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Research at the
Workers’ Compensation Board

EVALUATION OF PORTABLE LIFT AND TRANSFER
devices to reduce the risk of
musculoskeletal injury (MSI) to home care
workers

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Evaluation of Portable Lift and Transfer Devices to Reduce the Risk of Musculoskeletal Injury (MSI) to Home Care Workers

Issue: Reduction of musculoskeletal injury to home care workers.
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Context: Home care workers are at high risk of MSI, particularly to the lower back region, due to the nature of their job. They are often required to lift and transfer patient within small and confined spaces within homes, without assistance. The need for non-permanent home improvements or devices to reduce the risk of injury to home care workers is widely recognized.

Objectives: 1) Identify and assess factors that expose home care workers to MSI. 2) Evaluate existing portable client transfer aids in terms of reducing the risk of MSI to home care workers in a bathroom setting. 3) Develop a detailed set of performance requirements for an optimal device(s) for the bathroom setting.

Design: A biomechanical evaluation and a psychophysical assessment of a bathtub transfer board, a portable bathtub side-rail, a raised toilet seat, a walking transfer belt and a baseline manual method for bathtub and toilet transfers was conducted. A four-camera motion analysis system was used to measure the posture of home care workers during transfers. A three-dimensional biomechanical model was used to estimate the maximum potential external moment1 on the L5/S1 joint of the workers. Workers’ assessments of the devices were obtained using a perceived physical stress rating form and a device/client compatibility rating form.

Setting: A simulated bathroom setting, representative of a typical bathroom for middle to low income housing, was established at the Dr. Tong Louie Living Laboratory.

1 Moment = Vertical Force x Horizontal Distance

The term ‘moment’ refers to the tendency to produce a rotating motion and is generally described in units of ‘Newton * meters’. A numeric value of a moment is calculated by multiplying a force by its perpendicular distance from some significant related point. In the case of this project, the moment is determined by multiplying the weight (in Newtons) of the upper body by the horizontal distance of the centre of gravity of the upper body to the L5/S1 joint plus the weight of the object being lifted times the horizontal distance from the centre of gravity of the object to the L5/S1 joint. The higher the moment, the higher the loads on the spine, increasing the risk of injury. For a full explanation of this topic please see reference 16:

Subjects: Twenty home care workers with at least one year experience in client handling tasks and no history of cardiovascular disease or musculoskeletal problems.

Main Outcome Measures: External moments, particularly of the L5/S1 joint of the home care workers during transfers, perceived physical stress during transfers and perceived appropriateness of a device for various client types.

Results: The devices tested did not reduce the moment on the home care workers’ L5/S1 joint. The bathtub transfer board and walking transfer belt increased moment, however their perceived physical risk was low. Participants rated the performance of all devices as positive.

Home care workers identified three primary concerns regarding the devices: 1) transport of the devices to and from client residences, 2) hygiene if a device is used with multiple clients, and 3) liability if the home care worker introduces the device to a client’s home.

Conclusion: There is an identified need for affordable transfer devices for the home care setting. The devices must substantially reduce loads on the L5/S1 joint to safe limits under the highest risk conditions. Also, home care workers need to be trained to assess their clients’ ability to support themselves daily, and to think about their own safety. When a home care worker determines that they or their client are at risk of injury during a transfer, other options should be made available to the worker.
Evaluation of portable transfer devices to reduce the risk of musculoskeletal injury (MSI) to home care workers and development of performance requirements for such devices

Abstract:

A biomechanical evaluation and psychophysical assessment of a bathtub transfer board, portable bathtub side rail, raised toilet seat, walking transfer belt and baseline manual method for transferring clients into and out of the bathtub and on and off the toilet in the home bathroom setting were conducted. The objectives of the study were to: (1) identify and assess factors that expose a home care worker to MSI, (2) evaluate existing portable client transfer aids in terms of reducing the risk of MSI to home care workers in the bathroom setting, and (3) develop a detailed set of performance requirements for an optimal transfer device, or set of devices, for the bathroom setting. Twenty home care workers served as test participants; one able-bodied female adult participated as the client. A four camera motion analysis system was used to measure the posture on the home care workers during transfers. A three dimensional biomechanical model was used to estimate the maximum potential external moment on the L5/S1 joint of the home care worker. The home care workers also provided feedback on their perceived physical stress rating, device/client compatibility, overall device preference, likelihood of use, and device performance requirements.

The results indicate that the devices tested did not reduce the moment on the home care workers L5/S1 joint under the tested condition. The bathtub transfer board and walking transfer belts demonstrated an increase in the moment. The study participants reported the perceived physical stress ratings to be low, even when the biomechanical data shows that they are at risk. Due to the perception of low risk, the worker’s body biomechanics may not prepare them for a catastrophic failure of a transfer, such as a slip. Three primary concerns from the perspective of the home care workers regarding the devices were: 1) transport of the devices (to and from clients’ homes) was perceived as inconvenient (the walking transfer belt was an exception to this); 2) hygiene, if a device was to be used with multiple clients, was considered a significant problem, and 3) if these devices were to be introduced in clients’ homes by the home care worker, there was significant concern for liability. There was a consensus that the best scenario is for the client to acquire and keep each device on their own accord, then home care workers said they were very likely to use the device(s). Participants viewed the overall performance of all four devices positively, but the padded walking transfer belt was perceived as most positive.

