

# RESEARCH REPORT



## Battery Powered Lift for Disabled Persons



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Battery Powered Lift for  
Disabled Persons

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## ABSTRACT

A prototype of a lift for the disabled was tested in a clinical trial conducted by two occupational therapists and the lift's engineer developer. Six severely disabled and five non-disabled persons (attendants and health care professionals) used the lift in the test setting for a variety of transfers. Subsequently, each person completed an interview questionnaire evaluation with the therapists and engineer. The lift was very positively evaluated by all participants and they regarded it as having distinct advantages over any currently available lifts. Results of the trial suggested a number of minor modifications as well as the need for specific revisions to the sling, and it is recommended that this be followed by further testing of this component.

## PURPOSE

The purpose of this clinical trial was to provide an opportunity for potential disabled consumers and health care professionals to observe, try out, evaluate, and comment on a prototype for a unique, newly developed patient lifting aid. The information obtained will be used by the developer to modify and improve the lift design as a viable and marketable assistive device for the physically disabled.

## METHODS

### 1. Subjects:

A total of twelve subjects known to the occupational therapist were identified based on criteria including;

- a) that their level of disability was similar to that of the population that the lift is designed for, and
- b) that they and their attendants could be counted on to give open and discerning feedback.

These individuals were approached by the therapist, the trial was explained to them, and they were asked if they were willing to participate. Of the twelve, six were able to participate. Two were unable to take part due to timetable conflicts, two became ill the day before testing, one was hospitalized during the testing period, and one individual declined to participate stating they were "too modest" and did "...not want to try strange equipment in a strange place with strangers watching."

The occupational therapist provided any assistance required by the subjects as far as arranging and booking transportation or the Bus for the Handicapped.

Table 1 describes the disabled subjects.

In summary, the disabled sample included three males and three females. Of these, two had multiple sclerosis, two had muscular dystrophy, and two were quadriplegics. All were between the ages of 30 and 60. Three participants were accompanied by their attendants who also took part in the lift evaluation and completion of the questionnaire. One of the attendants also tried the lift.



Subject	Age	Sex	Body Build	Diagnosis
1	42	F	Medium height, very obese.	Muscular dystrophy
2	56	F	Tall, thin.	Multiple sclerosis
3	39	M	Medium height, thin.	Multiple sclerosis
4	60	M	Medium height, medium weight.	Quadriplegic
5	45	F	Medium height, thin.	Friedreich's Ataxia (M.D. classification)
6	32	M	Tall, very obese.	Quadriplegia.

Table 1. Description of Disabled Participants.

In addition to the disabled portion of the sample, 5 physically able health care professionals used and assessed the lift and completed the questionnaire evaluation. There was a total of 12 evaluations completed in the clinical trial.

## 2. Setting:

The trials were all conducted in the Queen's University School of Rehabilitation Therapy. The setting was selected as it was reasonably convenient for all subjects, and is wheelchair accessible. It also has a therapeutic laboratory ideally suited to transfer assessment as it contains a hospital bed, toilet, and bathtub. The simulated domestic type construction frame, built by the lift developer to suspend the lift, could be set up and remain in this lab for the trial period. A six inch raised toilet seat and padded, backed bath bench were rented to be available if needed for specific transfers. ✓

## 3. Questionnaire:

The evaluation questionnaire (see Appendix A) was designed by the two occupational therapists. Item selection was based on their clinical experience in assistive device prescription, design, evaluation, and user education. The questionnaire is designed to be administered by interview. It has a section for comments and a 5 point Likert scale can be used to generate a numerical score.

#### 4. Trials Protocol:

Each subject attended a scheduled 1-1.5 hour assessment session with the two occupational therapists and the engineer. Their attendants or primary caregivers were encouraged to participate and give feedback.

On arrival each subject was reminded that the goal of the session was to elicit their honest and open reactions and feedback about the lift. It was emphasized to them that the lift is still in its development phase and it is particularly useful for the designer to hear their criticisms and concerns at this time.

The evaluation form was shown to the subjects as a guide to the areas they might consider when evaluating the lift. Next, the lift was demonstrated by the therapists. If, after the demonstration, the subject or the attendants wished to try the lift, they were encouraged to do so. All of the subjects indicated that they wanted to try the lift.

Discussion, feedback, problem identification, and problem-solving took place among the subjects, attendants, therapists, and engineer throughout each trial. Following the trial the evaluation form was completed in an informal interview conducted by the therapists (see Appendix B for copies of the original scored interviews).

#### RESULTS

Table 2 presents a summary of the averaged results of the Likert scale scores on the questionnaire. In order to avoid possible skewing due to unanswered questions, all scores have been calculated as percentages of the total questions answered. Analysis consisted of averaging all respondents' scores for each item, summing them, and converting to percentage scores. Higher percent scores reflect a more positive evaluation of that aspect of the lift. Appendix C contains averages for individual items on the evaluation form.

Table 2. Average Evaluation Scores N=9

---

Design Features	90%
Ergonomics	73%
Specific Transfers	92%
Attendant Assisted Use	90%
Feasibility	78%

---

## DISCUSSION OF THE RESULTS

The results are discussed under the four headings used in the questionnaire; design features, ergonomics, specific transfers, and feasibility.

### 1. Design Features:

Generally, the lift performed extremely well in this category. Appearance and cosmesis were consistently scored as excellent. The only comment regarding speed was from one of the less disabled individuals who felt it was too slow. However, it is the investigators' opinion that a faster speed would be unsafe for the large majority of users.

Very few subjects commented on the noise of the lift. However, the investigators believe that the lift motor sounds noticeably stressed as it operates. While it in fact performed very well, we think the sound of the motor is a problem sufficient to deter prospective buyers. If the operating parts cannot be modified, then perhaps the pitch of the noise can be deepened in some way, or soundproofing material could be used to line the housing.

### 2. Ergonomics:

In this report the ergonomics of the device refer to the compatibility of the technology and design with the characteristics of the user. Any assistive device for the physically disabled presents complex ergonomic challenges due to the tremendous range in potential users. Persons desiring to use this

lift could range from physically disabled persons of all ages and sizes, with or without cognitive or perceptual impairments, who want to use the lift independently,... to attendants and primary caregivers of all ages and sizes, with varying cognitive and perceptual abilities, who will use the lift to assist someone. It is not possible for any one design to meet all of these needs. However, some are more critical and universal than others and they will be discussed here.

