

# Post-COVID-19 Condition in Canada: What We Know, What We Don't Know and a Framework for Action.

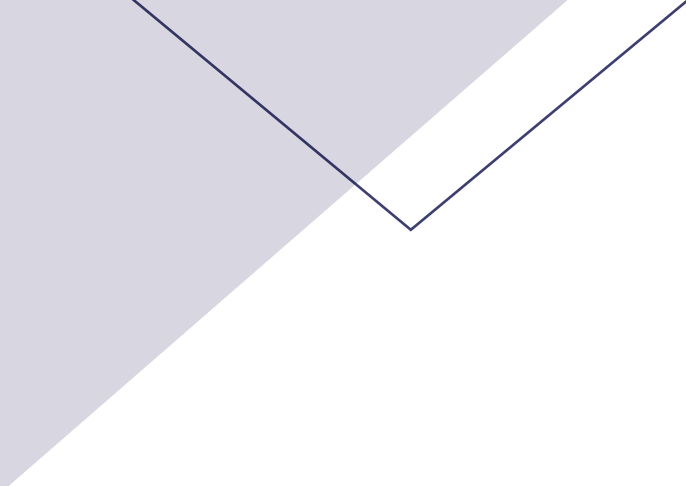
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Contact:  
[science@canada.ca](mailto:science@canada.ca)

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# POST-COVID-19 CONDITION IN CANADA: WHAT WE KNOW, WHAT WE DON'T KNOW AND A FRAMEWORK FOR ACTION

## EXECUTIVE SUMMARY

The COVID pandemic has had devastating effects on our society and on human health and mortality. Over the past two years, evidence has emerged to suggest that the impacts of COVID-19 extend beyond the acute phase of the disease which, in some infected individuals, can turn into a chronic illness. In Canada, as of August 2022, more than 1.4 million people – or about 15 percent of adults who have contracted COVID-19 – say they experience symptoms three months or more after their initial SARS-CoV-2 virus infection. These include respiratory, cardiovascular, neurological and cognitive impairments and they can be debilitating.

These longer-term symptoms are collectively identified as post-COVID-19 condition (PCC), or long COVID. PCC is not a homogeneous disease, as different individuals can present different sets of symptoms. Currently, there is no consensus definition of the condition or its diagnosis and few if any clinical practice guidelines are available. Globally, data for different countries consistently estimate that 10-20 percent of SARS-CoV-2 infected individuals experience PCC. Prevalence estimates for PCC will be refined over time as more data becomes available and wider consensus across the globe is reached on definitions and diagnostic criteria. People suffering from the condition receive standard of care for medically defined symptoms (e.g., cardiovascular complications) but for the many who suffer from other broad or medically undefined symptoms (such as chronic fatigue or brain fog), little other than rehabilitation therapy is presently offered. Several international clinical trials are ongoing to test new treatments or the benefits of existing repurposed medications. With the pandemic and the virus still spreading, PCC is likely to affect many more Canadians. Interestingly, COVID-19 vaccines significantly reduce, but do not eliminate, the risk of developing PCC.

The biological basis for the complex symptoms and conditions seen in PCC remains unknown and represents a major impediment to diagnosis and care of individuals suffering from the condition. Disease mechanisms may include effects on specific organs, systemic effects due to chronic inflammation and deregulation of the immune system or persistence of viral proteins or RNA in host cells. Known risk factors include female sex, hospitalization due to COVID, pre-existing chronic health conditions, and repeated SARS-CoV-2 infection.

PCC also has a significant socio-economic impact on individuals and communities. Among other things, PCC impacts the labour market, the workplace, and social support programs. The lack of defined diagnostic criteria and treatments together with the modest awareness of the condition is leading to stigma and disbelief, further affecting the mental and physical health of individuals living with PCC and their families.

In this context, Canada's Chief Science Advisor established a multidisciplinary task force in July 2022 to investigate and advise on ways to address post-COVID-19 condition in Canada. The product of their deliberations is a report that took into account existing scientific literature, published evidence, experience of service providers and the perspectives of people with lived experience. The report also proposes an integrated framework and recommendations for the management of PCC in Canada.

The recommendations include ensuring that research be interconnected with PCC clinical service delivery as part of a continuous learning framework; that services be developed and tailored to people and their families living with PCC, recognizing that females disproportionately suffer from PCC; and that sustainable human and physical infrastructure be put in place to support PCC management, prevention and research. These are integral to the broader effort of pandemic preparedness.

Below are the Task Force's recommendations, noting that applying PCC recommendations to other similar post-infection chronic conditions would also be of benefit.

1. As priorities, establish PCC diagnostic criteria, standardized assessments and clinical practice guidelines based on common definitions, in collaboration with national and international partners.
2. Develop, make available and consistently apply specific PCC diagnostic codes at all points of care to accurately track PCC cases in Canada and support the effective delivery of clinical services.
3. Provide timely and equitable access to person-centered care pathways for individuals living with PCC across the health care continuum regardless of ability, age, gender, geographic location or socio-economic or cultural background.
4. Develop a federal, provincial, territorial (FPT) long-term integrated research strategy for infection-associated chronic conditions, including PCC, that articulates clear priorities, considers both adults and children, and supports pandemic preparedness.
5. Establish a Canada-wide research and clinical care network for PCC and other similar post-infection chronic conditions to harmonize and coordinate efforts nationally and internationally.
6. Quickly advance five targeted priority research areas: (i) patho-physiology/biological mechanisms and risk factors; (ii) development of therapeutics; (iii) evidence-based prevention; (iv) clinical and translational research; and (v) socio-economic impact of PCC.
7. Update relevant policies and eligibility criteria to maximize the participation of people living with PCC in society, along with necessary supports and services.
8. Develop resources and tools that respond to the needs of people living with PCC and their caregivers and dependents, in partnership with persons with lived experience and community groups.
9. Acknowledge that PCC is real by raising awareness through outreach to citizens, schools and workplaces.

10. Develop and continuously update a web-based platform that lists available government services for individuals and families affected by PCC.
11. Develop, regularly evaluate, and adapt the effectiveness of PCC educational approaches for health care providers, particularly in primary health care.
12. Empower Canadians to make informed decisions about prevention of SARS-CoV-2 infection and PCC development, as our knowledge of the condition improves.
13. Establish a multidisciplinary scientific advisory council on infection-associated chronic conditions, in collaboration with the Office of the Chief Science Advisor, to support an integrated research strategy.
14. Set up a whole-of-government PCC coordination structure within the federal Health Portfolio to engage and coordinate with internal and external partners, including levels of government, the private sector, and patient groups.
15. Enhance the timely capture and sharing of data and the use of state-of-the-art data analysis strategies for improving both the care of individuals and evidence-informed policy.
16. Strengthen the human, digital and physical infrastructure that interconnects and supports research, care and emergency preparedness.
17. Scale-up and monitor effective prevention interventions, such as improving ventilation in schools, long-term care homes, work and public places as part of a first line of prevention of SARS-CoV2 infection and other respiratory/airborne pathogens.
18. Encourage innovation in PCC care models and evaluate them to inform future resilience in the health care system including the recruitment and retention of a thriving health care workforce.

The current pandemic is not the first, nor will it be the last. A legacy of learning from PCC and the current pandemic should include strengthening systems such as epidemiological surveillance, research readiness and coordination, as well as data collection and sharing. Combined with measures to reduce infectious disease transmission, notably through improved indoor air quality, along with efforts to recruit, train and retain health care providers, these systems will serve to enhance our preparedness and response to future outbreaks and emergencies.

## A MESSAGE FROM CANADA'S CHIEF SCIENCE ADVISOR

The COVID-19 pandemic has had devastating effects on populations around the world with over 6.6 million deaths to date. While the pandemic is not over yet, the long-term health sequelae of the infection are becoming increasingly evident with tens of million of people globally suffering from debilitating post-infectious symptoms. According to Statistics Canada, as of October 2022, 1.4 million adults in Canada have experienced or are experiencing the long-term symptoms of COVID-19. With the pandemic and the virus still spreading, many more Canadians are likely to be affected.

The lingering complex symptoms experienced by a significant number of COVID-19 survivors weeks after infection, has been referred to as long COVID, post COVID-19 condition or post-acute COVID-19 syndrome. Post-COVID-19 condition (PCC), the term used in this report, is not a homogeneous disease. Individuals suffer from a wide spectrum of symptoms and conditions ranging from well-defined medical entities, like hypertension and cardiac arrhythmia, to broad or medically undefined symptoms such as cognitive problems (“brain fog”), exhaustion, chronic pain and fatigue. Presently, there is no consensus definition of the condition nor for its diagnosis and few, if any, clinical practice guidelines are available. Individuals suffering from the condition receive the standard of care for medically defined symptoms but for the many who suffer from other symptoms, little other than rehabilitation therapy is presently offered.

The impact of PCC goes beyond health. PCC affects the ability to work and perform daily tasks, creating considerable consequences for individuals and communities. Analysis of the socio-economic impact of PCC from other countries, including the United Kingdom and the United States, indicates significant impacts on the labour market and the Gross Domestic Product (GDP), in addition to health costs and demands. In Canada, as in other countries, the health care system has been pushed beyond its limits by the pandemic. PCC stands to add further strain on the system due to the increasing number of people requiring health care access due to this new chronic condition. At the same time, a significant number of health care providers are experiencing PCC, which complicates the system as they have difficulty performing their professional duties and seek health care themselves.

Yet, the widening gap between supply and demand provides a unique opportunity for testing health system innovation for the care of PCC-afflicted individuals. Ultimately, lessons learned from PCC care could inform broader health care modernization.

It is in this context that I brought together a multidisciplinary task force and carried out a series of consultations with the aim of providing an integrated framework for managing PCC and its many societal impacts.

A highlight of the consultations was listening to the lived experiences of Canadians suffering from PCC as they navigate the health and social support systems, while battling stigma and disbelief. Their perspectives profoundly influenced the recommendations of this report. Awareness of PCC must be enhanced among the public, insurers, employers and health care providers.

We also heard from other Canadians who are suffering from poorly defined and studied post-infectious chronic conditions that share debilitating symptoms with PCC. Long-term sequelae of infectious diseases are well documented but have received insufficient attention, leaving many people behind. Addressing PCC provides a unique opportunity to strengthen our knowledge and preparedness to manage existing and future outbreaks and pandemics.

As we continue to battle the SARS-CoV-2 virus at a time of widespread collective pandemic fatigue, we now know that COVID-19 manifests as an acute and, for many, a chronic illness. Pandemic management must address the health and socio-economic effects of SARS-COV-2 infection *as a continuum over time*. In this respect, and given the accumulating evidence on the ability of COVID-19 vaccines to decrease the risks of PCC, the benefits of vaccination to prevent severe outcomes of both acute and chronic illnesses need to be broadly communicated.

I am grateful to the Task Force members and the many other subject matter experts who volunteered their time and expertise to inform the content of this report and the recommendations presented in support of an integrated approach to PCC management. I am especially thankful to the individuals who shared their personal experiences of living with PCC and ideas for improving its management.

I hope you enjoy reading this important report.