Opportunities for innovation exist in the development and commercialization of affordable transfer devices developed specifically for the home setting. One of the key performance requirements that must be met to substantially reduce risk of injury to a home care worker is to reduce loads on the L5/S1 joint to safe limits under the highest risk conditions. For example if a client collapses, the device must hold the client’s weight – it must not be carried by the home care worker. Although lift devices were not evaluated in this study it is well known that they do reduce the loads on the home care worker. An opportunity for innovation exists in the adaptation of lift systems currently used in home and institutions to be less expensive and easy to use in the home setting. Furthermore, home care workers need to be trained to assess their clients on a day-by-day basis to determine their clients’ ability to support themselves, particularly in case of degenerative disease. Home care workers also need to be trained to think about their own safety, as well as the safety of their clients, during transferring activities, and training in body awareness may very well need to be a part of this education. In cases where home care workers have determined that they and/or their client are at risk of injury during a transferring activity, they must be trained to use other methods to safely conduct the transfer. Other viable options must be made available to the home care worker by their employer such as calling for another home care worker or using a suitable lift device. This leads back to the need for new transfer devices designed for the home setting.
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1. Introduction

1.1. Background

Health care is considered to be a high risk occupation by the Workers Compensation Board (WCB Annual Report, 1996). Within this broad classification, any workers dealing directly with the moving and care of clients are at significant risk for musculoskeletal injury (MSI). Home care workers are exposed to MSI primarily when they are lifting and/or transferring their clients -- often a large part of their job. The risk is increased by the small, awkward spaces found in homes, the slippery surfaces found in bathrooms, and the circumstance that home care workers often must work alone. In addition there is a tremendous variation in the type and weight of clients and the degree of cooperation that can be counted upon from the client (Lavender et al., 1995). One of the priorities identified by the WCB for the 1998 Finding Solutions research competition is the development of a generic package of non-permanent home improvements for home care clients to reduce the risk of injury to home care workers.

The risk of MSI to home care workers was further identified as a problem through the literature review and in personal communications with agencies providing home care services. The following literature review demonstrates the incidence, costs, and etiology associated with MSI in health care workers. The most common musculoskeletal injury cited involved the lower back. As well, in conversations with home care providers, the most common site of injury was identified as the back. The literature also reviews methods and devices used to reduce back injury and demonstrates a lack of quantitative evaluation of such devices.

1.2. Literature review and gaps in the literature

Incidence and Costs

In studies carried out in hospital and institutional settings, back injury and back pain have long been acknowledged as common musculoskeletal problems of health care professionals such as nurses, nursing assistants and physiotherapists (Agnew, 1987; Bork et al., 1996; Fuortes et al., 1994; Knibble & Friele, 1996; Yassi et al., 1995). All of these professions engage in a significant amount of client lifting and transferring activities. Studies looking at the incidence of back injuries in the same professional groups report a range of 25% over a two year period (Yassi et al., 1995) to 45% in a one year period (Smedly et al., 1995). The number of back injuries within these professions tend to be higher in the younger age groups, (Knibbe & Friele, 1996; Ono et al., 1995). There is some evidence that nurse's aids are more than three times as much at risk for injury to their backs, than registered nurses or licensed practical nurses. This is attributed to the fact that nurses aids are more likely to be involved in transferring, bathing and toletting clients (Fuortes et al., 1994, Knibbe & Friele, 1996); tasks that are recognized as particularly hazardous. These studies indicate a wider range of incidences of both back injury and back pain, from 25% over 2 years to 45% in one year, in the nurses and nursing assistants. Despite the wide range of reported incidences found in the literature, most of the studies would place the incidence
somewhere between 25% to 45% in any given year, indicating that a significant number of health care workers are at risk of MSI.

Relatively little research has been done on the incidence of MSI among home health care workers. Knibbe and Friele, (1996), report an incidence rate of 66.8% for community nurses in the Netherlands over a 12 month period. Moens et al. (1993) relate that 63% of 4,723 Belgian home care workers reported an incidence of back pain over a 12 month period of study. A contradictory paper by Ono et al. (1995) reports that amongst all home care workers in Sweden, the rate of musculoskeletal and back injury was very low, being only 1.51% to 1.92 % in a single year of review.

The impact of back injury and low back pain is often expressed in lost days of work. In the Dutch study on community nurses, Knibbe and Friele (1996) found that an average of 15.1 days was lost per staff member taking time off as a result of back injury. Moreover, less than 10% of those experiencing pain actually took any time off work; over 90% continued to work, despite the pain. In the one-year Belgian survey, 28.8% of those affected with back pain took an average of 36.3 days sick leave per back pain incident. The total number of sick days taken due to back pain over the one year was 23,396 days (Moen et al., 1993).