In most aspects the lift performed very satisfactorily from an ergonomics point of view. It was easy for the subjects and their attendants to understand and learn how to operate the lift. Most believed that a child, provided they were tall enough and strong enough to apply the sling, could assist a disabled person to transfer using the lift. Even when loaded there was minimal friction on the track and it was easy to slide the individual across. It is important to position the sling well under the individual's upper legs in order to provide adequate support. This can be difficult if the legs are heavy, and the subject's ability to do a push-up to lift their buttocks off the seat makes it much easier to slide the sling under them.

The clinical trial was particularly useful in identifying problems and possible solutions related to the sling. The sling design works reasonably well with slightly built, short or medium height persons but should be re-fashioned so as to sit them in greater hip flexion. This will better secure them in the sling and the increased hip flexion is an inhibiting posture for persons prone to dangerous extensor spasms. Also the neck line was noted to be too high for this group as they complained of it digging into the back of their heads and necks. Areas of high pressure caused discomfort about the legs for some. This seemed to be entirely due to a combination of the cut of the sling, the way it is designed to be worn (crossed between the legs versus slung under them, versus pulling the legs apart into hip abduction), and the location of the loops. In some cases the discomfort could be remedied by tugging and rearranging the sling once on. Before making drastic changes to the design, it is important to note that all of the subjects and attendants were using the sling for the first time. As with any piece of new equipment, each person takes time and practice to develop a technique that works for them.

The sling did not fit tall or obese persons satisfactorily. It tended to bunch under the legs and in the crotch and the associated pressure was painful for those with sensation and could cause skin damage to those without. The sling problems with this group were the same as with the smaller statured subjects, only intensified due to larger and heavier bodies and limbs.

A biomechanist, Dr. S. Olney, was asked to consult specifically on sling design during one of the trials. Among her suggestions was the need to lengthen the support arm of the sling under the upper leg and to stiffen the point of attachment of the leg loop to deter the sling from bunching under the leg. By extending support more distally under the upper leg the torque about the hip, and the tendency for the hip to fall into extension, will be reduced.

It may be impossible to design a sling for universal fit. The result may be a variety of sizes, or a few standard sizes with the possibility of custom design if needed.

The loops on the sling could be colour coded to avoid confusion when attaching them. One subject suggested a stiffening wire be inserted into the loops to make them easier to manage for those with reduced finger dexterity.

This lift appears to offer exciting opportunities for some severely disabled persons to transfer independently. However, it is the opinion of the investigators that this will depend very much on the abilities of individual users and their environments. There are no feasible major design changes that would universally improve the possibility of independent operation, without trade-offs with existing positive features of the lift.

### 3. Specific Transfers

The lift performed well for all transfers. As with all patient lifts, each person would have to work out their own system of getting clothing on and off to use the toilet. Sling application that adducts the hips (brings the legs together) would make tub transfers easier than the present hip abduction design. Independent operation of the lift would be improved by a cord hanging at either end of the track so that the person could grasp and pull themselves across. Once transferred across, independent users had difficulty seeing whether they were safely positioned over the seat before they lowered themselves onto it. A mirror on the wall, landmark cues, practice, and caution seem to be reasonable solutions to this problem.

#### 4. Feasibility

Subjects were very excited about this lift and all felt they could and would use it were available. Maintenance protocols, and procedures in the event of battery/motor failure were explained and all indicated they were satisfied with these. The durability of the sling was questioned by some as it began to tear at a loop insertion during the later trials. An emergency system should be recommended to those intending to use the lift independently (e.g. alarm bell, call system). The cost concerned some subjects and this depended very much on their own financial situation and whether they thought they would be candidates for funding assistance to purchase a lift. It is suggested that the cost of track installation be separate from the price of the lift so that those who wish can organize their own installation to save money. All could see the lift being useful in many situations and settings, provided the track was in place. This lead a number of subjects to indicate that a free standing frame would be particularly useful for those wishing to travel. Also, questions were raised as to the feasibility of a hook for short transfers instead of ceiling track.

A summary of the advantages and disadvantages suggested by all subjects in answer to item 9 is as follows:

##### Advantages:

- the lift precludes the need to own a second lift since as long as track is installed in the workplace etc. the person can carry the unit with them in their wheelchair bag.
- the lift is out of the way unlike the large frame lifts.
- it is slightly less expensive than many of the available lifts.
- the lift does not require clearance under beds as do the frame lifts. Many beds do not have sufficient clearance for the other types of lifts.
- the lift is simpler to operate than other lifts.
- this lift is far more compact than other lifts.
- it is not "anxiety provoking" as are the frame type lifts.
- it is more versatile for various age groups to be attendants.
- maintenance is simple and the failure procedures are good.
- it is far more portable than other lifts.
- it is easier to operate than other lifts.

##### Disadvantages

- depending on body size and weight, the sling does not fit well and is not always comfortable.

- the motor sounds stressed when lifting and this can undermine one's confidence in the unit.
- while the track is one of the lift's positive features (no storage space, no obvious "equipment") the availability of tracking will limit portability and in the long term availability of an optional portable frame would be ideal.

## CONCLUSION

The results of the clinical trial indicate that this lift prototype performs very well and is viewed by consumers and health care professionals as significantly superior in many ways to currently marketed lifts. The unique concept fills a number of requirements that other lifts do not. It appears to require modification of two aspects in order to improve its safety, appeal, and marketability. The sling needs revision of a number of features, and ideally the altering of the sound of the motor in some way would improve perceived reliability of the lift. Sling design is a difficult but critical aspect of a lift and once modifications have been done further testing is advised on various body shapes and sizes.