**Dr. Mona Nemer**  
Chief Science Advisor of Canada



# INTRODUCTION AND CONTEXT

## THE “HEAD AND TAIL” OF COVID-19

The global COVID-19 pandemic caused by the SARS-CoV-2 virus has had devastating effects worldwide on individuals and societies. As of October 2022, over 600 million people have been infected around the world, a number that is likely an underestimate given testing limitations. The majority of individuals infected by the virus experience moderate symptoms, but COVID-19 can cause severe disease leading to hospitalization and death. Tragically, more than 6.6 million people around the world have died from COVID-19 – including over 46,000 individuals in Canada during the past three years. In addition, hundreds of thousands of people have been hospitalized because of COVID-19 leading to a significant increase in morbidity. Thankfully, the rapid development of highly effective vaccines against SARS-CoV-2 has protected against severe disease and significantly decreased the rate of hospitalization and death due to acute infection.

However, a few months into the pandemic, long-term health issues started to manifest in individuals who had recovered from COVID-19, whether or not they experienced a severe form of the disease. The post-acute sequelae of COVID-19 are varied, ranging from myalgia/fatigue to cardiovascular, respiratory and neurological symptoms. The persistence or appearance of these post-infection symptoms has been referred to as long-COVID (LC), post-COVID-19 condition (PCC) or post-acute sequelae of COVID-19 (PASC). Additionally, in some individuals, acute infection increases the risk for chronic conditions such as diabetes and cardiovascular disease.

Thus, at a population level, acute COVID-19 illness can be viewed as the “head” of the COVID-19 pandemic, while post-COVID-19 condition represents a transition to its long tail, a stage characterized by chronic illness.

Much has been learned about the pathogenesis of the SARS-CoV-2 virus and the acute COVID-19 phase over the past three years, leading to development of life-saving vaccines and therapies. However, knowledge of the causes, prevention and treatment of post-COVID-19 condition, the term that will be used in this report, remains modest, which impacts the care of affected individuals. Given the global scale of the COVID-19 pandemic and the potential numbers of Canadians that could be affected by PCC, in July 2022 the Chief Science Advisor established the multi-disciplinary [Chief Science Advisor’s Task Force on Post-COVID-19 Condition \(PCC\)](#) – the Task Force. The objective of the Task Force is to provide recommendations for addressing the health and socio-economic impact of PCC in the Canadian context.

This report reviews the scientific evidence and identifies knowledge gaps related to PCC epidemiology, biological mechanisms and socio-economic impact. It also proposes an integrated framework for the management of PCC in Canada based on current knowledge, the lived experience of individuals suffering from PCC, and deliberations of the Task Force.

## ACUTE COVID-19

SARS-CoV-2, the causative agent of COVID-19, belongs to the Beta Coronaviridae family, which includes severe acute respiratory syndrome coronavirus (SARS-CoV-1) and the Middle East respiratory syndrome coronavirus (MERS-CoV), which are responsible for the 2002-04 SARS epidemic and MERS outbreaks, respectively. COVID-19 was first reported in China at the end of 2019 with hospitalized individuals presenting with fever, cough, muscle pains and abnormal chest tomography; nearly 30 percent of hospitalized patients developed acute respiratory distress syndrome (ARDS). Fortunately, not all cases of the illness require hospitalization and in most cases the disease presents with mild to moderate symptoms with good recovery. Nonetheless, a significant number of individuals experience severe illness and death, especially older adults and those with pre-existing co-morbidities. Common symptoms of COVID-19 are cough, shortness of breath, fever, fatigue, muscle aches and gastrointestinal issues. Severe disease features more serious symptoms and complications like ARDS, cardiac inflammation and injury, stroke, and kidney and neurologic disease. While predominantly an airborne respiratory disease, acute COVID-19 can affect many systems and organs, including the nervous, cardiovascular, gastrointestinal, musculoskeletal and endocrine systems. The wide range of COVID-19 and PCC symptoms and organs affected are summarized in Table 1 on next page.

Since the initial description of COVID-19, scientists have mobilized to study its causative virus and its pathophysiology. In parallel, extensive efforts were deployed to provide effective treatments by repurposing existing drugs while developing targeted vaccines and therapies. Collectively, these efforts led to accurate diagnostic tests; the production of vaccines that are highly effective against severe disease, hospitalization and death; and life-saving therapeutic drugs. Together with epidemiological studies and public health measures (like masking and physical distancing) these advancements have provided invaluable tools to overcome the “head” of the pandemic. They were all made possible thanks to international and multidisciplinary research efforts that have led to a deeper knowledge of how the virus interacts with a human host, how it spreads and how it evolves over time. Rapid translation of new knowledge into health outcomes was, in turn, achieved by an unprecedented cooperation among governments, academics and the private sector.

**TABLE 1. COMMON MANIFESTATIONS AND POTENTIAL COMPLICATIONS OF COVID-19**

Acute COVID-19			Post-COVID-19 condition (PCC)
System	Common symptoms	Potential Complications	Common Symptoms
<b>Respiratory</b>	Cough Shortness of breath Runny nose	Pneumonia Acute respiratory distress syndrome (ARDS) Respiratory failure	Cough, Shortness of breath Lung disease
<b>Systemic</b>	Fever Fatigue	Sepsis, Kidney injury Liver injury	Fever Fatigue Post-exertional malaise
<b>Nervous System</b>	Headache Confusion Loss of smell Loss of taste	Stroke Seizure Guillain-Barré syndrome	Headache Loss of concentration Memory deficit Loss of smell Loss of taste Sleep difficulty Mood disorder Numbness and tingling Spinal cord injury Nerve damage Blurry vision Tinnitus
<b>Cardiovascular</b>	Chest pain Shortness of breath Palpitations	Myocardial infarction Myocarditis Cardiogenic shock Cardiomyopathy Clotting abnormalities	Chest pain Shortness of breath Palpitations Hypertension Angina Myocarditis Pericarditis Cardiac arrhythmias Postural orthostatic syndrome
<b>Gastrointestinal</b>	Nausea Vomiting Diarrhea Loss of appetite	Acute pancreatitis Acute appendicitis Intestinal obstruction Bowel ischemia Hemoperitoneum Abdominal compartment syndrome	Diarrhea Vomiting Loss of appetite Nausea Hepatitis
<b>Skin</b>	Rash	N/A	Hair loss
<b>Musculoskeletal</b>	Muscle aches	N/A	Muscle aches Joint pain Weakness
<b>Endocrine</b>	Hyperglycemia	Diabetes	Diabetes Hot/cold sensation Thyroid abnormalities Hormonal abnormalities

Adapted from: *The immunology and immunopathology of COVID-19. Merad et al. Science, 375 (6585), DOI: 10.1126/science.abm8108*

## ***Epidemiology***

We now know that age is an important risk factor for severe acute COVID-19. Individuals over 65 are at higher risk of hospitalization and severe illness. COVID-19 disproportionately affects the elderly and immunocompromised, as well as individuals with underlying health conditions such as cancer, diabetes, obesity and cardiovascular disease. Additionally, individuals living in congregate settings, racialized and marginalized populations, and health care and other essential workers who are more often in direct contact with people, are at increased risk of SARS-CoV-2 infection. Children and youth typically experience mild COVID-19. However, some children can experience serious forms of the disease including multisystem inflammatory syndrome (MIS-C), a condition in which multiple organs become inflamed, including the heart, lungs, kidneys, brain and gastrointestinal tract, among others.

Over the course of the pandemic, the initial SARS-CoV-2 lineage (referred to as the ancestral or Wuhan strain), has given rise to several lineages or variants, characterized by sequence changes or mutations, most notably in the spike (S) domain of the virus, which serves as the interface that allows the virus to enter the host cell. The various lineages differ with respect to their infectivity but produce similar symptoms. The more recent Omicron variant is far more contagious than previous ones but is less likely to produce severe disease such as pneumonia, especially in adequately vaccinated individuals.

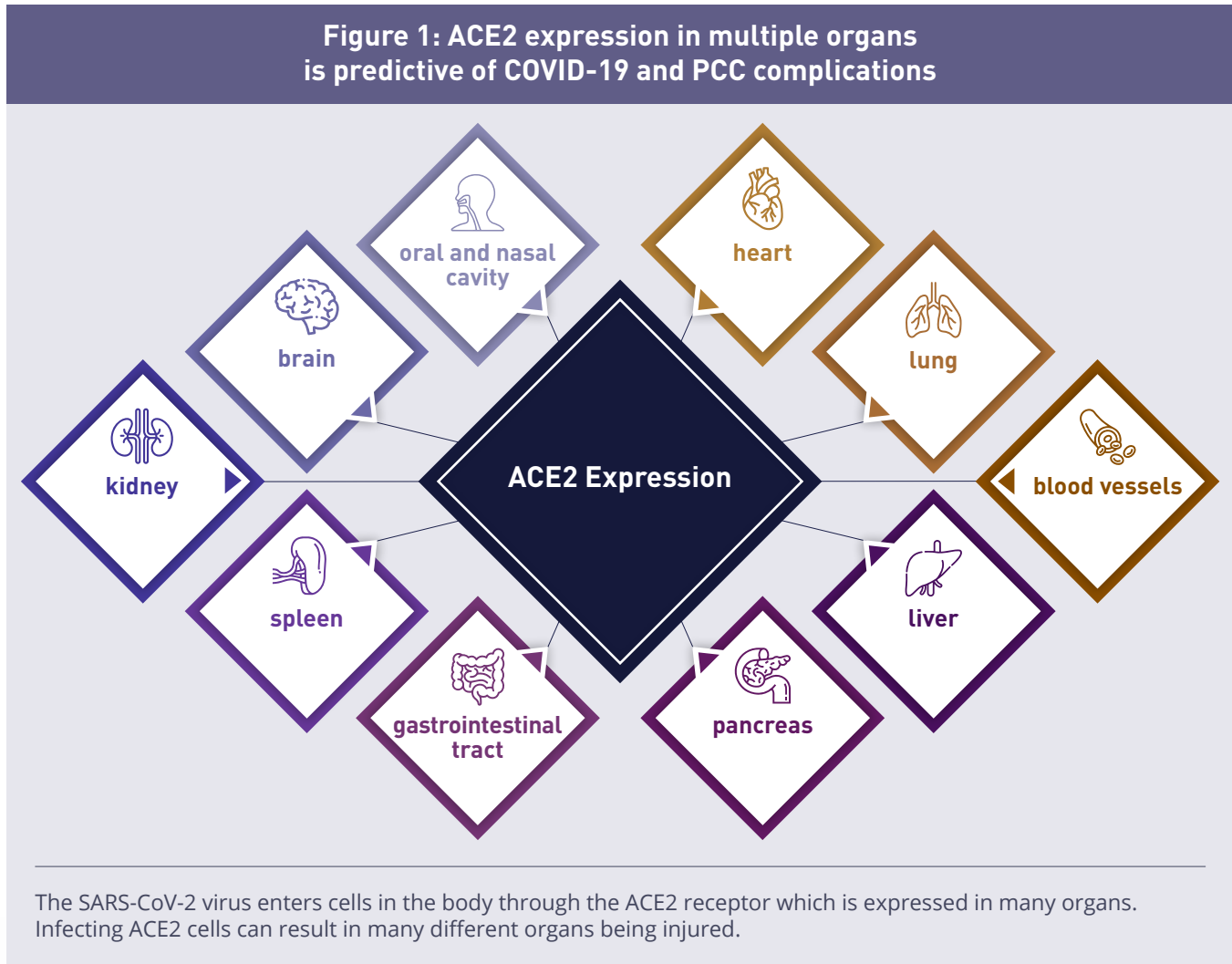
The mass deployment of vaccines has reduced the risk of SARS-CoV-2 infection and proved to be highly effective at protecting against severe disease and death caused by all circulating variants. Vaccines have undoubtedly limited disease spread and reduced COVID-19 mortality and morbidity. Protection against severe disease and death caused by different variants remains stable, but the ability of vaccines to protect against infection, especially with the Omicron variant, wanes after about two months. Vaccine effectiveness against Omicron infection after a first booster dose of an original mRNA COVID-19 vaccine is approximately 60% shortly after administration of a booster dose, and declines considerably over time in most studies. Consequently, many vaccinated individuals have experienced and recovered from COVID-19.