Hospital nurses in a university hospital reported taking an average of 16.5 days off as a result of back injury (Fuortes et al., 1994). In a study on ergonomics in the workplace of nursing assistants, 10% of nurses surveyed had lost one to seven work days due to back pain in the past three years and 25% had lost greater than eight days in the same time period (Garg et al., 1992). Of 1659 nurses responding to a survey done by Smedly et al., (1995), 10% had been absent from work for a period of four weeks or more due to back pain.

Finally, the cost of dealing with one single episode of back pain in nurses four years ago was estimated at 1714.60$US (Fuortes et al., 1994).

Etiology of back injury in health care workers

The most common causes cited for back injuries amongst health care professionals were incidents related to client handling (Agnew, 1987; Bork et al., 1996; Knibbe & Friele, 1996; Garg et al., 1992; Smedley et al, 1995; Yassi et al., 1995). Engels et al., (1996) identified more specific activities or aspects of nursing or home care contributing to back injury. Of respondents to a study in a long term care facility, 50% reported that the ergonomic layout of the facility was poor. This paper concluded that the awkward postures, lifting and stooping components of this work were risk factors for low back injury and pain. Handling of another person was cited as the most common risk factor (75.7%) for musculoskeletal injury in home care workers (Ono, 1995). Yassi et al. (1995) reported that the most serious injuries occurred during lifts. The authors also identified lack of training in proper lift and transfer techniques as a contributing factor to low back injury. Smedley et al. (1995) clearly identified manually moving clients on beds, lifting clients from the floor, and transferring clients from chair to bed as contributing factors to back injury. This risk disappeared when mechanical hoists or lifting devices were used.

Garg et al. (1992) reported that the perception held by nursing assistants that their jobs were physically taxing was verified by video analysis of activities during typical
shifts. Biomechanical analysis indicated that the strength requirements to carry out the required duties could not be dealt with solely through proper use of body mechanics and lifting techniques. Garg was of the opinion that assistive devices were necessary to reduce the stresses on the back. He also pointed out that in facilities having assistive devices available, staff were reluctant to use them for reasons, including lack of space, devices used being too slow to be practical, lack of training and client fear.

Studies have examined the biomechanics of movements associated with lifting and moving loads. Important factors are range of motion (ROM), asymmetrical lifting techniques, trunk rotation, distance of centre of motion to the lumbo sacral joint (L5/S1) (and resulting load moment), foot placement and the frequency or repetitive nature of lifts (Marras et al., 1995; Marras et al., 1993; Garg, 1992). Similar factors are identified as being risk factors to health care workers when lifting and transferring clients (Hodgeson, 1996; Garg et al. 1991). Additional factors identified were poor judgement or insufficient strength on a staff members part, unexpected collapse of client, uncooperativeness of client, equipment malfunction (i.e. brakes on wheelchair) and poor layout of the room (Laflin & Aja, 1995; Lavender et al., 1995).

Analysis of Methods and Devices used to Reduce Back Injury

It is evident that there is a need to reduce the risk of back injury to health care workers. Initiatives to address this issue have taken a number of directions. Education of workers in proper lifting techniques have been cited as being ineffective in reducing the number of back injuries in all industries requiring repeated lifting (Garg et al., 1991; Feldstein, 1993; Lavendar et al., 1995). Walsh et al., (1990) found that combined use of a back support and education led to a slight decrease in sick days, though the difference was not statistically significant. Yassi et al., (1995) reported that a multidiciplinary early intervention program coordinated by a physiatrist and including education, physiotherapy and occupational therapy, but no back support, led to a significant reduction in sick days for injured nurses.

The use of back belts worn by persons doing frequent lifting has become more commonplace over the past five years. It was theorized that by increasing intra-abdominal pressure and limiting ROM the lumbar spine would be protected from excessive forces. Little quantified research has been done to verify the biomechanical mechanism by which back belts may play change a body’s lifting mechanics. Reviews have been done as to whether or not the use of back belts leads to a reduction in number of back injuries. These show that the use of back belts does not lead to a significant decrease in back injuries. It is proposed that whilst back belts may improve biomechanics, they may also provide a false sense of security that leads workers to engage in even more strenuous tasks than they might without the use of a back belt (Hodgeson, 1996; Minor, 1996; Mitchell et al., 1994).

Reduction of risk factors is considered to be more important in the prevention of back injuries. This includes ergonomic redesign of the workplace, enforcing maximum load limits, use of mechanical lifts, and ensuring enough time and personnel is used to carry out a lift safely (Garg, 1992; Marras et al., 1995; Marras et al., 1993). Zhuang et al., (1999) conducted a biomechanical evaluation and psychophysical assessment of assistive devices for transferring nursing home residents from a bed to a chair. Several
devices were found to reduce biomechanical stress on the nursing assistants conducting the transfers. Design/use problems were identified with the various assistive devices tested. Evaluation of such devices in the home setting has not been identified in the literature as of the release of this report.