## Appendix A

### PATIENT LIFT PROTOTYPE CONSUMER AND OCCUPATIONAL THERAPIST EVALUATION

Trial No. \_\_\_\_\_

Disability: \_\_\_\_\_

Transfer requirements: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

SCORING: 1= very poor, 2= poor, 3= fair, 4= good, 5= excellent

#### COMMENTS

#### A: DESIGN FEATURES

- |                                      |           |
|--------------------------------------|-----------|
| 1. Appearance and cosmesis:          | 1 2 3 4 5 |
| 2. Noise:                            | 1 2 3 4 5 |
| 3. Speed of lifting/lowering action: | 1 2 3 4 5 |

---

15

#### B. ERGONOMICS: (human/technology match)

- |  |           |
|--|-----------|
| 1. Comfort:  | 1 2 3 4 5 |
| 2. Comprehension required:   | 1 2 3 4 5 |
| 3. Ease of operation: a) independent:  | 1 2 3 4 5 |
| b) attendant:  | 1 2 3 4 5 |
| 4. Safety a) perceived:  | 1 2 3 4 5 |
| b) actual:   | 1 2 3 4 5 |
| 5. Potential to damage skin:   | 1 2 3 4 5 |
| 6. Allowance for specific features common to severely disabled:<br>e.g. urinary drainage systems, ?? | 1 2 3 4 5 |

#### 7. Acceptable functional capacities required for independent operation:

- |                          |           |
|--------------------------|-----------|
| a) range of motion:      | 1 2 3 4 5 |
| b) arm strength:         | 1 2 3 4 5 |
| c) hand function:        | 1 2 3 4 5 |
| d) muscle tone:          | 1 2 3 4 5 |
| e) head control:         | 1 2 3 4 5 |
| f) co-ordination:        | 1 2 3 4 5 |
| g) perception/cognition: | 1 2 3 4 5 |
| h) sensation:            | 1 2 3 4 5 |
| i) other:                |           |



8. Acceptable functional capacities required for attendant operation:

- a) by child: 1 2 3 4 5  
b) by adult: 1 2 3 4 5  
c) by elderly or infirm adult: 1 2 3 4 5

-----  
95

C. SPECIFIC TRANSFERS

1. Sling on/off: a) independently: 1 2 3 4 5  
b) by attendant: 1 2 3 4 5

2. Bed <-> Wheelchair: 1 2 3 4 5

3. Wheelchair <-> Tub: 1 2 3 4 5

4. Wheelchair <-> Toilet: 1 2 3 4 5

-----  
25

5. Other:

D. FEASIBILITY

1. Maintenance (wash, lubricate, battery charge): 1 2 3 4 5

2. Procedure if battery/motor fails: 1 2 3 4 5

3. Applicability (settings where feasible): 1 2 3 4 5

4. Adaptability (usable with frame from other lifts?): 1 2 3 4 5

5. Portability (ease of transport): 1 2 3 4 5

6. Durability: a) home: 1 2 3 4 5  
b) institutional: 1 2 3 4 5

7. Cost: 1 2 3 4 5

8. General feasibility for independent operations: 1 2 3 4 5

9. Advantages/disadvantages over other attendant operated lifts: 1 2 3 4 5

-----  
50  
Total= /185

PATIENT LIFT PROTOTYPE  
CONSUMER AND OCCUPATIONAL THERAPIST EVALUATION

Trial No. 1: J-4.

Disability: M.D.

Transfer requirements: home, travels (incl. Caribbean)

SCORING: 1= very poor, 2= poor, 3= fair, 4= good, 5= excellent

COMMENTS

A: DESIGN FEATURES

- |                                      |           |
|--------------------------------------|-----------|
| 1. Appearance and cosmesis:          | 1 2 3 4 5 |
| 2. Noise:                            | 1 2 3 4 5 |
| 3. Speed of lifting/lowering action: | 1 2 3 4 5 |

---

15

B. ERGONOMICS: (human/technology match)

- |   |           |
|---|-----------|
| 1. Comfort:   | 1 2 3 4 5 |
| 2. Comprehension required:  | 1 2 3 4 5 |
| 3. Ease of operation: a) independent:   | 1 2 3 4 5 |
| b) attendant: loops too small.  | 1 2 3 4 5 |
| 4. Safety a) perceived:   | 1 2 3 4 5 |
| b) actual: harness problem to sling N/A   | 1 2 3 4 5 |
| 5. Potential to damage skin: Sturdiness? She's unsure of sturdiness of sling  | 1 2 3 4 5 |
| 6. Allowance for specific features common to severely disabled:<br>e.g. urinary drainage systems, ?? she thinks its ok. | 1 2 3 4 5 |

7. Acceptable functional capacities required for independent operation:

- |                          |           |                         |
|--------------------------|-----------|-------------------------|
| a) range of motion:      | 1 2 3 4 5 | too close for her hands |
| b) arm strength:         | 1 2 3 4 5 |                         |
| c) hand functions:       | 1 2 3 4 5 |                         |
| d) muscle tone:          | 1 2 3 4 5 |                         |
| e) head control:         | 1 2 3 4 5 |                         |
| f) co-ordination:        | 1 2 3 4 5 |                         |
| g) perception/cognition: | 1 2 3 4 5 |                         |
| h) sensation:            | 1 2 3 4 5 |                         |
| i) other:                |           |                         |

8. Acceptable functional capacities required for attendant operation:

- a) by child: 1 2 3 4 (5)  
 b) by adults: 1 2 3 4 (5)  
 c) by elderly or infirm adult: 1 2 3 4 (5)

95

C. SPECIFIC TRANSFERS

1. Sling on/off: a) independently:  
 b) by attendant:

1 2 3 4 5  
 1 2 3 4 5

2. Bed <-> Wheelchair:

1 2 3 4 5

3. Wheelchair <-> Tub:

1 2 3 4 5

4. Wheelchair <-> Toilet:

1 2 3 4 5

5. Other:

25

N/A due to shag

D. FEASIBILITY

1. Maintenance (wash, lubricate, battery charge): (plugged in each night ~10 transfers)  
 machine wash, hang dry.

1 2 3 4 (5)

2. Procedure if battery/motor fails:

1 2 3 4 (5)

3. Applicability (settings where feasible): own home.

1 2 3 4 (5)

4. Adaptability (usable with frame from other lifts?):

1 2 3 4 5

5. Portability (ease of transport):

1 2 3 4 (5)

6. Durability: a) home:

1 2 3 4 (5)

- b) institutional:

1 2 3 4 (5)

? wear where strap comes out of plastic.

7. Cost: ~\$2500.00

1 2 3 4 (5)

8. General feasibility for independent operation: due to shag & position of unit:

(1) 2 3 4 5

9. Advantages/disadvantages over other attendant operated lifts:

1 2 3 (5)

Adv

Dis

- out of the way  
unlike Hoyer.
- a little cheaper.
- can deal w  
no clearance  
under beds.
- 11.25 L.C.R.

Total= 50 / 185

PATIENT LIFT PROTOTYPE  
CONSUMER AND OCCUPATIONAL THERAPIST EVALUATION

Trial No. 2 A.S.

