Ms. Kapral's research interests include interprofessional collaboration, health policy, and health human resources. Ms. Kapral recently won the 2010 National Health Sciences Students' Association Essay Competition. Her winning essay titled "Healthcare managers on interprofessional teams" was published in the *Journal of Interprofessional Care*. In her spare time, Ms. Kapral is a dedicated member of St. John Ambulance and teaches first aid courses in the community. She will be continuing her studies at the University of Ottawa completing a Master of Arts in Public Administration.

Tina Pranger, PhD, has worked in the mental health field in Ontario and Prince Edward Island for the past 34 years as a practitioner, professor, researcher, evaluator and government consultant (provincial and federal). She is currently a mental health consultant with Veterans Affairs Canada where she has recently completed a qualitative study on Veterans' experience of workplace re-integration.

Stéphanie A.H. Bélanger, PhD, is the Associate Director of the Canadian Institute for Military and Veteran Health Research, the co-editor of the collective *Shaping the Future: Military and Veteran Health Research* (CDA Press 2011), as well as of the collective *Transforming Traditions: Women, Leadership and the Canadian Navy* (2010). She also collaborated to the collective *Le leadership des femmes dans les Forces canadiennes* (CDA Press 2009). Dr. Bélanger is a professor at the French Department of the Royal Military College of Canada where her research focus on War Testimony as well as on the Representation of the Warrior through Just War Theories, topic on which she published the monograph *Guerre, sacrifices et persécutions* (Paris: Editions l'Harmattan, 2010). She is on the Editorial board of the *The Arts of War and Peace Review* and on the Scientific committee of the International series of colloquium *War Memories: Commemoration, Re-enactment, Writings of War in the English-speaking World* (19th-20th centuries). An active researcher, she co-chaired two colloquiums and she is sitting on the board of a third; she frequently presents at conferences at the national and international level as

well as publishes articles and chapters in peer-reviewed journals and books. She is co-chair of the Kingston Garrison Diversity Advisory Group for Persons with Disabilities since 2010 and she serves as a logistics officer in the Naval Reserve since 2004.

ACRONYMS AND ABBREVIATIONS

%RMSD	Percent Root Mean Square Difference
A.baumannii	*Acinetobacter baumannii*
AAR	After Action Review
ACL	Anterior Cruciate Ligament
ADR	Alternative Dispute Resolution
AFL	Australian Football League
ANOVA	Analysis of Variance
APC	Activated Protein C
APN	Advanced Practice Nurses
APTT	Activated Partial Thromboplastin Time
BA	Bachelor of Arts
BAI	Beck Anxiety Inventory
BCE	Before Common Era
BDI-II	Beck Depression Inventory – II
BMI	Body Mass Index
BSA	Bovine Serum Albumin
BSc	Bachelor of Science
C.Psych.	Certified (Registered) Psychologist in Ontario
CAMA	Computer Assisted Mosaic Arthroplasty
CAPS	Clinician-Administered PTSD Scale
CAREN	Computer Assisted Rehabilitation Environment
CBRN	Chemical, Biological, Radiological and Nuclear
CBT	Cognitive-Behavioural Therapies
CC	Cross Correlation
CCHL	Canadian College of Health Leaders
CD	Canadian Forces Decoration
CDA	Canadian Defence Academy
cDNA	Complementary Deoxyribonuclenic Acid
CF	Canadian Forces

CFB	Canadian Forces Base
CFC	Canadian Forces College
CFHS	Canadian Forces Health Services
CHAMP	Comprehensive High-level Activity Mobility Predictor
CHCA	Canadian Home Care Association
CIHR	Canadian Institute for Health Research
CIMVHR	Canadian Institute for Military and Veteran Health Research
CIRRIS	Centre interdisciplimaire de recherche en readaptation et intégration sociale
CM	Master of Surgery
CMP	Chief of Military Personnel
CMTT	Civil Military Transition Team
COL1A1	Gene that codes for α1 Chain of type I Collagen
CPT	Cognitive Processing Therapy
CSC	Correctional Services Canada
CT	Computed Tomography
DASA	Defence Analytical Services and Advice
DASH	Disabilities of the arm, shoulder and hand
DCC	Dicyclohexylcarbodiimide
DCM	Dichloromethane
DGMEPM	Director General Maritime Equipment Program Management
DGMPRA	Director General Military Personnel Research and Analysis
DIC	Disseminated Intramuscular Coagulation
DLS	Dynamic Light Scattering
DMAP	Dimethylaminopyridine
DMSO	Dimethylsulfoxide
DNA	Deoxyribonuclenic Acid
DND	Department of National Defence
DO	District Office
DRDC	Defence Research and Development Canada

DSM-IV	*Diagnostic and Statistical Manual of Mental Disorders*, fourth edition
DSRI	Defence and Security Research Institute
DTT	Dithiothreitol
DVA	Department of Veterans Affairs
DVM	Doctor of Veterinary Medicine
EMDR	Eye-Movement Desensitization and Re-processing
ESBL	Extended Spectrum Beta-Lactamase
ESS	Edgren Sidestep
ET	Exposure Therapy
EWI	Eminence Width Index
FRCPC	Fellow of the Royal College of Physicians of Canada
FRCS	Fellowship of the Royal College of Surgeons
FV	Factor 5
FVIII	Factor 8
FXII	Factor 12
GAPDH	Glyceraldehyde 3 Phosphate Dehyrogenase
GDMO	General Duty Medical Officer
HADS	Hospital Anxiety and Depression Survey
HIV	Human Immunodeficiency Virus
HMCS	Her Majesty's Canadian Ship
HPF	Hours Post Fertilization
HQ	Headquarters
HQP	High Qualified Personnel
IAT	Illinois Agility Test
ICC	Intraclass Correlation Coefficient
ICRS	International Cartilage Repair Society
ICRS II	International Cartilage Repair Society and Histological Repair
IED	Improvised Explosive Device