Similarly, the use of existing anti-inflammatory therapy (e.g., corticosteroids) and the timely development of new antiviral therapeutics, including monoclonal antibodies and small molecules (e.g., Paxlovid™), have contributed to saving many lives and changed the course of the pandemic. These medical countermeasures were made possible thanks to the rapid identification and sharing of the primary sequence of the virus and the mechanism by which it enters and functions in human cells.

## ***Pathogenesis***

The SARS-CoV-2 virus (the ancestral Wuhan lineage and all subsequent variants) enters human cells by interacting with angiotensin converting enzyme-2 (ACE2) that serves as the virus cell surface receptor. This interaction occurs through the spike (S) domain of the virus, the region targeted by most vaccines and monoclonal antibodies. The virus is released into the cell following further events that include cleavage by transmembrane proteases, fusion of viral and cellular membranes and release of viral RNA in the cell cytoplasm. The range of acute COVID-19 symptoms reflects, in good part, the presence of ACE2 in specific cells and organs. These include the epithelial cells of the nasal cavity, lung, gastrointestinal tract and eye, as well as the pericytes — cells lining the capillaries in the central nervous system (CNS), heart, pancreas and adrenals. The presence of ACE2 in microvascular and specialized cells of several

organs means that they can be targeted directly by SARS-CoV-2. Additionally, virus-induced disruptions in these cells can impact other organs and cell types, including endothelial cells of the vasculature, cardiomyocytes and neuronal cells.



ACE2 is an integral part of the renin-angiotensin-aldosterone system (RAAS), the main regulator of blood pressure and vascular homeostasis. ACE2 has protective effects as it degrades Angiotensin II, the main pro-inflammatory, vasoconstrictive hormone of RAAS. In so doing, ACE2 contributes to lowering blood pressure and preventing vascular inflammation and organ fibrosis. ACE2 cleaves other physiologic substrates, including bradykinin, a molecule that plays an important role in inflammation, and apelin, an important regulator of the endocrine and cardiovascular systems. ACE2 also regulates other cellular processes, independent of its enzymatic activity, such as amino acid transport in the intestines. By lowering ACE2 surface levels, SARS-CoV-2 interferes with important physiologic pathways in target cells. This in turn disrupts some cell-cell interactions, hormonal balance and the concentrations of oxygen and nutrients in many organs. The physiologic role of ACE2 and its cellular distribution are relevant for understanding the pathogenesis of SARS-CoV-2 in the acute phase and possible mechanisms of the post-acute COVID condition.

## POST-COVID-19 CONDITION (PCC)

PCC refers to clusters of mid- and long-term symptoms and conditions that some people experience after recovering from acute SARS-CoV-2 infection. Presently, there are many definitions for PCC, as detailed in Annex 1. For the purposes of this report, the definition of the World Health Organization has been adopted, which defines PCC as “*symptoms and medical complications that persist, return, or emerge 12 weeks after the initial acute infection phase.*” As our knowledge of this heterogeneous condition progresses, the definition may well change to include earlier disease manifestation and more defined subgroups, given that individuals experience distinct PCC symptoms or a combination thereof.

### **Clinical Manifestations**

PCC symptoms can be grouped into three general categories. In the first, some symptoms, such as cardiovascular ones, are well studied and part of other diseases. In the second category, symptoms are less well clinically and biologically defined, and include myalgia (muscle aches and pain) and cognitive deficits such as “brain fog”. The third category regroups neuro-cognitive symptoms. Symptoms occur in different combinations or clusters and may interfere with daily life and regular activities. Common symptoms include debilitating fatigue which may worsen after activity, shortness of breath, “brain fog” and cardiac problems including heart palpitations. Of note, several symptoms overlap with acute COVID-19 symptoms (see Table 1). PCC symptoms also overlap with other medical conditions, including post-intensive care syndrome, which can develop as a result of being hospitalized. Furthermore, PCC can have a similar symptom profile as other poorly understood post-infection chronic conditions like chronic Lyme disease which is caused by the bacteria *Borrelia burgdorferi* and other complex chronic conditions like myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS) and fibromyalgia (FM), which are characterized by fatigue and generalized pain.

Studies are also providing accumulating evidence that acute COVID-19 increases the risk for other health conditions, such as autoimmune and neurological disorders, stroke, heart failure, diabetes mellitus and liver injury. Other system deregulations not necessarily considered as part of the PCC spectrum are also being reported, like changes to the auditory and vision systems.

The course of PCC, including illness severity and duration, varies widely. Given that COVID-19 has been around for only three years, long-term prognosis and follow up are not yet available. Individuals who experience PCC in the absence of COVID-19 hospitalization, have symptoms lasting an average of four months, while symptoms last at least nine months in individuals hospitalized during acute infection. Some patients have not recovered two to three years after the initial infection and it is uncertain whether a proportion may never fully recover their pre-infection health status. Additionally, recovery is not always linear and many

“[During] my initial COVID-19 infection I wasn't hospitalized and I expected to fully recover... 21 months later, I now deal with dozens of incapacitating symptoms. I'm housebound, and I'm an ambulatory wheelchair user.”

— *Lived experience panelist*

experience relapses of symptoms that occur in irregular or episodic patterns. Triggers of symptom relapse include physical activity (including exercise and domestic chores), stress, cognitive activity, sleep disturbances and menstruation.

### ***Underlying causes***

Understanding the underlying causes of PCC is critically important for providing diagnostic criteria and biological/clinical markers and for the management and care of individuals suffering from PCC. At present, the underlying causes of PCC remain undefined, and it is unclear why a subset of individuals infected with SARS-CoV-2 develop PCC. By analogy to acute COVID-19, PCC is a multi-organ disease affecting many systems, including the respiratory, cardiovascular, nervous and endocrine systems. These various symptoms may share a common mechanism but distinct organ-specific pathways, induced by the viral infection, may be responsible for a subset of clinical manifestations. Recent machine learning analysis of over 130 symptoms and conditions reported in a large cohort has suggested four distinct sub-phenotypes of PCC, each with distinct demographics, pre-existing conditions and acute COVID-19 severity. While further confirmatory studies are needed, the results confirm the importance of clinical and biomarkers for population stratification and the likelihood that more than one biological pathway may be implicated in PCC onset and progression.

**“A major blind spot for infectious diseases is that our surveillance systems are not built for long-term sequelae after the event... We need to think about how to capture the after effects of acute infection.”**

**— *International clinical expert***

A few hypotheses are under consideration to explain PCC. They include: 1) persistence of the virus or viral antigens or viral RNA in the tissues of infected individuals; 2) a dysregulated immune response; including triggering of autoimmunity, suggested by increased levels of several immune modulators; 3) unrepaired tissue damaged due to ACE2 dysregulation which can lead to a variety of outcomes, including increased vascular inflammation, tissue fibrosis and metabolic damage as discussed earlier; and, 4) latent organ-specific effects of acute infection suggestive of cumulative damage or genetic/environmental factors.

### ***Prevention and treatment***

The best way to prevent PCC is to avoid SARS-CoV-2 infection by following public health measures such as indoor masking in public places and staying up-to-date with vaccinations. In addition to decreasing the risk of COVID-19 spread, evidence indicates that vaccination also decreases the risk of developing PCC following breakthrough infection by up to half. Similarly, emerging evidence suggests that antiviral treatment with Paxlovid™ during the acute phase also decreases the risk of PCC. The reason why vaccines or antivirals are protective is not yet fully understood, but may reflect decreased viral load and a shortened infection period that underlie the protective actions of both interventions against acute COVID-19. Other studies suggest that rest during the acute COVID-19 phase may also decrease PCC severity.

“When we first opened [the long COVID clinic] in 2021... within a month, we had 1,000 patients, and now we're at 4,000 on our waiting list... Can we more creatively use telemedicine platforms in addition to tools that are web-based, that involve self-assessment and self-management?”

— *Canadian physician participant*

Given the heterogeneity of PCC, there is no specific treatment for now. Patients may receive a standard of care treatment for distinct PCC symptoms and referral to interventions such as physiotherapy, occupational therapy, rehabilitation and psychotherapy, depending on need and availability. Symptoms that are poorly defined medically are the most challenging to treat. Several randomized clinical trials are under way to provide new treatments to individuals suffering from PCC. Many new and repurposed drugs, such as the antidepressant fluvoxamine, are being tested against inflammation, blood clots or other symptoms.

The US, UK and Israel have had success with specialized multidisciplinary treatment centres for PCC and most include allied health professionals, such as physiotherapists, occupational therapists, and social workers.

Specialized PCC clinics and rehabilitation services for adults are available in some Canadian provinces. Ontario, Alberta, British Columbia and Quebec have set up PCC clinics, though their exact number and locations are not readily available.

In the fall of 2022, the province of Quebec announced 15 new clinics focused on the treatment of people living with PCC and Lyme disease, another infection-associated chronic condition whose symptoms partially overlap those of PCC. Currently, the demand for PCC services far outpaces the supply. Even when specialized clinics are available, the wait times are long. Few specialized clinics are available for children and youth living with PCC.

Most PCC care models include strong integration with primary care for long-term care coordination, follow-up, and referrals. Clinics may leverage virtual care strategies to increase geographical reach, coordination of care and patient education strategies. Some of the clinics have an embedded research component, such as British Columbia's Post-COVID-19 Interdisciplinary Clinical Care Network and the Quebec PCC and Lyme disease clinics.



## **Epidemiology**

The exact prevalence, or total number of individuals who are living with PCC is uncertain. Prevalence is under intense study, and is complicated by the differing definitions and the lack of agreed upon clinical criteria or biomarkers. The number of people affected with PCC will be refined over time as new data comes to light and science evolves. Taken in this context, studies so far suggest that between 10-20 percent of people infected with SARS-CoV-2 develop PCC. This percentage is higher in studies conducted during the earlier pandemic waves, prior to vaccine deployment. Additionally, the frequency of PCC may be affected by the circulating virus strain. For example, it is reported that Omicron infections appear to be associated with a 50 percent *lower PCC risk* than earlier variants. Nonetheless, given the greater number of people infected by Omicron given its high transmissibility, the absolute number of people developing PCC following Omicron infection is very significant.