Disability: \_\_\_\_\_

Transfer requirements: apartment & mobile home

SCORING: 1= very poor, 2= poor, 3= fair, 4= good, 5= excellent

COMMENTS

A: DESIGN FEATURES

1. Appearance and cosmesis: *far better than others.* 1 2 3 4 (5)
2. Noise: *fix the plate pounding. Would the sound carry?* 1 2 3 (4) 5
3. Speed of lifting/lowering action: *if anything was too slow.* 1 2 3 (4) 5

15

B. ERGONOMICS: (human/technology match)

1. Comfort: *too tight under thighs. Tight behind neck in supine. Slings under legs.* 1 (2) 3 4 5
2. Comprehension required: *loops could be source of confusion.* 1 2 3 4 (5)
3. Ease of operation: a) independent: *loops.* ~~1 2 3 4 5~~  
b) attendant: *loops.* 1 2 3 (4) 5
4. Safety a) perceived: *when it engaged it sounds like well quit* (1) 2 3 (4) 5  
b) actual: 1 2 3 4 (5)

5. Potential to damage skin: *too tight on skin: slings under legs* (1) 2 3 4 5

6. Allowance for specific features common to severely disabled: 1 2 3 (4) 5

e.g. urinary drainage systems, *?(braces), clothing removal for toileting same as other lifts. (slings only)*

7. Acceptable functional capacities required for independent operation:

- a) range of motion: 1 2 3 4 5
- b) arm strength: 1 2 3 4 5
- c) hand function: 1 2 3 4 5
- d) muscle tone: 1 2 3 4 5
- e) head control: 1 2 3 4 5
- f) co-ordination: 1 2 3 4 5
- g) perception/cognition: 1 2 3 4 5
- h) sensation: 1 2 3 4 5
- i) others:

8. Acceptable functional capacities required for attendant operation:

- a) by child: 1 2 3 4 (5) *light will limit*  
 b) by adult: 1 2 3 4 (5)  
 c) by elderly or infirm adult: 1 2 3 4 (5)

95

C. SPECIFIC TRANSFERS

1. Sling on/off: a) ~~independently~~ *technique*  
 b) by attendant: (3) *to explain*

~~1 2 3 4 5~~  
 1 2 3 4 (5)

2. Bed <-> Wheelchair:

1 2 3 4 5

3. Wheelchair <-> Tub:

1 2 3 4 5

4. Wheelchair <-> Toilet: *getting pants down.*

1 2 3 4 5

25

5. Other: *w/c <-> big chair*

- *concerns re finding ceiling adequate supports.*
- *portable frame?*

D. FEASIBILITY

1. Maintenance (wash, lubricate, battery charge):

1 2 3 4 (5)

2. Procedure if battery/motor fails: *supply grease from manufacturer*

1 2 3 4 (5)

3. Applicability (settings where feasible): *Not mobile home.*

1 2 3 4 5

4. Adaptability (usable with frame from other lifts?): *as long as ceiling strong enough.*

1 2 3 4 5

5. Portability (ease of transport):

1 2 3 4 5

6. Durability: a) home:

1 2 3 4 5

b) institutional:

1 2 3 4 5

7. Cost: *for him to back pain he may have no choice.*

1 2 3 4 (5)

8. General feasibility for independent operation:

(1) 2 3 4 5

9. Advantages/disadvantages over other attendant operated lifts:

1 2 3 4 (5)

- *size of others too big, anxiety provoking*
- *one unit can serve several places in house.*

Total= 50 / 185

PATIENT LIFT PROTOTYPE  
CONSUMER AND OCCUPATIONAL THERAPIST EVALUATION

Trial No. 3 B.B.

Disability: M.S.

Transfer requirements: home. independent.

SCORING: 1= very poor, 2= poor, 3= fair, 4= good, 5= excellent

COMMENTS

A: DESIGN FEATURES

- |  |                  |
|--|------------------|
| 1. Appearance and cosmesis:                          | 1 2 3 <u>4</u> 5 |
| 2. Noise: <i>a bit noisy.</i>                        | 1 2 3 <u>4</u> 5 |
| 3. Speed of lifting/lowering action: <i>too slow</i> | 1 2 3 <u>4</u> 5 |

15

B. ERGONOMICS: (human/technology match)

- |   |  |
|---|--|
| 1. Comfort: <i>cross over medial loops to</i>   | 1 <u>2</u> 3 4 5                         |
| 2. Comprehension required: <i>Harness 2 machinery 5</i>   | 1 2 3 4 <u>5</u>                         |
| 3. Ease of operation: a) independent: <i>add long string or rope so he can pull self across.</i><br>b) attendant: | 1 2 3 4 <u>5</u><br><del>1 2 3 4 5</del> |
| 4. Safety a) perceived:   | 1 2 3 <u>4</u> 5                         |
| b) actual:  | 1 2 3 4 <u>5</u>                         |
| 5. Potential to damage skin:  | 1 2 <u>3</u> 4 5                         |
| 6. Allowance for specific features common to severely disabled:<br>e.g. urinary drainage systems, ??              | 1 2 <u>3</u> 4 5                         |
| 7. Acceptable functional capacities required for independent operation:   |  |
| a) range of motion:   | 1 2 <u>3</u> 4 5                         |
| b) arm strength:  | 1 2 3 <u>4</u> 5                         |
| c) hand function:   | 1 2 <u>3</u> 4 5                         |
| d) muscle tone:   | 1 2 3 <u>4</u> 5                         |
| e) head control:  | 1 <u>2</u> 3 4 5                         |
| f) co-ordination:   | 1 2 3 <u>4</u> 5                         |
| g) perception/cognition:  | 1 2 3 <u>4</u> 5                         |
| h) sensation:   | 1 2 3 <u>4</u> 5                         |
| i) other:   |  |

*hand function - loops*

8. Acceptable functional capacities required for attendant operation:

- a) by child: 1 2 3 4 5  
 b) by adult: 1 2 3 4 5  
 c) by elderly or infirm adult: 1 2 3 4 5