IKDC	International Knee Documental Committee
IPC	Interprofessional collaboration
IT&E	Individual Training and Education
JPSU	Joint Personnel Support Units
JSPS	Japanese Society the Promotion of Science
$KClO_4$	Potassium Pecholrate
LASS	Life After Service Studies
LB	Luria Broth
LCG	Liquid Crystalline Gel
LOA	Limits of Agreement
LPS	Lipolysaccharide
MA	Master of Arts
MB Telehealth	Manitoba Telehealth Network
MCSCS	Ministry of Community Safety and Correctional Services
MD	Doctor of Medicine
MDD	Major Depressive Disorder
MDR	Multidrug Resistant
MFA	Masters in Fine Arts
MFRC	Military Family Resource Centre
MID	Mentioned in Dispatches
MIT	Massachusetts Institute of Technology
MMPS	Matrix Metalloproteinases
MMT	Manual Muscle Strength Training
MMV	Medal of Military Valour
Mosaicplasty	Computer Assisted Mosaic Arthroplasty
MRI	Magnetic Resonance Imaging
mRNA	Messenger Ribonucleic Acid
MSc	Master of Sciences
MSC	Mental Composite Score

MSK	Musculoskeletal
MVHR	Military and Veteran Health Research
NAP	Netrophil Activating Protein
NATO	North Atlantic Treaty Organization
NCAA	National Collegiate Athletic Association
NCHL	National Centre for Healthcare Leadership
NDHQ	National Defence Headquarters
NE	Neutrophil Elastase
NF	Nieuwkoop and Faber
NFL	National Footbal League
NHP	Normal Human Plasma
NIS	Na^+/I^- symporter
NSERC	Natural Sciences and Engineering Research Council of Canada
NTC	No Template Controls
NWI	Notch Width Index
OATS	Osteochondral Autograft Transfer
OCD	Obsessive Compulsive Disorder
OCdt	Officer Cadet
OMM	Order of Military Merit
OSI	Operational Stress Injury
OSIC	Operational Stress Injury Clinic
OSISS	Operational Stress Injury Support System
PACU	Post Anaesthesia Care Unit
PAI1	Plasminogen Activator Inhibitor 1
PAI2	Plasminogen Activator Inhibitor 2
PBS	Phosphate Buffered Saline
PCL	Posterior Cruciate Ligament
PCL-M	PTSD Checklist – Military Version
PCR	Polymerase Chain Reaction
PCS	Pain Catastrophizing
PEG	Carboxylated Polyethylene Glycol

PE	Prolonged Exposure Therapy
PhD	Doctor of Philosophy
PK	Prekallikrein
PM	Peak Strength Value
PRT	Provincial Reconstruction Team
PTA	Phosphotungstic Acid
PTSD	Post Traumatic Stress Disorder
QRF	Quick Reaction Force
RCMP	Royal Canadian Mounted Police
RCT	Randomized-control Trials
RLOA	Ratio Limits of Agreement
RMCC	Royal Military College of Canada
RN	Registered Nurse
RNA	Ribonucleic Acid
RND	Resistance-Nodulation-Cell Division
RO	Regional Officer
ROM	Range of Motion
RT	Reverse Transcription
RT-PCR	Reverse Transcription Polymerase Chain Reaction
SDS-PAGE	Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis
SF36	Short Form Health Survey
SISIP	Service Income Security Insurance Plan
SLS	Single Limb Stance
SSHRC	Social Sciences and Humanities Research Council
SSRI	Selective Serotonin Reuptake Inhibitors
S. tropicalis	*Silurana tropicalis*
TCCC	Tactical Combat Casualty Care
TE	Typical Error
TEM	Transmission Electron Microscopy
TF	Tissue Factor

TFPI	Tissue Factor Pathway Inhibitor
TH	Thyroid Hormones
tPA	Tissue Plasminogen Activator
TR	Thyroid Receptor
TT	T-Test
TTCP	The Technical Cooperation Program
UCD	University of California, Davis
UOIT	University of Ontario Institute of Technology
uPA	Urikinase Plasminogen Activator
US	United States
VA	Veterans Affairs
VAC	Veterans Affairs Canada
VAMC	Veterans' Affairs Medical Centre
VAS	Visual Analogue Scale
VR	Virtual Reality
WIS	Work Instability Survey
WLQ	Work Limitations Questionnaire
WSIB	Workplace Safety Insurance Board
WWI	World War I
WWII	World War II
WWP	The Women & War Project
Y. pestis	*Yersinia pestis*

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This volume brings together some of the research presented at the November 2011 Military and Veteran Health Research Forum, addressing the health issues and needs of Canadian military members, veterans, and their families.

CIMVHR
Canadian Institute for Military and Veteran Health Research

ICRSMV
L'Institut canadien de recherche sur la santé des militaires et des vétérans