Work in the home setting includes the same risks found in an institutional setting along with several additional factors. High risk activities in the home have been identified as: a) bathing clients in bathtubs, b) small cramped rooms, c) lack of mechanical lifting equipment (due to expense), d) insufficient space in the typical home to use mechanical lifting equipment should funds be available for purchase and, e) lack of help from other colleagues when performing high risk tasks (Jarrel, 1997; Knibbe & Friele, 1996, Garg et al. 1992). As well, lifting and transferring are identified as high risk activities. (Garg and Owen, 1992; Knibbe & Friele, 1996; Laflin & Aja, 1995; Feldstein et al., 1993)

1.3. Importance of addressing the issue

In response to the limitations of the home care setting, alternative lower cost methods of lifting and transfers have evolved from necessity. Various devices are used: those commercially available and those improvised in the individual home to assist caregivers in their tasks. Commercially available devices include transfer belts, transfer boards, raised toilet seats, and portable side railings (personal communications: Free to Be, June 1998; Lifeline, May 1998). A review of the literature shows that these inexpensive transfer aids have never been compared quantitatively as to their ability to reduce forces on the lumbar spine. Transfer belts are the only of these devices that have been examined. Transfer belts were shown to be most effective when two caregivers were involved in doing the transfer. The belt tested was rated as being uncomfortable to wear by the clients, uncomfortable to use by the nurses and the sizes available did not fit all clients. It was also found that the belts were poorly designed, rarely used and that nursing staff actually feared for clients’ safety when using these devices.

Clearly there is a need for a quantitative analysis of low cost assistive devices for health care workers. The outcome of this project provides a quantitative assessment of the factors contributing to the risk of MSI to home care workers during transfers in the home bathroom. In addition, it provides a quantitative evaluation of commercially available, portable, low cost, client transfer devices. These two outcomes are of immediate benefit to those working in the field. The outcomes reduce guesswork in the selection of the appropriate transfer devices from existing products. Basing device selection on quantitative data reduces the risk of injury to the home care worker. A need also exists for devices with improved effectiveness and user acceptance. The project has created new knowledge in the area of device development by identifying the performance requirements and functional specifications for an optimal client lift and transfer device, or set of devices, for the bathroom setting. The home care workers have had direct input into the device design. This information has been made available to device developers to assist them in developing superior client transfer devices. The research team is also pursuing funding for the development and evaluation of a prototype device based on the performance requirements and functional specifications.
2. Project objectives

2.1. Overall objectives:

- identify and assess factors that expose a home care worker to MSI
- evaluate existing portable client transfer aids in terms of reducing the risk of MSI to home care workers in the bathroom setting
- develop a detailed set of performance requirements for an optimal transfer device, or set of devices, for the bathroom setting

2.2. Research and evaluation objectives:

- to determine if the external moments on the lumbo sacral joint (L5/S1) of home care works are significantly reduced by the use of the client transfer aids evaluated
- to rank each of the client transfer aids included in the study in terms of:
  - its ability to reduce moments on the lumbo sacral joint (L5/S1)
  - perceived physical stress rating and
  - home care worker preference and likelihood of use

3. Method

3.1. Participants

Twenty home care workers took part in this study as participants. Participants had at least one year of experience in client handling tasks. Participants had no history of cardiovascular disease or musculoskeletal problems.

3.2. Procedure

Twenty participants conducted three bathtub transfers and toilet transfers (see section 3.5 for transfer methods). Experimental procedures and data collection methods were explained to the participants. Each participant was asked to read and sign the informed consent form. One healthy female participated as a client to minimize the variability between tests. The client was instructed to support her own body weight. Participants were instructed to refrain from lifting the client whilst doing the transfer. This was in accordance with the transfer methods being used in the course of this study.

Passive reflective markers were placed on the participant to capture her or his three-dimensional range of motion data using the PEAK Performance Motion Analysis System. The markers were placed on the hip joint, the lumbo sacral joint (L5/S1), the spinous process of the first thoracic vertebra (T1), the gleno humeral joint, the elbow joint, and the wrist joint. Four calibrated cameras were set up in the bathroom, one in
each of the four upper corners of the bathroom. The set-up and calibration procedure was conducted in accordance with PEAK’s protocol.

Measurement of the trials were done by videotaping each transfer using the three-dimensional PEAK system with an event-synchronizing unit marking the first frame when the computer began data sampling. The video filming of each activity was done at 60 frames per second.

The first participant was randomly assigned to either the bathtub or toilet transfer conditions. All subsequent participants then alternated, starting with the bathtub or the toilet conditions first. The order of the two devices and the manual transfer was randomly assigned for each participant, to control for order effect. Next, the weight of each participant and the client were measured and recorded.

**Biomechanical data**

Prior to the start of measurement, the first assigned client transfer procedure was demonstrated. The participant was then asked to replicate the transfer and, if necessary, corrections to the technique were made. The participant was then given the opportunity to practice the transfer, under supervision, until they felt confident in doing the transfer. This was typically achieved in one or two practice trials. Once the participant felt confident, the transfers were conducted and videotaped for analysis. For each transfer technique, the participant conducted the transfer four times with a fifteen-second break between each transfer to minimize potential fatigue effect. The biomechanical model used to calculate the external moment on the L5/S1 joint with the biomechanical data collected is presented in Section 3.6. The results of the moments calculated with this data are presented in Section 4.2.1.