To illustrate, the Office of National Statistics in the UK estimated that over 2 million people had long COVID symptoms as of September 1, 2022, or about 3 percent of the UK population. In the US, several studies estimated that about 18 million US adults suffer from PCC/long COVID during the same period. A recent modelling study for the World Health Organization estimated that 17 million people have experienced long-COVID/PCC in the first two years of the pandemic across Europe. Data are lacking on PCC prevalence and impact from countries with less developed infrastructure for data capture and monitoring.

Current Canadian PCC prevalence estimates align with US and European studies. A recent [Statistics Canada survey](#) provided the first population-level estimate of the impact of longer term symptoms of COVID-19 in Canada. Results show that approximately 15 percent of Canadian adults reported some PCC symptoms at least three months after a positive COVID-19 test or suspected SARS-CoV-2 infection. This equates to about 4.6 percent of the Canadian population aged 18 years and older or **1.4 million individuals**. More in-depth results from this survey will be released over the coming months. Recent [seroprevalence data in Canada](#) estimated that approximately 60 percent of adults have been infected with the highly transmissible Omicron variant and 6 percent pre-Omicron. With the virus still spreading at the time of writing this report, many more Canadians may be affected by PCC.

Risk factors for PCC remain uncertain. Repeated SARS-CoV-2 infections may increase PCC, which would have serious consequences on the number of individuals affected by PCC in an endemic or seasonal COVID-19 state. Independent risk factors identified so far include female sex, severity of acute COVID-19 infection, COVID-19 hospitalization, and comorbidities such as chronic obstructive pulmonary disease. In pediatric populations, more female than male present with PCC symptoms, but there are very few studies in children to draw from and it is an important area of research. The occupations at highest risk of SARS-CoV-2 infection and consequently at higher PCC risk include health care workers/social assistance, retail trade, and educational services. Data from Quebec (discussed further in the report) confirm the high prevalence of PCC among health care workers, a situation that has significant impact on the health care system.

## SOCIO-ECONOMIC IMPACT OF POST-COVID-19 CONDITION

PCC has a significant socio-economic impact on individuals and their families, on clinical and social support services, on the labour market and on the economy more broadly. Future socio-economic implications for Canada may be far-reaching and require planning and monitoring.

### *Individuals and families*

PCC symptoms can seriously impact the daily activities of previously healthy individuals and reduce their ability to work and care for their family.

Therefore, PCC can have dramatic health and financial consequences on individuals and their families. Furthermore, individuals living with PCC may experience a “rollercoaster course,” in which flare-ups and relapses occur which prolongs the time that services and supports may be required. For example, given the lack of knowledge and understanding of PCC, individuals may be pressured to prematurely return to their previous productivity at work or at home, which can worsen the symptoms and set them back. Additionally, living with PCC and going from “thriving to surviving” can increase anxiety and depression and exacerbate people’s physical and mental state.

The demographics of people affected by PCC indicate that adults of working age – with higher representation of women versus men – make up the majority of individuals suffering from or at risk of PCC. As women are often the caregivers of children and elderly parents or family relatives, their dependents could also be negatively impacted unless alternative supports are available. For example, healthy children can suffer from their caregiver’s reduced capacity to do daily tasks such as helping with homework, taking them to school, or feeding and caring for them.

Some groups are especially vulnerable to the impact of PCC. For example, racialized communities and recent immigrants are more likely to be providing care and financial support to extended family members and a higher proportion of them live in multigenerational households. These groups require special attention, as data indicate that, because of occupation and/or housing conditions, they are at higher infection risk and consequently at increased risk for PCC.

“Just accomplishing the essential activities of daily living is beyond the capacity for many, including me.”

— *Lived experience panelist*

“The same factors that lead someone to be at a higher risk for COVID-19 also might preclude them accessing services that are largely only available if they can afford it.”

— *Canadian public health expert*

## **Clinical Services**

The pandemic has strained health systems around the world, including in Canada. PCC has the potential to put further pressure on the system given the large number of health care providers suffering from PCC combined with the increased needs of a significant new group of users with complex chronic conditions. Strategies to avoid overloading the system while caring for all individuals need to be carefully considered.

When establishing a clinical care pathway for PCC, the entire health system needs to be considered, including existing non-PCC health care needs. PCC is further stressing the system in many ways, by increasing demands on primary care, medical tests and imaging, medical specialists, rehabilitation and physiotherapists services, as well as social workers, psychologists and other mental health support. At the same time, given the number of health care providers suffering from PCC and the burnout caused by covering for absent colleagues, the available health workforce is reduced. To illustrate, a study in Ontario on health care use found that a small subset of people who tested positive for SARS-CoV-2 experienced a very significant increase in their rate of health care use over many weeks, as compared to similar people who tested negative, raising a concern for a serious burden long after the acute infection.

Regarding the health care workforce, evidence also suggests that health care workers are a demographic that is highly impacted by PCC. [Statistics Canada data](#) reveal that 7% of COVID-19 cases are people working in health care settings. A study by researchers in Quebec found that 76% of health care workers who were hospitalized for COVID-19 developed PCC symptoms lasting at least four weeks and 68% lasting at least 12 weeks. Among the non-hospitalized, PCC prevalence was 46% and 40%, respectively. Both physical and cognitive symptoms were reported by health care workers in the study. The loss of health care workers from the labour force due to PCC adds additional strain to health system capacity.

## **Labour Market and the Economy**

Canadian data on the labour and economic impact of PCC are sparse. One study from Alberta found that out of 81 workers with PCC who completed a specific rehabilitation program, only 53% were able to return to work, and of these 93% required modified duties. While estimates vary, European and US studies show that the inability to return to work is likely in the range of 26–49% of people living with PCC.

The economic burden of PCC and the implications for sectors of the labour market in Canada could be profound. For example, US economist David Cutler estimated that 10 million people with three or more symptoms of long COVID in the US could carry an [economic cost](#) of \$3.7 trillion dollars, considering three factors: lost quality of life, lost earnings and higher spending on medical care.

**“Prompt diagnosis and a multidisciplinary treatment approach are key, rather than the alternative of patients being referred to various practitioners who may not be able to help them.”**

**— International physician participant**

Furthermore, a recent World Economic Forum report estimated that around 16 million working-age Americans (aged 18-65) have PCC and 2 to 4 million of them are out of work due to the condition. This translates into US\$170 billion a year of lost wages (and potentially as high as US\$230 billion/year), and double that when health system and productivity loss are included. Additionally, a recent Brookings Institution report estimates that about 420,000 workers ages 16-64 likely have already left the US labour force because of long COVID (0.2%-0.4% of the labour force).

**“Many people [with PCC] do not drop out of work entirely, but reduce their hours. Others do not reduce their hours but their productivity drops significantly.”**

**— International socio-economic expert**

The impact on the labour market is expected to be similar in other countries. For example, the Bank of England estimates a 1.3% decrease in labour participation, in part due to PCC.

### **Social Supports**

As PCC affects working-age Canadians, an increase in short- and long-term disability claims related to PCC is already happening and expected to increase. The average duration of PCC disability and the proportion of temporary versus permanent disability is not yet known.

Accessing disability support is reportedly an issue. Barriers to disability support include the lack of uniform PCC clinical guidance and diagnostic criteria, a low awareness of PCC among clinicians, and a lack of access to a primary health care provider, which could lead to a missed or delayed diagnosis. Some health care providers may feel uncomfortable submitting claim forms for “uncertain” diagnoses, and others may charge a fee for completing these forms, creating additional barriers to accessing disability benefits. There is and will be much interest in how PCC is ultimately defined and categorized, given that long-term disability claims require supporting medical information.

**“Sick leave doesn't work for long haulers because we're better for a few days and upon return, we overdo it, then we crash and get into trouble.”**

**— Lived experience panelist**

“To reduce economic [and fiscal] burden... first we need to prevent cases of COVID-19, we need significantly better research and to get to clinical trials faster, we need better employer accommodations, and we need a safety net.”  
— *International socio-economic expert*

Practical community supports such as childcare, delivering groceries, transportation to and from medical appointments, availability of social workers to complete disability forms, access to mental health therapy, and virtual care can all have a positive impact on individuals living with PCC. Children and young adults affected by PCC would further benefit from flexible return-to-school policies, school accommodations, and social and community support.

Individuals living with PCC have expressed a strong desire to return to work, yet work tasks can exacerbate cognitive, physical and emotional symptoms, causing relapse. Return to work arrangements need to be flexible and adapt to the non-linear PCC recovery and provide accommodations for workers with physical and cognitive limitations due to PCC.

Whether or not people living with PCC will be eligible for social assistance or employment insurance is uncertain and depends on multiple factors such as the duration and severity of symptoms. A flexible approach that recognizes and accommodates the fluctuating nature of PCC will need to be considered. Employers could work collaboratively with the insurance industry to ensure that patients receive a certain level of medical care as needed, including on-site access (for example to rehabilitation services, nurse practitioners, mental health support) as well as virtual care and referrals to health provider networks.

## KNOWLEDGE GAPS

Over the past three years, extensive efforts have provided invaluable insight into COVID-19 and produced sensitive and accurate diagnostic tools, highly effective vaccines and new therapeutics, which has saved countless lives. Knowledge of the evolution and behaviour of SARS-CoV-2, the causative agent of the COVID-19 pandemic, has evolved rapidly. Nonetheless, knowledge of the long-term effects of viral infection (and reinfection) remains incomplete. Preventing and treating the long-term sequelae of acute infection requires more in-depth knowledge of the systemic and organ-specific effects of virus entry into the cells combined with well-designed human longitudinal studies. At the same time, health and socio-economic challenges generated following acute infection by this relatively new virus need to be better documented and understood. This section provides a brief overview of the key knowledge gaps that need to be addressed in the context of an integrated plan for managing post-COVID-19 condition.

### *PCC Diagnosis*

Accurate diagnosis of PCC is essential for providing adequate social support and health care to affected individuals. Unfortunately, there is a lack of consensus on a PCC definition and diagnostic criteria, including biomarkers. This is leading to multiple challenges, including difficulty in accurately estimating how many people have PCC and for raising awareness among clinicians so they can diagnose and treat PCC in a consistent manner. Diagnostic criteria, medical assessments and medical records are also needed for social assistance and supports like disability and insurance claims. Consistent definitions, standardized assessments and diagnostic criteria allow for comparison across research studies; these gaps have a system-wide impact. For example, how health care systems can be organized and coordinated starts with understanding the expected volume of PCC patients, which is required to quantify the anticipated health services to be used across the continuum of care (from hospital to community clinics to home care). Understanding the burden and impact of PCC is crucial to formulating appropriate policies, yet it is impossible to accurately assess the burden without clearly defining PCC.