95

C. SPECIFIC TRANSFERS

1. Sling on/off: a) independently: *on hand / off ok.*  
 b) by attendant:

1 2 3 4 5  
~~1 2 3 4 5~~

2. Bed <-> Wheelchair:

1 2 3 4 5

3. Wheelchair <-> Tub:

} NA

1 2 3 4 5

4. Wheelchair <-> Toilet:

1 2 3 4 5

25

5. Other:

D. FEASIBILITY

1. Maintenance (wash, lubricate, battery charge):

1 2 3 4 5

2. Procedure if battery/motor fails:

1 2 3 4 5

3. Applicability (settings where feasible):

1 2 3 4 5

4. Adaptability (usable with frame from other lifts?): *? open hook.*

1 2 3 4 5

5. Portability (ease of transport):

1 2 3 4 5

6. Durability: a) home: *couldn't assess.*  
 b) institutional:

1 2 3 4 5

1 2 3 4 5

7. Cost:

1 2 3 4 5

8. General feasibility for independent operation:

1 2 3 4 5

9. Advantages/disadvantages over other attendant operated lifts:

1 2 3 4 5

- *sling not great.*
- *he doesn't have an att operated lift*
- *so no opinion.*

Total=

50  
 /185

PATIENT LIFT PROTOTYPE  
CONSUMER AND OCCUPATIONAL THERAPIST EVALUATION

Trial No. 5. J.M.

Disability: E. Ataxia

Transfer requirements: pub, right down into tub.

? could use when alone

SCORING: 1= very poor, 2= poor, 3= fair, 4= good, 5= excellent

COMMENTS

A: DESIGN FEATURES

- |                                      |                  |
|--------------------------------------|------------------|
| 1. Appearance and cosmesis:          | 1 2 <u>3</u> 4 5 |
| 2. Noise:                            | 1 2 <u>3</u> 4 5 |
| 3. Speed of lifting/lowering action: | 1 2 <u>3</u> 4 5 |

15

B. ERGONOMICS: (human/technology match)

- |  |   |  |
|--|---|--|
| 1. Comfort:  | <u>heel. Prefers pressure on shoulders.</u> | 1 2 <u>3</u> 4 5                             |
| 2. Comprehension required:   |   | 1 2 3 4 <u>5</u>                             |
| 3. Ease of operation: a) independent:  | <u>loops too small.</u>                     | 1 2 3 <u>4</u> 5                             |
| b) attendant:  |   | 1 2 3 4 <u>5</u>                             |
| 4. Safety a) perceived:  |   | 1 2 3 <u>4</u> 5                             |
| b) actual:   |   | 1 2 3 4 <u>5</u>                             |
| 5. Potential to damage skin:   |   | 1 2 3 4 <u>5</u>                             |
| 6. Allowance for specific features common to severely disabled:<br>e.g. urinary drainage systems, ?? |   | 1 2 3 4 5                                    |
| 7. Acceptable functional capacities required for independent operation:                              |   |  |
| a) range of motion:  | 1 2 3 4 5                                   |  |
| b) arm strength:   | 1 2 3 4 5                                   |  |
| c) hand functions:   | 1 2 3 4 5                                   | <u>loops different.</u>                      |
| d) muscle tone:  | 1 2 3 4 5                                   | <u>thing would need to be left under her</u> |
| e) head control:   | 1 2 3 4 5                                   |  |
| f) co-ordination:  | 1 <u>2</u> 3 4 5                            |  |
| g) perception/cognition:   | 1 2 3 4 5                                   |  |
| h) sensation:  | 1 2 3 4 5                                   |  |
| i) other:  |   |  |

Increase flexion in case of extension out.  
hough distance track.



8. Acceptable functional capacities required for attendant operation:

- a) by child: 1 2 3 4 ⑤ yrs.  
 b) by adult: 1 2 3 4 ⑤  
 c) by elderly or infirm adult: 1 2 3 4 ⑤

95

C. SPECIFIC TRANSFERS

1. Sling on/off: a) independently: *thinks she could do indep*  
 b) by attendant:

1 2 3 4 5  
 1 2 3 4 ⑤

2. Bed (-) Wheelchair:

1 2 3 4 ⑤

3. Wheelchair (-) Tub:

1 2 3 ④ 5

4. Wheelchair (-) Toilet: *maybe too slow? Clothing on/off.*

1 2 ③ 4 5

25

5. Other:

D. FEASIBILITY

1. Maintenance (wash, lubricate, battery charge):  
*- very small recharges*

1 2 3 4 ⑤

2. Procedure if battery/motor fails:

1 2 3 4 ⑤

- emergency bell; dependent on calling someone for crash.*

3. Applicability (settings where feasible):

1 2 3 4 ⑤ 2b

4. Adaptability (usable with frame from other lifts?): *No.*

~~1 2 3 4 5~~

5. Portability (ease of transport):

1 2 3 4 ⑤

6. Durability: a) home:

1 2 3 4 ⑤

- b) institutional:

1 2 3 4 5

7. Cost:

1 2 3 ④ 5

8. General feasibility for independent operation: *slings & loops.*

1 2 3 4 ⑤

9. Advantages/disadvantages over other attendant operated lifts:  
*smaller, more versatile,*

1 2 3 4 ⑤

Total= 50 / 185

*- some type of frame for travel - espec tub - freestanding*

*- make installation separate cost from lift*

*so companies can't make extra \$ on that phase.*

*- excludes need for 2nd lift b/c could take it on hand*

PATIENT LIFT PROTOTYPE  
CONSUMER AND OCCUPATIONAL THERAPIST EVALUATION

Trial No. \_\_\_\_\_

Disability: able bodied

Transfer requirements: Health care professional

SCORING: 1= very poor, 2= poor, 3= fair, 4= good, 5= excellent

COMMENTS

A: DESIGN FEATURES

- |                                      |           |
|--------------------------------------|-----------|
| 1. Appearance and cosmesis:          | 1 2 3 4 5 |
| 2. Noise:                            | 1 2 3 4 5 |
| 3. Speed of lifting/lowering action: | 1 2 3 4 5 |

15

B. ERGONOMICS: (human/technology match)

- |  |                        |
|--|------------------------|
| 1. Comfort: <u>different sling sizes, or simply adjustable strap lengths would be needed</u>         | 1 2 3 4 5              |
| 2. Comprehension required:   | 1 2 3 4 5              |
| 3. Ease of operation: a) independent: <u>depends on user</u><br>b) attendant:                        | 1 2 3 4 5<br>1 2 3 4 5 |
| 4. Safety a) perceived:<br>b) actual:  | 1 2 3 4 5<br>1 2 3 4 5 |
| 5. Potential to damage skin:   | 1 2 3 4 5              |
| 6. Allowance for specific features common to severely disabled:<br>e.g. urinary drainage systems, ?? | 1 2 3 4 5              |
| 7. Acceptable functional capacities required for independent operation:                              |                        |
| a) range of motion:  | 1 2 3 4 5              |
| b) arm strength:   | 1 2 3 4 5              |
| c) hand functions:   | 1 2 3 4 5              |
| d) muscle tone:  | 1 2 3 4 5              |
| e) head controls:  | 1 2 3 4 5              |
| f) co-ordination:  | 1 2 3 4 5              |
| g) perception/cognition:   | 1 2 3 4 5              |
| h) sensation:  | 1 2 3 4 5              |
| i) other:  |                        |