**Perceived physical stress rating**

After completing a set of transfers, either for the toilet or the bathtub, the participants were asked to fill out the perceived stress rating form. On this form, the participants were asked to rate their perception of the amount of physical stress they experienced during each of the transfers on the shoulder, upper back, lower back, whole body and knees. This was done using the perceived physical stress rating form (Appendix 1) which consisted of a 9-point Likert Scale where 0=no stress and 9=extreme stress. The results are presented in Section 4.2.2.

**Device/client compatibility**

Upon completion of the perceived physical stress rating form, the participants were then asked to rate the appropriateness of each of the devices for various client types using the device/client compatibility rating form (Appendix 1). The client types were: can bear weight, can not bear weight, heavy, contracted, combative and using equipment (such as walker or cane). The client compatibility rating was also done using a Likert Scale, where 0= does not work at all and 9=works perfectly. The results are presented in Section 4.2.3.
Interview data

Next, the interview data was collected. Each participant was asked to provide feedback on a number of dimensions related to their perceptions and performance of each transfer device. This information was collected by oral interview. The researcher asked each question and wrote the participant’s response(s) on a form. The device being evaluated was placed in front of the participant, thus they were able to view and handle the device as they responded to the following questions:

1. Any comments on the installation, ease of use, or maintenance (e.g., cleaning) of this device?
2. Do you have any concerns about safety with this device, for either the client, or the home care worker?
3. What design features of the device do you like or dislike?
4. Any comments on the size, weight, or shape of the device?
5. If you could design the ideal Walking Transfer Belt (or portable side rail, toilet booster seat, etc.) what features would it have?
6. Would you use the device if your client had it in her/his home? Why or why not?
7. Any other comments about this device?
8. Please do a comparative rating between each set of devices: a) toilet devices – walking transfer belt vs. raised seat; and b) bathtub devices – transfer board vs. portable safety rail.

These self-report data for all 20 participants were transcribed into a text file by a research assistant, divided by device (e.g., walking transfer belt, booster seat, etc.) and evaluation dimension (e.g., installation, safety, design feature likes/dislikes, etc.). A senior level researcher from the project team then analyzed the content of a total of 1032 recorded responses (keeping devices and each evaluation dimension separate), which allowed one to collapse similar responses, observe consensus responses, etc.

Please note that respondents were allowed to give multiple responses to each question/dimension. The results of these qualitative analyses are presented in summary form in Appendix 2.

Following completion of the forms and interview, the participant returned to the bathroom, where training for and measurement of the next set of transfers took place. This process was repeated until both toilet and bathtub conditions had been completed.

Participant overall device preference and likelihood of use

Finally, the participant was asked to rate the devices, based on overall performance. (1=excellent, 2=good, 3=fair, 4=poor). The participants were also asked the following three questions regarding their likelihood of using each transfer device:

1) Would you spend your own money to buy the device to use in your home care duties (they were shown the current retail price of each device on a card);
2) Would you use the device if your employer bought the device and provided it to you to use in your home care duties; and
3) Would you use the device if your client(s) owned one themselves?
The results are presented in Section 4.2.5.

Once these were complete the participant signed for and was given their stipend.

In the initial trials it was found that some confusion arose from the scales that were used. This was due to the fact that on the first rating form (perceived physical stress) the ‘best case’ (no stress) was ranked as 0 and the ‘worst case’ (extreme stress) was ranked as 9. In the second case (Device/client compatibility) the ‘best case’ (works perfectly) was ranked as 9 and the ‘worst case’ (does not work at all) was ranked as 0. To overcome this problem, two visual aids were made, one for each of the questionnaires, where each of the scales were enlarged and enhanced with colour. The ‘best case’ rating was indicated in green with the colour transforming to red as it approached the ‘worst case’ rating. The transition between green and red occurred at the middle of the scale, between 4 and 5, which was labeled medium. The rating system was re-enforced by verbally reviewing the scale with the participant prior to them beginning the completion of the questionnaires. In addition, the visual aid corresponding to the appropriate questionnaire was displayed to the participant while he or she completed the questionnaire.

3.3. Client transfer devices

A literature search and discussions with Free to Be, a supplier of assistive devices, and Life Line, an employer of home care workers, were conducted to ascertain the client transfer devices currently available that were portable and under $200. The following devices were chosen for study (Figure 1).

For bathtub transfers:

Padded Tub Transfer Board, manufactured by Duramed Designs, Vancouver, BC., retail cost: $115. This transfer board consists of a padded foam surface that is placed horizontally across the bathtub. Two sliding feet are pushed from the underside of the board to both sides of the tub to secure the board to the sides of the tub.