At the clinical level, an important question will be whether PCC/long-COVID is a single disease, or a constellation of conditions requiring distinct treatment and follow up. Answering this question will require close collaboration between epidemiologists, health care providers and health researchers, as well as the use of novel approaches such as artificial intelligence (AI)-enabled data analysis. Similarly, the present arbitrary definition of PCC as “symptoms present 12 weeks after infection” will need to be reviewed. While some life-threatening symptoms and conditions may develop suddenly, such as stroke or cardiac arrhythmia, much is known about risk factors and prevention. Other PCC symptoms, including vascular, neurological and immune symptoms, are often characterized by a progressive or degenerative state that can be stabilized or reversed early on. Other symptoms such as hearing loss or chronic fatigue can lead to depression and social withdrawal, if not properly addressed. Early intervention would help decrease disease burden and enhance the quality of life of affected individuals.

### ***PCC Causal Mechanisms and Risk Factors***

The mechanism(s) of pathogenesis of PCC and the full disease course from first exposure to clinical phase and recovery is not understood. Furthermore, it is not clear what constitutes the onset of PCC; that is, when and how the transition from the acute infection to the later chronic phase occurs. PCC patients are typically studied when they are far removed from the initial infection and, at least for non-hospitalized individuals, without sufficient knowledge of the biological changes that took place during or shortly after infection. Furthermore, it remains unclear whether different PCC features are the consequence of distinct, organ-specific mechanisms, or if a unified mechanism can lead to different symptoms and affect different organ systems in different patients. These types of questions are important to inform disease definition, diagnostic criteria and treatment options for PCC and are relevant for post-infection chronic conditions more broadly.

**“The silver lining of the pandemic is the ability to study not only long-COVID [PCC] but also to shed light on the decades of ignoring these conditions [i.e., post-infection chronic conditions] which we’ve known about since the flu pandemic.”**

**— *International clinical expert***

In this regard, the reason why some but not all infected individuals develop PCC merits consideration in order to develop preventative options. Virus-host interactions are influenced by many factors, including genetics, environmental and health status. How any of these contributes to PCC is not yet known.

The impact of PCC on human development in children and on normal aging in adults is uncertain. Evidence is mounting that COVID-19 increases the risk for other chronic conditions as stated earlier. COVID-19 is also increasingly associated with immune deregulation affecting the ability to fight other infections. Given the significant number of individuals who have had acute COVID-19 and who are at risk of PCC, it will be important to determine if and how PCC interacts with other acute or chronic medical conditions. Additionally, and in the context of an endemic COVID-19 state, it will be important to determine the consequences of SARS-CoV-2 reinfection on the course of PCC. SARS-CoV-2 will continue to evolve and the future impact of new variants of concern will need to be monitored.

### ***Prevention and Treatments***

Vaccination prior to COVID-19 infection appears to lower the risk of PCC and emerging evidence suggests that antiviral treatment may have similar benefits. Robust studies are needed to confirm these observations and understand their basis since they could have important impacts including on guidelines for treating acute COVID-19 in individuals at risk of PCC. Similarly, the benefit of nonpharmacological treatments, such as resting during acute COVID-19 infection, should be clarified in robust observational studies as the results could impact health and workplace guidelines. As stated above, genetic studies can help identify

genetic variation that may influence the development and severity of PCC and provide genetic markers to determine predisposition or protection.

PCC manifestations include symptoms and conditions for which treatments exist as well as other less well-defined medical conditions such as chronic fatigue, exertion intolerance or brain fog. Individuals experiencing these debilitating conditions are at great risk of exploitation or mistreatment. Clear, factual and informative communications, including on effective and authorized therapies, are essential. Additionally, given the scarcity of treatment options, efforts should be deployed to enhance access to new or repurposed therapies, including through accelerating participation in national and international clinical trials. These efforts must nonetheless be pursued with the highest ethical and scientific rigour and be an integral part of a learning health care system.

Several possible care models are being tested in Canada and abroad. Which ones are most suited to the needs of patients in the Canadian context is unknown. Proactive evaluation of the effectiveness and quality of PCC clinical care models in an iterative fashion would ensure the model can be optimized and adapted to best serve individuals living with PCC. Lessons can be drawn from other multi-system chronic diseases, especially regarding educational outreach, early intervention, triage to ensure optimal use of specialized expertise, and use of rehabilitation allied health services. Current international evidence suggests PCC care models should be co-designed with patients, clinicians, decision-makers and researchers.

### ***Data Gaps and Broader Impact***

More Canadian data is needed on various aspects of PCC, such as prevalence, demographics, risk factors, socio-economic impact and the impact on the health system.

Getting accurate data on the number of PCC patients and risk factors is challenging given the lack of a consistent definition and the absence of PCC-specific diagnostic codes, especially for the outpatient population. Collecting, sharing and using health data was highlighted as a gap during the COVID-19 pandemic and this is limiting improvements in health outcomes and for overall preparedness for health emergencies.

As evidence on PCC evolves, robust modelling projections are needed to determine how many Canadians will be affected by PCC in the coming years and how to best adapt schools, workplaces, social supports and the health care system to support these individuals and their dependents. Potential socio-economic “ripple effects,” such as on housing and food security in Canada remain unknown. Modelling the impact on business, the public sector and cascading effects on individuals based on accurate data would be highly beneficial for developing appropriate policy and programs.



## LIVING WITH POST-COVID-19 CONDITION

To inform the recommendations on managing PCC in Canada, a virtual public roundtable was held, convening members of the Task Force and individuals living with PCC. Participants shared what it is like to live with PCC and offered perspectives and suggestions that could contribute to improved outcomes. What follows are highlights of the roundtable discussion.

Individuals living with PCC described a variety of debilitating PCC symptoms, particularly breathlessness, heart palpitations, extreme fatigue, “brain fog” and post-exertional malaise.

They described in detail how these symptoms affect their ability to work, participate in regular day-to-day activities like grocery shopping, doing chores around the house, getting to appointments or even reading. Some described PCC as “losing your life without dying”. Over-exertion both physically and cognitively can lead to a relapse that may take weeks or months to overcome. Existing health and social supports do not appear to be set up with enough flexibility to accommodate episodic disability or cases where the only remedy at present is resting and pacing oneself.

Participants also described their experiences facing stigma, inequitable access and inadequate support from the health care system, long wait times for tests and diagnoses, and the loss of personal and professional identity. They expressed palpable frustration at not being believed by their health care providers, family and employers, and the lack of diagnostic tests and criteria as well as the absence of effective treatments. Some shared stories of losing their jobs, their homes and sometimes the will to keep going. Common sentiments included feeling ignored by the health care and social support systems, and by governments and society more generally; this leaves them in the difficult situation of having to fend for themselves in spite of their reduced capacities.

One key message relayed from individuals with lived experience was the importance to simply acknowledge that PCC is real in order to help overcome barriers to care. As such, they called for an increased awareness of PCC among governments, health care providers and the public.

Participants highlighted the limited Canadian data on PCC and the importance of longitudinal research to understand the long-term impact of infection and re-infection on PCC development and probe the protective effects of vaccination. They emphasized the need for diagnostic biomarkers and early identification of PCC. They urged investments and accelerated research to support quality care and management of PCC.

“People at work use up all their energy and crash at the end of the day... no cooking, no cleaning, ... I don't help my child.”

— *Lived experience panelist*

A variety of other suggestions were also offered. These include the importance to track and publicly report on PCC statistics in Canada, much like we presently report on the number of COVID-19 hospitalizations and deaths. They also suggested having a national patient registry to provide much-needed data on the nature and scale of the issue and help inform future policies and actions. Another key emphasis was on ensuring equity in access to care, scaling up multidisciplinary clinics (including for children), enabling primary care providers to refer PCC patients to appropriate specialists, and providing practical community support, including for getting to and from medical appointments.

Synergies between PCC and other conditions like chronic fatigue syndrome were emphasized and it was suggested that research and care should build on the existing knowledge from other infection-associated chronic diseases.

On the social support side, individuals with lived experience noted the importance of social programs and community supports (both financial and logistical) compatible with PCC's episodic and long-term nature. These include flexible workplace accommodations and a general safety net for those affected by PCC. Access to mental health support was underscored as something urgently needed for the PCC community.

Lastly, participants reiterated the need for clear messaging with respect to prevention to reduce the societal impact of PCC by reducing SARS-CoV-2 infection and reinfections in the first place and ensuring vaccinations are up-to-date. Targeted public health measures and messaging were supported as a means to protect the vulnerable, given the ongoing community spread of the virus.

# A THREE-POINT FRAMEWORK FOR THE MANAGEMENT OF POST-COVID-19 CONDITION IN CANADA

In developing this framework, the Chief Science Advisor’s Task Force on Post-COVID-19 Condition considered the evidence available up to October 2022 as well as the information gathered from seven roundtable discussions with experts and individuals living with post-COVID-19 condition (PCC). The three-point framework proposes 18 actions that, taken together, will help manage the health and socio-economic impact of PCC in Canada and enhance pandemic preparedness and recovery. Many Task Force recommendations related to PCC could also be applied more broadly to benefit similar post-infection chronic conditions.

## VISION

The number of Canadians living with disabling, long-term effects of SARS-CoV-2 infection is reduced, and the negative health and societal impacts of post-COVID-19 condition (PCC) are limited through enhanced services and supports.

## GOALS AND OUTCOMES

- 1** Individuals with PCC, their families, and dependents have timely access to the health services and support they need.
- 2** Research on PCC mechanistic pathways, risk factors, and effective treatments is accelerated and translated into better care for PCC and other infection-associated chronic conditions.
- 3** Accurate data on PCC in Canada are collected and shared as part of a learning health system to inform clinical approaches, communication, and policy and program development.
- 4** Socio-economic policies and programs address the realities of living with PCC and provide the necessary support and services.
- 5** Health care providers, individuals living with PCC, and the general public have access to accurate information about PCC, thereby reducing stigma and promoting access to quality health care.
- 6** Broader systemic and infrastructure changes that can benefit individuals living with PCC and other chronic post-infection conditions are identified and actioned. This will contribute to pandemic preparedness.

## PRINCIPLES

*Actions should be guided by the following seven principles:*

1

**Equity**, recognizing all people have the right to be treated fairly and have equitable access to resources, opportunities, and benefits.

2

A **person-centred** research agenda to improve prevention, treatment and quality of life.

3

**Open and collaborative data and research** within an appropriate ethical-legal-social framework.

4

**System innovation** that encourages an implementation science approach in the context of learning health systems that address systemic barriers and evaluates novel approaches to overcome them.

5

**Partnership across disciplines**, sectors, and levels of government focussing on common goals.

6

**Inclusivity**, noting that individuals living with other infection-associated chronic conditions face similar challenges and would benefit from a similar approach.

7

**Pandemic preparedness and recovery**, such that actions taken to address PCC contribute to Canada's preparedness and response to future pandemics and infection-associated chronic conditions.

## A THREE-POINT FRAMEWORK

*Recommendations within this framework are aimed at public, not-for-profit and private organizations, as relevant, including levels of government, employers, institutions and insurers.*

Preventing and managing PCC and its socio-economic impact across Canada requires a **dynamic framework that is informed by the most current scientific evidence**. Actions to achieve the vision and goals, guided by the principles outlined above, are multipronged.