8. Acceptable functional capacities required for attendant operation:
- a) by child: 1 2 3 ④ 5 over 8 years
  - b) by adult: 1 2 3 4 ⑤
  - c) by elderly or infirm adult: 1 2 3 ④ 5

---  
95

### C. SPECIFIC TRANSFERS

- 1. Sling on/off: a) independently: 1 2 ③ 4 5  
b) by attendant: 1 2 3 4 ⑤
- 2. Bed <-> Wheelchair: 1 2 3 4 ⑤
- 3. Wheelchair <-> Tub: 1 2 3 4 ⑤
- 4. Wheelchair <-> Toilet: 1 2 3 ④ 5
- 5. Other: ---  
25

### D. FEASIBILITY

- 1. Maintenance (wash, lubricate, battery charge): 1 2 3 ④ 5
- 2. Procedure if battery/motor fails: 1 ② 3 4 5
- 3. Applicability (settings where feasible): 1 2 3 ④ 5
- 4. Adaptability (usable with frame from other lifts?): 1 2 3 4 ⑤
- 5. Portability (ease of transport): 1 2 3 4 ⑤
- 6. Durability: a) home: 1 2 3 ④ 5  
b) institutional: 1 2 3 ④ 5
- 7. Cost: 1 2 3 ④ 5
- 8. General feasibility for independent operation: 1 2 3 ④ 5
- 9. Advantages/disadvantages over other attendant operated lifts: 1 2 3 ④ 5

- good size  
- easy to transport & operate

---  
50  
Total= /185

PATIENT LIFT PROTOTYPE  
CONSUMER AND OCCUPATIONAL THERAPIST EVALUATION

Trial No. \_\_\_\_\_

Disability: \_\_\_\_\_

Transfer requirements: Health Care Professionals

SCORING: 1= very poor, 2= poor, 3= fair, 4= good, 5= excellent

COMMENTS

A: DESIGN FEATURES

1. Appearance and cosmesis: - looks modern 1 2 3 4 5
2. Noise: It is noisy. 1 2 3 4 5
3. Speed of lifting/lowering action: It is rather slow. ~~bad~~ 1 2 3 4 5

10  
15

B. ERGONOMICS: (human/technology match)

1. Comfort: It (sling) is uncomfortable when legs are lifted independently of ~~each~~ one. 1 2 3 4 5
2. Comprehension required: - minimal 1 2 3 4 5
3. Ease of operation: a) independent: - must have leverage to move sling on track 1 2 3 4 5  
b) attendant: - track is very smooth 1 2 3 4 5
4. Safety a) perceived: 1 2 3 4 5  
b) actual: 1 2 3 4 5
5. Potential to damage skin: - Although the sling may cut into one's legs, the client is in the sling only temporarily. 1 2 3 4 5
6. Allowance for specific features common to severely disabled:  
e.g. urinary drainage systems, ?? It seems adaptable. 1 2 3 4 5

7. Acceptable functional capacities required for independent operation:

- a) range of motion: 1 2 3 4 5 - necessary to arrange sling around body
- b) arm strength: 1 2 3 4 5 - not much strength is required
- c) hand functions: 1 2 3 4 5
- d) muscle tone: 1 2 3 4 5
- e) head control: 1 2 3 4 5
- f) co-ordination: 1 2 3 4 5
- g) perception/cognition: 1 2 3 4 5
- h) sensation: 1 2 3 4 5 ie, not a great deal of sensation is necessary
- i) other:

8. Acceptable functional capacities required for attendant operation:

- a) by child: 1 2 3 4 ~~5~~ - sling may need size adjustment  
 b) by adult: 1 2 3 4 5  
 c) by elderly or infirm adult: 1 2 3 4 5

63  
95

C. SPECIFIC TRANSFERS

1. Sling on/off: a) independently: 1 2 3 4 5  
 b) by attendant: 1 2 3 4 5
2. Bed <-> Wheelchair: 1 2 3 4 5
3. Wheelchair <-> Tub: 1 2 3 4 5
4. Wheelchair <-> Toilet: Although I did not see the transfer performed, I am skeptical that the sling may be in the way. 1 2 3 4 5  
22  
25
5. Other:

D. FEASIBILITY

1. Maintenance (wash, lubricate, battery charge): 1 2 3 4 5
2. Procedure if battery/motor fails: 1 2 3 4 5
3. Applicability (settings where feasible): - bedroom, washroom, living room  
 - toilet? 1 2 3 4 5
4. Adaptability (usable with frame from other lifts?): - could possibly use with rings in the ceiling 1 2 3 4 5
5. Portability (ease of transport): - track must be moved; or have more than one track 1 2 3 4 5
6. Durability: a) home: 1 2 3 4 5  
 b) institutional: - with increased use, it may not last as long as in a home for one person 1 2 3 4 5
7. Cost: - possibly not as expensive as other lifts but still is expensive 1 2 3 4 5
8. General feasibility for independent operation: - need a grab bar or loop from ceiling 1 2 3 4 5
9. Advantages/disadvantages over other attendant operated lifts: - very smooth running 1 2 3 4 5  
35  
50

Total = 130/185

PATIENT LIFT PROTOTYPE  
CONSUMER AND OCCUPATIONAL THERAPIST EVALUATION

Trial No. \_\_\_\_\_

Disability: \_\_\_\_\_

Transfer requirements: Biomechanist / physiotherapist

SCORING: 1= very poor, 2= poor, 3= fair, 4= good, 5= excellent

COMMENTS

A: DESIGN FEATURES

1. Appearance and cosmesis:

1 2 3 4 (5)

2. Noise:

1 2 3 4 (5)

3. Speed of lifting/lowering action:

1 2 3 4 (5)

15

B. ERGONOMICS: (human/technology match)

1. Comfort:

1 2 3 4 (5)

2. Comprehension required:

1 2 3 4 (5)

3. Ease of operation: a) independent:

1 2 3 4 (5)

b) attendant:

1 2 3 4 (5)

4. Safety a) perceived:

1 2 3 4 (5)

b) actual:

1 2 3 4 5

5. Potential to damage skin:

(The question is a problem 1 means no potential to damage skin; 5 means excellent for damaging skin.)