Portable Tub-Guard (reg. Trademark) Bathtub Safety Rail, manufactured by Lumex, Bayshore, New York, retail cost: $82.95. The tub guard has a patented ergonomic design with a textured surface, which molds comfortably to the hand for a safe, secure grip. The body made of a durable plastic and is waterproof. The device is portable and weighs 2.5 lbs. Tools are not required for installation. Maximum user weight is 250 lbs.

For toilet transfers:

Padded Walking Transfer Belt, manufactured by Sunnyfield Supplies, Victoria BC, retail cost: $52.95. The walking belt is 10 cm wide and of varying lengths, has three handles of varying orientation and size on each side, and has a quick release buckle so the belt
Figure 1-A. Padded Tub Transfer Board

Figure 1-B. Portable Bathtub Safety Rail

Figure 1-C. Padded Walking Transfer Belt

Figure 1-D. 4" Raised Toilet Seat
can be fastened around the client. It is made from a high strength webbing material on the outside with a cotton liner on the inside and is padded for client comfort.

“Savanah” 4” Raised Toilet Seat, manufactured by Smith & Nephew Roylan, Germantown, Wisconsin, retail cost: $37.95. The toilet seat is an accessory for the toilet bowl. It raises the seat level 4” to a height more conveniently used by elderly persons and those who suffer from immobilizing diseases or trauma. The seat is installed by lifting the toilet bowl seat to a raised position and placing the “Savanah” directly on the porcelain toilet bowl rim with the flange fitting into the toilet bowl.

These specific devices were chosen as they represent a wide range of the most portable, cost-effective, and accessible devices available to home care workers.

3.4. Laboratory facility: The Dr. Tong Louie Living Laboratory

The Dr. Tong Louie Living Laboratory contains a Flexible Wall System that can create rooms that are fully functional, and the PEAK Performance Motion Analysis System. The Flexible Wall System is composed of movable galvanized stainless steel framing and detachable wall panels. The framing is braced for lateral stability of the walls. The Flexible Wall System was configured and furnished into a bathroom design typical of that encountered by home care workers. The design was provided to us by the British Columbia Housing Management Commission (Figure 2) and represents a typical bathroom for middle and low income housing during the last 30 years.

3.5. Transfer methods

At the beginning of the study three senior level professionals, each of whom trains home health care workers to do lifts and transfers, were consulted regarding the transfer method to be used in the study. Interestingly, each of the professionals showed our study team different methods of transferring persons in and out of a bathtub. The methods for assisting persons on and off the toilet were similar across the three professionals.

The study team chose to use the safest of the transfers demonstrated to ensure the safety of both the participant and the person simulating the client. In all cases, the client was able bodied and was instructed to act as an able bodied person and specifically instructed to bear their own weight which resulted in minimal loads on the participants. Therefore the perceived stress ratings and the interview data received from the participants were based on the best-case-scenario simulated in the study. Conversely, the model used to calculate the moments on the L5/S1 joint was based on the worst-case scenario (i.e. home care worker carries full body weight of the client).

Each of the following methods was conducted such that the client was transferred from a standing position to a seated position in the bathtub and on the toilet. A 15-second
Fig. 2    Bathroom configuration
rest was given between each of the four trials. A standard transfer procedure was
developed for each condition and conducted as follows:

3.5.1. Bathtub transfer – manual (condition 1) and portable side rail
(condition 2)

Aside from the position of the hands on the client, the portable side rail and manual
conditions were similar in protocol. The client stood in a marked start area with feet
parallel to the length of the tub. The Home Care Worker (HCW) stood slightly to the left
and behind the client in a supporting position with the left hand under the client’s left
arm. The HCW’s right arm went around the client’s back with the hand at the client’s
waist. The feet were placed perpendicular to each other to broaden the support base,
with the left foot parallel to the tub. The client lifted her right leg first to step into the tub,
then the left, making minor adjustments in footing for balance. The client then squatted
into the tub, bending the knees and steadying herself with the right hand on the edge of
the tub. During this time, the HCW remained by the client’s side as described, providing
support and guidance as the client sat down. For Condition 1 the client also used her
left hand on the edge of the tub to steady herself, while for Condition 2 she used the
portable side rail. In either case, the position of the hands and the position of the rail
were marked to maintain consistency. From the squatted position the client went down
on her left knee and, leaning to the side of the tub, slid her legs out and to the right,
finally letting go of the tub with both hands to assume a seated position in the bottom of
the tub.

3.5.2. Bathtub transfer: transfer board (condition 3)

For this condition the client again stood in a marked start area, this time with her back
to the tub and facing the HCW. The client’s hands were placed on the HCW’s waist for
support while the HCW, standing slightly to the right with feet slightly wider than
shoulder width apart, held his/her hands about the client’s hips. While the client moved
to a seated position the HCW controlled the ingress, keeping her back straight, knees
bent, pelvis neutral and using the legs to control the majority of the transfer. Once the
client was seated the HCW helped place the client’s legs into the bathtub.