Recommended actions are organized from direct to broader and include A) *Direct Actions* Related to PCC Clinical Practice and Research; B) *Broad Actions* Related to PCC Socio-Economic Policies and Communication; and C) *Foundational Actions* Related to Infrastructure, Systems and Coordination that would further support individuals living with PCC. The proposed actions within this three-point framework span: clinical practice and services; research to guide practice and policy; communication; socio-economic policies and programs; and infrastructure, systems and coordination that contribute to PCC management and the foundation for pandemic preparedness.

### 1. DIRECT ACTIONS RELATED TO POST-COVID-19 CONDITION CLINICAL PRACTICE AND RESEARCH

#### Clinical Practice and Services

Clinical practice and services for PCC should be guided by person-centred and interdisciplinary approaches, including allied health services (e.g., rehabilitation, mental health and other services), drawing on lessons learned from the management of other chronic diseases. Interconnected continuous learning, research, standardized and accessible data, evaluation and quality improvement should be integral parts of timely clinical services. Common definitions and objective, quantifiable functional assessments (mental and physical) in relation to acute infection will be essential for effective PCC policy, care and preparedness.

- 1. As priorities, establish PCC diagnostic criteria, standardized assessments and clinical practice guidelines based on consistent definitions, in collaboration with national and international partners.** Canadian federal guidance would address an urgent gap and help build consistent approaches across provinces and territories. Other countries are making progress in this area, such as the United States Centers for Disease Control and Prevention's "Evaluating and Caring for Patients with Post-COVID Conditions: Interim Guidance" and "Post-COVID Conditions: Information for Health care Providers".
- 2. Develop, make available and consistently apply specific PCC diagnostic codes at all points of care to accurately track PCC cases in Canada and support the effective delivery of clinical services.** The World Health Organization has been developing emergency use international classification of disease (ICD) codes for COVID-19, including for PCC. The application of standardized PCC diagnostic code(s) at all levels is a shared responsibility at local, provincial, territorial and federal levels.

**3. Provide timely and equitable access to person-centred care pathways for individuals living with PCC across the health care continuum regardless of ability, age, gender, geographic location or socio-economic or cultural background.** PCC care pathways within provinces and territories should be developed in collaboration with community care services and established within different geographic regions and sub-population groups, considering who is at risk.

**3.1.** Accelerate the availability and use of PCC care models and access to treatments in the context of a continuous learning framework. Models should be informed by learnings from other complex, multi-system chronic diseases. They should also be accessible, culturally appropriate, and effectively address community needs.

**3.1.1.** Engage and partner with PCC communities and health care providers to develop PCC care models and health care delivery solutions.

**3.1.2.** Scale up and evaluate interdisciplinary PCC clinics, including allied health services (as above) and self-management components.

**3.1.3.** Establish learning health systems and networks to develop a cohesive infrastructure enabling knowledge building and exchange.

**3.1.4.** Provide faster and equitable access to clinical trials and studies, including approaches to rehabilitation, while ensuring patient safety.

**3.2.** Support primary health care providers as a key point of entry into the health care system through education, training, and human resource capacity to address PCC.

**3.3.** Consider the development and use of services and tools to assist people, as appropriate. These include virtual/web-based tools, telehealth, self-management tools, group-based care and peer support, including for triage prior to clinical assessment.

**3.4.** Provide health care workers who develop PCC with timely care and flexible return-to-work arrangements, considering the significant impact of their absenteeism on the health care system.

**3.5.** Implement and evaluate the effectiveness of PCC virtual clinical assessment and care approaches, especially in remote areas.

**3.6.** Using existing cohorts, monitor changes in the frequency or presentation of other chronic illnesses such as diabetes, and cardiovascular and neurological diseases.

## Research

Understanding the biological triggers and pathways underlying PCC is essential for developing diagnostics as well as preventative and therapeutic avenues. Knowledge of the molecular effects of SARS-CoV-2 infection in various cells and organs is essential. Persistent knowledge gaps are an impediment to improved health outcomes. Research that is interdisciplinary and collaborative spanning basic biomedical, clinical and translational (discovery to treatment) pillars should be accelerated. As noted above, research should be interconnected with PCC clinical service delivery as part of a continuous learning framework. Attention should be given to data stewardship, as advancing research and care depends on accessible and standardized approaches to data collection and management, the availability of appropriately trained human resources and access to secure data repositories. Additionally, there is an urgent need to better document the socio-economic impact of PCC in order to adequately address this.

4. **Develop a federal, provincial, territorial (FPT) long-term integrated research strategy for infection-associated chronic conditions (including PCC) that articulates clear priorities, considers both adults and children, and supports pandemic preparedness.** Such a resourced research strategy could enable cross-jurisdictional collaboration, data sharing, and the rapid mobilization of knowledge. It must be co-developed with patients and community groups.
5. **Establish a Canada-wide research and clinical care network for PCC and other similar post-infection chronic conditions** to harmonize and coordinate efforts nationally and internationally. This national network would accelerate the translation of research into care and policy.
6. **Quickly advance targeted priority research areas, given the number of people potentially affected by PCC.** Standardization of PCC definitions, use of consistent study methodologies, sample collection procedures and stratification of participant groups (across jurisdictions in Canada and internationally) would enable comparative analyses and accelerate the development of evidence-based care and therapies for PCC. Five priority research areas are proposed below to address needs and knowledge gaps, including understanding **pathophysiology and risk factors** and developing **effective therapies for treatment and prevention**.

### 6.1. *Pathophysiology/biologic mechanisms and risk factors*

**6.1.1.** Encourage basic research into the molecular consequences of SARS-CoV-2 entry into different cell types by reaching out to researchers with expertise in different systems and organs and including them in the Canada-wide research network that will provide national platforms to share research tools and facilitate preclinical, clinical and translational research. More specifically:

**6.1.1.1.** Apply modern approaches of immunobiology, genetics, genomics, proteomics and metabolomics and harmonize bioinformatic analyses and data sharing to understand PCC pathogenesis and risk factors associated with host-virus interactions.

**6.1.1.2.** Provide sustainable funding for technological platforms such as data and biobanks that enable collecting and sharing of biological materials and serve skills and capacity development.

**6.1.1.3.** Develop and validate animal models that reproduce the systemic and organ specific effects of COVID-19 and the PCC phenotypes as accessible and shared resources.

**6.1.2.** Apply learnings from other infectious and zoonotic diseases to define direct and indirect effects of SARS-CoV-2 infection and help inform pandemic preparedness plans. More specifically:

**6.1.2.1.** Differentiate between the long-term health effects of viral infection and health effects associated with hospitalization, intensive care unit admission, or extended social isolation.

**6.1.2.2.** Analyze the impact of PCC on the immune response to subsequent infections and the impact of repeated SARS-CoV-2 infections on the development of PCC.

**6.1.2.3.** Study historical outbreaks of infectious diseases for insight into virus evolution, human behavior and their long-term health outcomes.

## **6.2. *Development of therapeutics***

**6.2.1.** Invest in the development of effective broad-acting antivirals to minimize long-term sequelae from SARS-CoV-2 infection and reinfection. This requires adequate funding of medicinal chemistry research and making platforms for preclinical testing of bioactivity accessible to chemists as done by the National Institutes of Health in the USA.

**6.2.2.** Accelerate research into therapeutics that target the burdensome symptoms of PCC, including those related to inflammation, neuropsychiatric, respiratory and cardiovascular symptoms where there are unmet clinical needs.

**6.2.3.** Establish a clinical trial framework with strong central coordination to test the effectiveness of existing therapies that may be successfully repurposed for treating PCC, as part of the Canada-wide research network. Central coordination would add value through building on common protocols, enabling domestic and international linkages, and combining efforts thereby avoiding several small-scale underpowered trials.

## **6.3. *Evidence-based prevention***

Study the effectiveness of potential prevention measures using socio-behavioural, clinical and biochemical approaches. In particular:

**6.3.1.** Evaluate primary prevention of SARS-CoV-2 infection through the built environment and adaptive behaviour over the long-term to reduce COVID-19 transmission.

**6.3.2.** Improve secondary prevention once infected with SARS-CoV-2, through the use of effective antivirals or other therapies that are known to prevent organ damage, to minimize severe infection and evaluate the effect on reducing the likelihood of developing PCC.



**6.3.3.** Support tertiary prevention of organ damage and disability in the context of living with PCC, using pharmacological and non-pharmacological interventions (such as rehabilitation and clinical care models).

**6.3.4.** Document the impact of prior vaccination and use of antivirals such as monoclonal antibodies and Paxlovid™ on the risk of PCC development in various demographics and define the biologic basis.

**6.3.5.** Identify the reason why female sex is an independent risk factor for PCC.

**6.3.6.** Engage in behavioural and sociological research on effective public health communication strategies and messages to raise population-level awareness about PCC and prevention.

#### **6.4. *Clinical and translational research***

With the objective of promoting synergies and accelerating the transfer of new knowledge into health outcomes, promote collaboration between preclinical and clinical investigators and between researchers and practitioners within the framework of the research network noted above. Among others:

**6.4.1.** Advance diagnostic and biomarker development.

**6.4.2.** Support cohort studies with appropriate comparator groups to evaluate long-term health effects, including on aging and human development, as well as prognostic factors.

**6.4.3.** Determine effectiveness of treatments, including rehabilitation and physical therapy approaches, and clinical care models across the continuum of care and across different subpopulations.

**6.4.4.** Evaluate the effectiveness of teams led by people with lived experience and the impact of citizen science approaches in improving PCC care.

**6.4.5.** Ensure adequate physical and human infrastructure through sustainable capacity for interoperable data collection systems and biobanking (see also 6.1.1.2) This includes having data sharing and material transfer agreements in place as part of emergency preparedness in the spirit of transparency and open, secure science.

#### **6.5. *Socio-economic impact of PCC***

**6.5.1.** Collect data and support research related to accessibility of benefits and services, including for disability; impact on family life; and effects on the labour market for individuals suffering from PCC. Data required for modelling the ongoing and future socio-economic impact of PCC should also be dynamically collected and analyzed, including by Statistics Canada and the Bank of Canada.

**6.5.2.** Study the socio-economic impact across the life course (children, youth, middle years, the elderly), on women and their dependents who may bear the brunt of PCC impacts, and in marginalized population groups (e.g., Indigenous, racialized, homeless, etc.)

**6.5.3.** Collect data and analyze the current and projected impact of PCC on the health care workforce. More specifically, understand and mitigate the impact of PCC on health care workforce burnout within the broader study of causes and solutions of burnout in health care workers.

## **2. BROAD ACTIONS RELATED TO POST-COVID-19 CONDITION SOCIO-ECONOMIC POLICIES AND COMMUNICATION**

### **Socio-Economic Policies and Programs**

Individuals living with PCC can experience a variety of symptoms that occur in irregular or episodic patterns over time. Tailored supports and services through effective policies and programs are required to meet their needs, including those related to physical and/or cognitive impairment, recognizing the impact on families and the fact that females disproportionately suffer from PCC. Determining and addressing needs should consider equity, inclusivity and accessibility, and be done in partnership with persons with lived experience.

### **7. Update relevant policies and eligibility criteria to maximize the participation of people living with PCC in society, along with necessary supports and services.**

**7.1.** Develop best practices around flexible return to school and work policies that accommodate the episodic, medium-term, and long-term nature of PCC, in partnership with persons with lived experience as well as private and public sector partners.