1 2 3 4 5

6. Allowance for specific features common to severely disabled:

e.g. urinary drainage systems, ??

Pulling ~~as~~ as lifting  
needs

1 2 (3) 4 5

7. Acceptable functional capacities required for independent operation:

a) range of motion:

1 2 3 4 (5)

only to place sling on

b) arm strength:

1 2 3 4 (5)

c) hand functions:

1 2 3 4 (5)

very little needed

d) muscle tone:

1 2 3 4 (5)

no little needed

e) head control:

1 2 3 4 (5)

need some control

f) co-ordination:

1 2 3 4 (5)

little needed

g) perception/cognition:

1 2 3 4 5

would increase, I guess

h) sensation:

1 2 3 4 (5)

unless patient sits in it, not h-b.

i) other:

only pullers getting sling  
placed well under bottom

8. Acceptable functional capacities required for attendant operation:

- a) by child: 1 2 3 4 (5) *with small sling*  
 b) by adult: 1 2 3 4 (5)  
 c) by elderly or infirm adult: 1 2 3 4 (5)

95

C. SPECIFIC TRANSFERS

1. Sling on/off: a) independently:  
 b) by attendant:

1 2 (3) 4 5  
 1 2 3 4 (5)

2. Bed (->) Wheelchair:

*With sling not feel to hold legs  
 together without binding,*

1 2 3 4 (5)

3. Wheelchair (->) Tub:

1 2 3 (4) 5

4. Wheelchair (->) Toilet:

*Don't observe*

1 2 3 4 5

25

5. Other:

D. FEASIBILITY

1. Maintenance (wash, lubricate, battery charge):

*?*

1 2 3 4 5

2. Procedure if battery/motor fails:

1 2 3 4 5

3. Applicability (settings where feasible):

1 2 3 4 5

4. Adaptability (usable with frame from other lifts?):

*Don't know*

1 2 3 4 5

5. Portability (ease of transport):

*Not without frame*

1 2 3 4 5

6. Durability: a) home:

- b) institutional:

*looks good*

*?*

1 2 3 4 (5)  
 1 2 3 4 5

7. Cost:

*reasonable*

1 2 3 (4) 5

8. General feasibility for independent operation:

1 2 3 4 (5)

9. Advantages/disadvantages over other attendant operated lifts:

*N/A*

1 2 3 4 5

50

Total= /185

PATIENT LIFT PROTOTYPE  
CONSUMER AND OCCUPATIONAL THERAPIST EVALUATION

Trial No. 6

Disability: quadriplegic

Transfer requirements: hoyer bed  
roll in shower

SCORING: 1= very poor, 2= poor, 3= fair, 4= good, 5= excellent

COMMENTS

A: DESIGN FEATURES

- |                                       |           |
|---------------------------------------|-----------|
| 1. Appearance and cosmesis:           | 1 2 3 ④ 5 |
| 2. Noise:                             | 1 ② 3 4 5 |
| 3. Speed of lifting/lowering actions: | 1 2 ③ 4 5 |

15

B. ERGONOMICS: (human/technology match)

- |  |                                   |
|--|-----------------------------------|
| 1. Comfort: <u>battery blocks vision</u>   | 1 ② 3 4 5                         |
| 2. Comprehension required: <u>demonstration required</u>   | 1 2 ③ 4 5                         |
| 3. Ease of operation: a) independent:<br>b) attendant:   | <del>1 2 3 4 5</del><br>1 2 ③ 4 5 |
| 4. Safety a) perceived:<br>b) actual:  | 1 2 ③ 4 5<br>1 2 ③ 4 5            |
| 5. Potential to damage skin:   | 1 2 3 ④ 5                         |
| 6. Allowance for specific features common to severely disabled:<br>e.g. urinary drainage systems, ?? <u>hoyo could be impossible</u> | 1 2 3 ④ 5                         |

7. Acceptable functional capacities required for independent operation:

- |                          |           |
|--------------------------|-----------|
| a) range of motion:      | 1 2 3 4 5 |
| b) arm strength:         | 1 2 3 4 5 |
| c) hand functions:       | 1 2 3 4 5 |
| d) muscle tone:          | 1 2 3 4 5 |
| e) head control:         | 1 2 3 4 5 |
| f) co-ordination:        | 1 2 3 4 5 |
| g) perception/cognition: | 1 2 3 4 5 |
| h) sensation:            | 1 2 3 4 5 |
| i) other:                |           |

NA



8. Acceptable functional capacities required for attendant operation:

a) by child:

1 2 3 4 5

12 yr. old

b) by adult:

1 2 3 4 5

c) by elderly or infirm adult:

1 2 3 4 5

positioning sling problem

95

C. SPECIFIC TRANSFERS

1. Sling on/off: a) independently:

b) by attendant:

~~1 2 3 4 5~~

2. Bed (->) Wheelchair:

1 2 3 4 5

3. Wheelchair (->) Tub:

~~1 2 3 4 5~~

4. Wheelchair (->) Toilet:

~~1 2 3 4 5~~

25

5. Other:

D. FEASIBILITY

1. Maintenance (wash, lubricate, battery charge):

X

1 yr.