3.5.3. Toilet transfer – manual (condition 1), transfer belt (condition 2),
raised toilet seat (condition 3)

Aside from the position of the hands of the HCW, all toilet conditions were similar in
protocol. The client began in a standing position in front of, but facing away from, the
toilet. Her hands were placed at the HCW’s waist. The HCW stood directly in front of
the client, feet widely set, with both hands about the client’s waist. To proceed to the
seated position the client bent loosely about the knees. For Condition 2, a slight
modification of the hand position was incorporated for both the HCW and the client to
make use of the handles on the walking transfer belt.

For complete details on each of these transfer protocols see Appendix 3.
3.6. Biomechanical model

Calculation of the external moments on the lumbo sacral joint (L5/S1) of the participant during the transferring activities was conducted assuming 100% weight bearing of the client during the maximum risk period. An inter-rater reliability procedure was conducted to determine that there was consensus among three researchers regarding selection of the maximum risk period. It was shown that the maximum risk period selected by one researcher was reliably similar to the others. It was decided that one researcher could identify the maximum risk periods for all 20 participants. The maximum risk period was identified as the estimated time frame during which the home care worker’s center of mass was furthest away from his/her body, i.e. furthest reach. Upon visual identification of the point of maximum risk, an additional 1.5 seconds of movement before and after the maximum risk point were also evaluated to ensure the maximum risk point had in fact been identified.

Note: Preliminary evaluation of both ingress and egress identified higher moments of force during ingress in comparison to egress therefore only ingress was used in this evaluation.

External Moment Calculation

Using position data recorded by the PEAK system and standard anthropometric measures (Winter, 1990), the anatomical body segment centre of mass (COM) positions for the lower arm, upper arm, head and shank were calculated for the participant. The centre of mass (COM) position of the client was estimated to be at the average of the two wrist markers (Figure 3-A). The external moments experienced by the lumbo sacral joint were estimated by multiplying the loads due to the full body weight of the client and the partial body weight of the participant (that above the L5/S1 joint) by their distance from the lumbo sacral joint of the participant in the x and z directions (Figure 3-B).

Distance: middle of wrists to L5S1= \( d_{\text{hands}} = \sqrt{(X_{\text{hands}} - X_{\text{L5S1}})^2 + (Z_{\text{hands}} - Z_{\text{L5S1}})^2} \)

Moment about L5S1 with respect to hands = \( M_{\text{hands}} = (d_{\text{hands}}) \times (W_{\text{client}}) \)

Distance: COM of upper body to L5S1 = \( d_{\text{com}} = \sqrt{(X_{\text{com}} - X_{\text{L5S1}})^2 + (Z_{\text{com}} - Z_{\text{L5S1}})^2} \)

Moment about L5S1 with respect to COM = \( M_{\text{com}} = (d_{\text{com}}) \times (W_{\text{tub}}) \)

Total Moments = \( M_{\text{tot}} = M_{\text{hands}} + M_{\text{com}} \)

Note:
COM co-ordinates were calculated using PEAK Motion Analysis System
All length units are in meters.
Client wt = \( W_{\text{client}} = 160 \text{ lbs} \times 4.448222 \text{ N/lb} = 711.71552 \text{ N} \)
Home Care Worker’s upper body wt = \( W_{\text{tub}} = \text{Tot.Wt.(lbs)} \times 67.8\% \times 4.448222 \text{ N/lb} \)
Figure 3-A Biomechanical model top view

Figure 3-B Biomechanical model side view
Assuming 100% weight bearing in the calculations, the model represents a worst-case scenario for the moments generated on the lumbo sacral joint. The maximum moment calculated over the 3 second data collection period was obtained for statistical analysis.

3.7. Data Analysis

The project was designed as follows:

Two studies
1) bathtub transfer
   2) toilet transfer

Each study had one independent variable – device condition
1) Bathtub study
   • no device
   • transfer board
   • portable side rail
2) toilet study
   • no device
   • walking transfer belt
   • booster seat

Each transfer was repeated four times (trials).

Each study had one dependent variable
1) Peak external moment acting on lumbo sacral joint (L5/S1), $M_T$

An Analysis of Variance (ANOVA) statistical test was performed on the dependent variables. If statistical differences were found, then statistical comparisons were made between the devices used and the manual transfer control method.

The data collected on the physical stress rating form and the device/client compatibility rating form were also both analyzed using the ANOVA statistical test. Pairwise comparisons were made to determine if there were any statistically significant differences between the various conditions.

Participants’ device performance feedback was treated to typical content analyses. Responses were transcribed, categorized, analyzed for overlap and content allowing researchers to present the most frequent comments from home care workers with regard to each device’s performance.
4. Results

4.1. Identification of risk factors that expose a home care worker to MSI

Many risk factors that expose a health care worker to MSI have been identified by the literature review. The following is a summary of the risk factors identified by the literature. **The most common causes cited for back injury amongst health care professionals were related to client handling.** Risk factors identified in the literature include:

- poor ergonomic layout of work environment
- awkward postures
- lifting
- stooping
- lack of training in proper lift and transfer techniques
- strength requirements greater than strength of worker even with the proper use of lifting techniques
- range of motion experienced by the worker
- asymmetrical lifting techniques
- trunk rotation
- distance of centre of mass to the lumbo sacral joint (L5/S1)
- foot placement
- frequency or the repetitive nature of lifts
- poor judgement
- unexpected collapse of client
- uncooperative client, and
- equipment not working

One further risk factor identified in the course of the study was that some home care workers bore more weight than was required to safely transfer a client. It is hypothesized that the home care workers did this to ensure the client’s safety even if it added to the home care workers’ risk of injury.