**7.2.** Consider updating the requirements of short- and long-term disability, insurance claims, workers' compensation, social assistance and employment insurance as appropriate, to provide flexibility given the episodic and medium- to long-term nature of PCC.

### **8. Develop resources and tools that respond to the needs of people living with PCC, their caregivers and dependents, in partnership with persons with lived experience and community groups.**

**8.1.** Introduce community-level support resources and programs that help people living with PCC with everyday tasks.

**8.2.** Encourage employers to provide suitable accommodations (such as for resting and pacing themselves) for workers with physical and cognitive limitations due to PCC.

**8.3.** Enhance access to wellness programs and mental health support for individuals with PCC.

## Communication and Outreach

Effective and culturally sensitive PCC communication and outreach efforts are needed to maintain public trust, provide consistent messaging, help reduce stigma and protect vulnerable individuals from disinformation, profiteering and unauthorized treatments.

### **9. Acknowledge that PCC is real by raising awareness through outreach to citizens, schools and workplaces.**

- 9.1.** Develop PCC public awareness and outreach efforts through consistent and culturally sensitive messages, in partnership with patient and community groups.
- 9.2.** Provide public education on the risks of PCC and the importance of tools for preventing SARS-CoV-2 infection and PCC development.
- 9.3.** Provide proactive outreach and education to help people living with PCC make informed decisions about treatment options.
- 9.4.** Follow communication campaigns on PCC prevention with public health campaigns to increase the rates of vaccination and other pertinent public health measures across the country.

### **10. Develop and continuously update a web-based platform that lists available government services for individuals and families affected by PCC.** Local municipal and provincial sites along with patient associations may provide such information. A federal Health Portfolio PCC coordinating structure (see also recommendation 14) could collate links to local and provincial/territorial PCC supports through a federal website, thereby improving awareness and access.

### **11. Develop, regularly evaluate and adapt the effectiveness of PCC educational approaches for health care providers, particularly primary care.** Effective PCC educational activities should be promoted through Continuing Professional Development, the College of Family Physicians of Canada and the Royal College of Physicians and Surgeons of Canada.

### **12. Empower Canadians to make informed decisions about prevention of SARS-CoV-2 infection and PCC, as our knowledge of the condition improves.** Among others, make data available that facilitates individual risk assessment and use messages that emphasize the personal and collective benefits of individual actions.

### 3. FOUNDATIONAL ACTIONS RELATED TO INFRASTRUCTURE, SYSTEMS AND COORDINATION

#### Infrastructure, Systems and Coordination

Sustainable human and physical infrastructure and systems are foundational to support health and socio-economic management of PCC, including research and care to individuals and communities. All elements required for effective data monitoring systems and related infrastructure should be strengthened within and across jurisdictions. In addition, the physical environment of schools, institutions, workplaces and public spaces can support primary prevention and can help reduce ongoing transmission of infectious respiratory diseases and the development of PCC and other post-infection conditions. Coordination of PCC efforts is required domestically and internationally, given the various sectors and actors implicated. Shared commitment, collaborative and interoperable approaches to sample/data collection and sharing, while supporting open and secure science within a learning environment, are all required to effectively manage PCC and future pandemic threats.

**13. Establish a multidisciplinary scientific advisory council on infection-associated chronic conditions, in collaboration with the Office of the Chief Science Advisor, to support an integrated strategy.** In addition to providing updates on scientific developments and recommendations on synergies among various efforts, the council could provide advice to ensure that the infrastructure needed to address post-infection challenges is part of future pandemic preparedness.

**14. Set up a whole-of-government PCC coordination structure within the federal Health Portfolio to engage and coordinate with internal and external partners, including levels of government, the private sector and patient groups.**

**15. Enhance the timely capture and sharing of data and the use of state-of-the-art data analysis strategies for improving both the care of individuals and evidence-informed policy.**

**15.1.** Immediately implement the Pan-Canadian Health Data Strategy, in particular the recommendation to establish a harmonized pan-Canadian health data policy framework, which supports person-centred data that can be shared within an appropriate ethical-legal-social framework.

**15.2.** Contribute to ongoing readiness for pandemics by strengthening and streamlining monitoring systems across the health system and beyond, so there is a continuum from infectious disease outbreaks through to monitoring chronic (long-term) health effects.

**16. Strengthen the human, digital and physical infrastructure that interconnects and supports research, care and emergency preparedness.**

**16.1.** Work towards standards for research ethics board (REB) review that accelerate clinical studies, and the integration of findings for improved health policy and effective care.

**16.1.2.** Streamline REB review and establish a REB of record for multi-jurisdictional research.

**16.1.3.** Promote data sharing and data sharing agreements based on open and secure science between public health laboratories and researchers on priority research questions.

**16.1.4.** Align actions with legal and public health research ethics frameworks and work towards developing pan-Canadian consensus on data sharing guidelines.

**16.2.** Enhance biobanking capacities through sustainable funding and the development of sample sharing/material transfer agreements that can enable rapid collaborations for the management of acute infections and their post-acute illnesses, including PCC.

**16.3.** Provide an effective governance framework to enable readiness to address new and ongoing research needs for infectious diseases and their sequelae. Among others, enhance linkages between discovery research strengths in Canada and life sciences/biomanufacturing sectors to accelerate the development of new therapies and support multi-site clinical trials within and between provinces.

**17. Scale-up and monitor effective prevention interventions, such as improving ventilation in schools, long-term care homes, work and public places as part of a first line of prevention of SARS-CoV2 infection and other known and emerging respiratory/airborne pathogens.**

This can be achieved by improving and enforcing indoor air quality standards, such as through heating, ventilation, and air conditioning (HVAC) improvements, upper room ultraviolet germicidal irradiation or other approaches.

**18. Encourage innovation in PCC care models and evaluate them to inform future resilience in the health care system including the recruitment and retention of a thriving health care workforce.** A learning health care system must be organized in a way that makes health data available for research, evaluation, and quality improvement.

**18.1.** Establish learning collaboratives and scalable pilot studies, with provincial, territorial and academic health centers, to help address some of the major health challenges that may be worsened by PCC, such as human resources shortages and medical imaging backlogs. This will lead to scientific data that supports best practices in care and helps guide health system innovation.

**18.2.** Foster resilient learning health care systems through proactive evaluation of the effectiveness and quality of PCC interventions, taking an implementation science approach.

**18.3.** Consider multi-pronged approaches to PCC care that include case management and triage, treatment (medical and rehabilitative), self-management, education, and social support, including community and peer support.

**18.4.** At all levels of government, consider the needs of individuals who have or may develop PCC in the future as part of continuing to manage the current COVID-19 pandemic, as well as domestic efforts related to pandemic preparedness and health care reform.

## CONCLUSION AND PROSPECTIVE

SARS-CoV-2 continues to spread worldwide, and the COVID-19 pandemic continues to have a serious impact on individuals and communities. The development of highly effective vaccines has saved countless lives and changed the course of the disease and the pandemic. Vaccines continue to protect against hospitalization and death from COVID-19 even in the face of new virus variants that are increasingly resistant to vaccine-generated neutralizing antibodies. Together with the mounting evidence on the long-term health effects of SARS-CoV-2 infection, this is changing our view of COVID-19 from an acute to a chronic illness.

Acute infection in around 10-20% of individuals leads to a complex and, at times, debilitating chronic condition in some individuals, known as post-COVID-19 condition or long COVID. Additionally, it is increasingly evident that acute COVID-19 increases the risk for several chronic cardio-metabolic diseases, including diabetes, hypertension and arrhythmia. The long-term effect of COVID-19 on the nervous system is equally concerning with accumulating evidence that several common symptoms reported by individuals suffering from PCC, such as memory loss, blurred vision, mood disorders and neuropathies, may reflect irreversible cellular changes observed in aging or in some neurodegenerative disorders. Thus, PCC has the potential to become a mass-disabling event given the highly transmissible SARS-CoV-2 Omicron variant in circulation and the unpredictability of evolving future variants.

In Canada, there are almost 30 times more people living with long-term symptoms of a SARS-CoV-2 infection (1.4 million) than have tragically died from it (46,000) in the past three years. The number of individuals suffering from PCC may be an underestimate given the lack of a clear definition of PCC, the challenges of getting a COVID-19 diagnostic test at many times during the past three years, and the lack of diagnostic criteria and biomarkers for PCC. COVID-19 vaccines decrease the risk of PCC and as such are an important line of defence against both the acute and chronic illness caused by SARS-CoV-2.

Direct actions that improve PCC clinical practice and generate new knowledge through research are needed. Establishing PCC diagnostic criteria and clinical practice guidelines for health professionals would have immediate beneficial impacts. Accelerating research into the short- and long-term effects of virus entry into different cells and organs is vital for better understanding the basis of the acute and chronic phase of the disease and is a prerequisite for developing diagnostic markers and treatments for PCC. At the same time, clinical and population level studies to identify risk factors (i.e., who is more likely to develop a chronic condition after acute COVID-19) as well as preventative approaches to limit COVID-19 long-term sequelae are urgently needed. Patient care, using existing standards of care as well as repurposed therapeutics, needs to be integral to research efforts and vice versa to create a continuum of learning that accelerates translation of new knowledge into better health outcomes.

Managing PCC will benefit from lessons learned from other chronic illnesses and from the long-term effects of other infectious diseases. Several infectious agents are well known to cause chronic long-term health effects, starting with the acquired immunodeficiency syndrome (AIDS) caused by the human immunodeficiency virus (HIV). Several other infectious agents lead in some survivors to chronic health conditions, including cognitive, psychiatric, and physical. This is seen in some survivors of Ebola virus disease, MERS-CoV (another coronavirus), Hepatitis B and Epstein Barr Virus, to name a few. Additionally, some of the symptoms of PCC, like pain, fatigue and difficulty concentrating, are reminiscent of those experienced by individuals suffering from a chronic form of Lyme disease caused by the bacterium *borrelia burgdorferi*. There is also symptom overlap between PCC and myalgic encephalomyelitis, also known as chronic fatigue syndrome, a still poorly understood condition with possible infectious origin. Thus, a long-term integrated research strategy for infection-associated chronic conditions, including PCC, presents an opportunity to fast-track our understanding and systematically shed light on conditions that affect many Canadians now and in the future.

The COVID-19 pandemic has revealed many vulnerabilities in our health systems. PCC is putting added pressure on already exhausted health care providers and overloaded health care systems. It nonetheless presents a unique opportunity to test new care models and approaches, evaluate them and, if successful and as appropriate, use them as learnings to modernize and improve other aspects of the entire system.

The pandemic has also challenged our siloed approach to research, innovation and care by demonstrating the power of bringing governments, researchers and the private sector together from the outset in order to find solutions to an urgent need. The many successes witnessed in the development and deployment of life saving therapies and vaccines should inspire continued multidisciplinary collaboration to address PCC and other post-infectious chronic conditions. This includes the development of point of care diagnostics, broad acting antivirals and anti-inflammatory agents, as well as therapies targeting specific organs and diseases where there is persistent unmet clinical need.