1 2 3 4 5

2. Procedure if battery/motor fails:

1 2 3 4 5

3. Applicability (settings where feasible):

1 2 3 4 5

4. Adaptability (usable with frame from other lifts?):

~~1 2 3 4 5~~

5. Portability (ease of transport):

1 2 3 4 5

6. Durability: a) home:

b) institutional:

need to use to evaluate

1 2 3 4 5

1 2 3 4 5

7. Cost:

1 2 3 4 5

8. General feasibility for independent operations:

~~1 2 3 4 5~~

9. Advantages/disadvantages over other attendant operated lifts:

1 2 3 4 5

- don't need to worry about wheels

= carpets;

- Hoyer bar on forehead

- bed needs to be raised 8" clearance

Total=

50

/185

PATIENT LIFT PROTOTYPE  
CONSUMER AND OCCUPATIONAL THERAPIST EVALUATION

Trial No. 4

Disability: quadriplegic

Transfer requirements: overhead loops + transfer  
attendant positions feet self

SCORING: 1= very poor, 2= poor, 3= fair, 4= good, 5= excellent

COMMENTS

A: DESIGN FEATURES used

1. Appearance and cosmesis:

1 2 3 4 (5)

2. Noise:

1 2 3 4 (5)

3. Speed of lifting/lowering action:

1 2 3 4 (5)

15

B. ERGONOMICS: (human/technology match)

1. Comfort:

sling ? how long it would last.  
no extremity

1 2 3 4 (5)

2. Comprehension required:

1 2 3 4 (5)

3. Ease of operation: a) independent: needs strap  
b) attendant:

sensative

1 2 3 4 (5)

4. Safety a) perceived:

b) actual: problems w/ hip extension

1 2 3 4 (5)

(2) 3 4 5

5. Potential to damage skin:

no sensation  
potentially irresponsible user

1 2 (3) 4 5

6. Allowance for specific features common to severely disabled:  
e.g. urinary drainage systems, ??

1 2 3 4 (5)

7. Acceptable functional capacities required for independent operation:

- a) range of motion: 1 2 3 4 5
- b) arm strength: 1 2 3 4 5
- c) hand function: 1 2 3 4 5
- d) muscle tone: 1 2 3 4 5
- e) head control: 1 2 3 4 5
- f) co-ordination: 1 2 3 4 5
- g) perception/cognition: 1 2 3 4 5
- h) sensation: 1 2 3 4 5
- i) other:

NA

\* only needed for bath transfer.

15q

8. Acceptable functional capacities required for attendant operation:

- a) by child: 1 2 3 4 5  
 b) by adult: 1 2 3 4 5  
 c) by elderly or infirm adult: 1 2 3 4 5

only if 10 yr. old  
 to position  
 sling

95

C. SPECIFIC TRANSFERS

1. Sling on/off: a) independently:  
 b) by attendant:

not possible

~~1 2 3 4 5~~  
 1 2 3 4 5

2. Bed <-> Wheelchair:

1 2 3 4 5

3. Wheelchair <-> Tub:

leg. apart would be problem

1 2 3 4 5

4. Wheelchair <-> Toilet:

~~1 2 3 4 5~~

25

5. Other:

D. FEASIBILITY

1. Maintenance (wash, lubricate, battery charge):

sling wearing  
 out

1 2 3 4 5

2. Procedure if battery/motor fails:

1 2 3 4 5

3. Applicability (settings where feasible):

1 2 3 4 5

4. Adaptability (usable with frame from other lifts?):

~~1 2 3 4 5~~

5. Portability (ease of transport):

1 2 3 4 5

6. Durability: a) home:

1 2 3 4 5

- b) institutional:

~~1 2 3 4 5~~

7. Cost:

not an issue - CPA would pay

1 2 3 4 5

8. General feasibility for independent operation:

~~1 2 3 4 5~~

9. Advantages/disadvantages over other attendant operated lifts:

1 2 3 4 5

50

Total= /185

## Appendix C

### PATIENT LIFT PROTOTYPE CONSUMER AND OCCUPATIONAL THERAPIST EVALUATION

Trial No. \_\_\_\_\_  
 Disability: \_\_\_\_\_ Transfer requirements: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

SCORING: 1= very poor, 2= poor, 3= fair, 4= good, 5= excellent

#### COMMENTS

#### A: DESIGN FEATURES

1. Appearance and cosmesis:	1 2 3 4 ⑤
2. Noise:	1 2 3 ④ 5
3. Speed of lifting/lowering action:	1 2 3 ④ 5
	<div style="display: flex; justify-content: flex-end; align-items: center;"> <div style="margin-right: 10px;">90.3%</div> <div style="text-align: right;"> <math>\frac{13}{15}</math> </div> </div>

#### B. ERGONOMICS: (human/technology match)

1. Comfort:	1 2 ③ 4 5
2. Comprehension required:	1 2 3 ④ 5
3. Ease of operation: a) independent:	1 2 3 ④ 5
b) attendant:	1 2 3 4 ⑤
4. Safety a) perceived:	1 2 3 ④ 5
b) actual:	1 2 3 ④ 5
5. Potential to damage skin:	1 2 ③ 4 5
6. Allowance for specific features common to severely disabled: e.g. urinary drainage systems, ??	1 2 3 ④ 5
7. Acceptable functional capacities required for independent operation:	
a) range of motion:	1 2 3 4 5
b) arm strength:	1 2 3 4 5
c) hand function:	1 2 3 4 5
d) muscle tone:	1 2 3 4 5
e) head control:	1 2 3 4 5
f) co-ordination:	1 2 3 4 5
g) perception/cognition:	1 2 3 4 5
h) sensation:	1 2 3 4 5
i) other:	

75%

59
80

8. Acceptable functional capacities required for attendant operation:

- a) by child: 1 2 3 ④ 5  
 b) by adult: 1 2 3 4 ⑤  
 c) by elderly or infirm adult: 1 2 3 ④ 5

$$90.3\% \quad \frac{13}{15} \quad \frac{13}{15}$$

C. SPECIFIC TRANSFERS

1. Sling on/off: a) independently:  
 b) by attendant:

1 2 ③ 4 5  
 1 2 3 4 ⑤

2. Bed <-> Wheelchair:

1 2 3 4 ⑤

3. Wheelchair <-> Tub:

1 2 3 4 ⑤

4. Wheelchair <-> Toilet:

1 2 3 4 ⑤  
 23  
 25

92%

5. Other:

D. FEASIBILITY

1. Maintenance (wash, lubricate, battery charge):

1 2 3 ④ 5

2. Procedure if battery/motor fails:

1 2 3 ④ 5

3. Applicability (settings where feasible):

1 2 3 ④ 5

4. Adaptability (usable with frame from other lifts?):

1 2 3 ④ 5

5. Portability (ease of transport):

1 2 3 ④ 5

6. Durability: a) home:

1 2 3 ④ 5

- b) institutional:

1 2 3 ④ 5

7. Cost:

1 2 3 ④ 5

8. General feasibility for independent operation:

1 2 ③ 4 5

9. Advantages/disadvantages over other attendant operated lifts:

1 2 3 ④ 5

78%

32  
 50

Total = 147 / 185

= 80%

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