PCC and other post-infectious debilitating conditions carry significant socio-economic impact. Social supports and services must be examined and readied for the post-acute phase of an outbreak or pandemic. Among other, effective policies and programs, including for mental health, must consider the non-linear course of disease progression and recovery to mitigate short- and long-term socio-economic impact. Flexible return to school and work policies, community supports, and access to disability supports that recognize the episodic nature of PCC should be enabled and would reduce isolation and help maximize participation in society. This in turn reduces the risk for long-term isolation and the ensuing physical and mental health issues for individuals suffering from PCC and similar long-term health problems associated with other acute infections.

Last but not least, as done for acute COVID-19, it is essential for Canada to remain in close contact with the international science, regulatory and clinical communities and networks. Many countries have developed or are in the process of developing roadmaps and strategies to address PCC and several international clinical trials are ongoing. As more is learned collectively, disease definition and clinical practice guidelines will need to be harmonized. Canadian researchers, health policy experts and health care providers must be encouraged to participate, and at times, lead in these endeavours.

The current pandemic is not the first, nor will it be the last. A legacy of learning from PCC and the current pandemic should include strengthening systems such as epidemiological surveillance, research readiness and coordination, as well as data collection and sharing. Combined with measures to reduce infectious disease transmission, notably through improved indoor air quality, and efforts to recruit, train and retain health care providers, these systems will serve to enhance our preparedness and response to future outbreaks and emergencies.



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### Task Force Members

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- Mona Nemer, PhD, Chief Science Advisor of Canada (**chair**)
- Roxane Borgès Da Silva, PhD, University of Montreal
- Angela Cheung, PhD, MD, FRCPC, Toronto General Hospital Research Institute
- Doug Gross, PhD, BScPT, University of Alberta
- Alan Katz, MBChB, MSc, CCFP, University of Manitoba
- Joanne Langley, MD, Dalhousie University
- Nazeem Muhajarine, PhD, MSc, University of Saskatchewan
- Srinivas Murthy, MD, B.C. Children's Hospital
- Kieran Quinn, MD, PhD, University of Toronto
- Allison Sekuler, PhD, University of Toronto
- Supriya Sharma, MD, Health Canada
- André Veillette, MD, Institut de recherches cliniques de Montréal (IRCM)
- Sarah Viehbeck, PhD, Public Health Agency of Canada
- Donald Vinh, MD, FRCPC, FACP, McGill University
- Rae Yeung, MD, PhD, Hospital for Sick Children
- Christian Baron, PhD, Canadian Institutes of Health Research (observer)
- Robert Geneau, PhD, Public Health Agency of Canada (observer)

Task Force consultative roundtables were held on August 11, August 18, August 25, September 8, September 15, September 22, and October 7, 2022.

*The Task Force invited additional subject matter experts to the following roundtables:*

### **Roundtables on Clinical Research and Practice held on August 11 and 18, 2022**

#### **Invited Subject Matter Experts\***

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- Husam Abdel-Qadir, MD, FRCPC, DABIM, University of Toronto (August 11)
- Susanne Basiuk, RN, Alberta Health Services (August 11)
- Laura Benard, PT, Alberta Health Services (August 18)
- Anne Bhéreur, MD, University of Montreal
- Simon Decary, PT, PhD, University of Sherbrooke
- Jessica DeMars, PT, Breathe Well Physio
- Emilia Falcone, MD, PhD, Institut de recherches cliniques de Montréal
- Alan J. Forster, MD, FRCPC, MSc, University of Ottawa (August 18)
- Gary Groot, MD, PhD, FRCSC, FACS, University of Saskatchewan
- Salim S. Hayek, MD, University of Michigan (August 11)
- Chester Ho, MD, University of Alberta (August 11)
- Thao Huynh, MD, PhD, McGill University
- Grace Lam, MD, PhD, University of Alberta
- Adeera Levin, MD, FRCPC, University of British Columbia (August 18)
- Peter Liu, MD, University of Ottawa (August 11)
- Manali Mukherjee, MSc., PhD, McMaster University
- Sharon Pierson, BScN, MPA, Hamilton Health Sciences (August 11)
- Cara Tannenbaum, MD, University of Montreal
- Carmela Tartaglia, MD, FRCPC, University of Toronto
- Karen Tran, MD, University of British Columbia
- Sze Man Tse, MD, FRCP, University of Montreal
- Anu Wadhwa, MD, University of Toronto

*\* participated in both meetings unless otherwise indicated*

## **Roundtable on Pathogenic and Mechanistic Pathways held on August 25, 2022**

### **Invited Subject Matter Experts**

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- Slava Epelman, MD, PhD, FRCPC, University of Toronto
- Eleanor Fish, PhD, University of Toronto
- Samira Mubareka, MD, FRCPC, Sunnybrook Health Sciences Centre
- Gavin Oudit, MD, PhD, University of Alberta
- Anne Claude Gingras, PhD, University of Toronto
- Josef Penninger, MD, PhD, University of British Columbia

## **Roundtable on Socio-Economic Impact held on September 8, 2022**

### **Invited Subject Matter Experts**

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- Lynn Barr-Telford, MA, Statistics Canada
- Noel Baldwin, Future Skills Centre
- Colleen M. Flood, PhD, University of Ottawa
- Dana Hirsh, JD, Schmidt Mediation Group
- Hal Koblin, BA, C.D. Howe Institute
- Kim Lavoie, PhD, FCPA, FABMR, University of Quebec in Montreal
- Louise Lemyre, PhD, University of Ottawa
- Parisa Mahboubi, PhD, C.D. Howe Institute
- Ellen Rafferty, PhD, Institute of Health Economics, Alberta Canada
- William B.P. Robson, ICD.D, C.D. Howe Institute
- Tingting Zhang, MA, C.D. Howe Institute

## **Roundtable on Health System Impact held on September 15, 2022**

### **Invited Subject Matter Experts**

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- Simon Decary, PT, PhD, University of Sherbrooke
- Carl-Ardy Dubois, PhD, University of Montreal
- Alan Forster, MD, University of Ottawa
- Donna Goodridge, RN, PhD, University of Saskatchewan
- Benita Hosseini, PhD, University Health Network
- Emily Jenkins, PhD, MPH, RN, University of British Columbia
- Kim Lavoie, PhD, FCPA, FABMR, Université du Québec à Montréal
- Cory (Cordell) Neudorf, MD, MHSc, FRCPC, University of Saskatchewan
- Beate Sander, PhD, University of Toronto
- Louis-Martin Rousseau, PhD, Université Polytechnique de Montréal
- Tom Wong, MD, MPH, CCFP, FRCPC, University of Ottawa, Indigenous Services Canada
- Rosalie Wyonch, MA, C.D. Howe Institute

## **Public Panel on Understanding the Lived Experience of Post-COVID-19 Condition held on September 22, 2022**

### **Invited Subject Matter Experts**

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- Anne Bhéreur, MD, CCMF(SP), FCMF, Université de Montréal,
- Carrie Anna McGinn, MSc.
- Susie Goulding, COVID Long-Haulers Canada, Long COVID Kids
- Cara Kaup, BScPT, Executive Board, Long-COVID Physio
- Hannah Wei, BSc, Long COVID Patient-Researcher
- Jonah McGarva, Long COVID Canada
- Adriana Patino, Long COVID Canada
- Manali Mukherjee, MSc., PhD, McMaster University
- Sarah Butson, MSc., Canadian Lung Association

## Roundtable on International Approaches held on October 7, 2022

### Invited Subject Matter Experts

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- Olalekan Lee Aiyegbusi, MBChB, PhD, University of Birmingham, UK
- Ziyad Al-Aly, MD, Washington University, USA
- Katie Bach, MBA, MSc., Brookings Institution, USA
- Matthew Burke, MD, University of Toronto, Canada
- Janet V Diaz, MD, World Health Organization, Switzerland
- Temeika Fairley, PhD, White House Office of Science and Technology Policy, USA
- Trish Greenhalgh, MD, University of Oxford, UK
- Charu Kaushic, PhD, McMaster University, Canada
- Avindra Nath, MD, National Institutes of Health, USA
- Pragna Patel, MD, MPH, Centers for Disease Control and Prevention, USA
- Jeremy Rossman, PhD, University of Kent, UK
- Dafna Yahav, MD, Sheba Medical Center, Israel
- Dana Yelin, MD, Tel Aviv University, Israel

### Observers:

- Taylor Morisseau, PhD Candidate, Chief Science Advisor's Youth Council Member, University of Manitoba, Canada
- Farah Qaiser, MSc., Chief Science Advisor's Youth Council Member, Evidence for Democracy, Canada

### Office of the Chief Science Advisor Support

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- Lori Engler-Todd, MSc.
- Masha Cemna, PhD
- Vanessa Sung, PhD
- Andreea-Diana Moisa, BSc.
- Mary Helmer-Smith, BSc., MSc. Candidate, University of British Columbia
- Melinaz Barati, BSc., MSc. Candidate, Queens University

## RESOURCES

The following is a compilation of select references and resources related to Post-COVID-19 Condition.

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## ANNEX 1

In addition to the term “Post-COVID-19 Condition” used in this report (see World Health Organization-Clinical Case Definition below), there are other definitions and criteria used to describe persistent and lasting symptoms after acute COVID-19 infection. These include: “Chronic COVID-19 syndrome”, “Late-sequelae of COVID-19”, “Post-acute sequelae of COVID-19”, “Post COVID conditions”, “Long-haul COVID-19”, “Post-acute COVID-19 syndrome” and “Long COVID”.

Other definitions and criteria for PCC include:

1. Public Health Agency of Canada: “Post COVID-19 Condition” is defined as physical or psychological symptoms more than 12 weeks after contracting COVID-19. PCC symptoms may occur in some people weeks or months after initial infection.
2. US Centres for Disease Control and Prevention (CDC): The CDC uses the term “post-COVID conditions” (PCC) as an umbrella term for the wide range of health consequences that can be present four or more weeks after infection with SARS-CoV-2, the virus that causes COVID-19.
3. World Health Organization Clinical Case Definition: “Post COVID-19 condition” occurs in individuals with a history of probable or confirmed SARS CoV-2 infection, usually 3 months from the onset of COVID-19 with symptoms that last for at least 2 months and cannot be explained by an alternative diagnosis. Common symptoms include fatigue, shortness of breath, cognitive dysfunction, but also others which generally have an impact on everyday functioning. Symptoms may be new onset following initial recovery from an acute COVID-19 episode or persist from the initial illness. Symptoms may also fluctuate or relapse over time. A separate definition may be applicable for children.
4. UK National Institute for Health and Care Excellence: Criteria to identify and diagnose long-term effects of COVID-19:
  - Acute COVID-19: Signs and symptoms of COVID-19 for up to 4 weeks.
  - Ongoing symptomatic COVID-19: Signs and symptoms of COVID-19 from 4 weeks up to 12 weeks.
  - Post-COVID-19 syndrome: Signs and symptoms that develop during or after an infection consistent with COVID-19, continue for more than 12 weeks and are not explained by an alternative diagnosis. It usually presents with clusters of symptoms, often overlapping, which can fluctuate and change over time and can affect any system in the body. Post-COVID-19 syndrome may be considered before 12 weeks while the possibility of an alternative underlying disease is also being assessed.