4.2. Evaluation of existing transfer devices

The following sections present the results for the assorted collected data.

4.2.1. External moments on the lumbo sacral joint (L5/S1) (biomechanical data)

An analysis of variance showed that the external moment on the L5/S1 joint was significantly higher for the transfer board than for either the manual (no device) or portable side railing in the bathtub transfers (Tables 1 & 2). For the toilet transfers, the moment was significantly higher for the walking transfer belt than for the manual (no device) or booster seat condition (Tables 3 & 4).
Table 1. External moments (N*m) on L5/S1 joint for bathtub transfers (n=19)

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>Mean (N*m)</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual - 1</td>
<td>557.624</td>
<td>15.690</td>
</tr>
<tr>
<td>Transfer Board - 2</td>
<td>701.919</td>
<td>17.876</td>
</tr>
<tr>
<td>Portable Side Rail - 3</td>
<td>557.977</td>
<td>15.857</td>
</tr>
</tbody>
</table>

Table 2. Pairwise comparisons of external moments (N*m) for bathtub transfers

<table>
<thead>
<tr>
<th>(I) DEVICE</th>
<th>(J) DEVICE</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>-144.295</td>
<td>16.550</td>
<td>.000</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>-353</td>
<td>7.243</td>
<td>.962</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>144.295</td>
<td>16.550</td>
<td>.000</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>143.941</td>
<td>17.658</td>
<td>.000</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>353</td>
<td>7.243</td>
<td>.962</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>-143.941</td>
<td>17.658</td>
<td>.000</td>
</tr>
</tbody>
</table>

Based on estimated marginal means
* The mean difference is significant at the .05 level.

Table 3. External moments (N*m) on L5/S1 joint for toilet transfers (n=19)

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>Mean (N*m)</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Booster Seat - 1</td>
<td>497.651</td>
<td>12.722</td>
</tr>
<tr>
<td>Transfer Belt - 2</td>
<td>531.582</td>
<td>9.194</td>
</tr>
<tr>
<td>Manual – 3</td>
<td>510.754</td>
<td>12.790</td>
</tr>
</tbody>
</table>

Table 4. Pairwise comparisons of external moments (N*m) for toilet transfers

<table>
<thead>
<tr>
<th>(I) DEVICE</th>
<th>(J) DEVICE</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>-33.930</td>
<td>9.990</td>
<td>.003</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>-13.102</td>
<td>6.429</td>
<td>.057</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>33.930</td>
<td>9.990</td>
<td>.003</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>20.828</td>
<td>9.117</td>
<td>.035</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>13.102</td>
<td>6.429</td>
<td>.057</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>-20.828</td>
<td>9.117</td>
<td>.035</td>
</tr>
</tbody>
</table>

Based on estimated marginal means
* The mean difference is significant at the .05 level.
4.2.2. Perceived physical stress ratings

The perceived physical stress ratings for the bathtub transfers are listed in Table 5. The perceived physical stress ratings for the toilet transfers are listed in Table 6. The conditions that demonstrated a significant difference are listed in Table 7 for bathtub transfers and Table 8 for toilet transfers.

4.2.3. Device/client compatibility ratings

The device/client compatibility ratings for the bathtub transfers are listed in Table 9. The device/client compatibility ratings for the toilet transfers are listed in Table 10. The conditions that demonstrated a significant difference are listed in Table 11 for bathtub transfers and Table 12 for toilet transfers. The ranking of the device/client compatibility into high, medium and low groups is listed in Table 13 for the bathtub transfers and Table 14 for the toilet transfers.

4.2.4. Interview Data

The results of qualitative analyses of the interview data are presented in Appendix 3.

4.2.5. Participant overall device preference and likelihood of use

The participant overall device preference is presented in Table 15 for the bathtub devices and Table 16 for the toilet devices. Participants rated the portable side rail and transfer board as very similar. For the two toilet transfer devices, 15 participants (75%) rated the walking transfer belt as “excellent” compared to 9 (45%) for the raised toilet seat.

The likelihood of use is presented in Table 17 for the bathtub transfers and Table 18 for the toilet transfers. The number of participants who said they would use each device varied dramatically depending on whether they were asked to buy it themselves or whether the client owned the device (from 25 to 30% for the former up to 85-100% for the latter). Slightly fewer participants said they would use the device if their employers purchased it for them (75-90%). The two exceptions to this pattern were: 1) Eleven (55%) of the participants said they would buy a transfer belt with their own money, and 2) Only 10 (50%) of participants said they would use the raised toilet seat, even if their employer bought it for them.

Participants who said they would NOT use a particular device were also asked to tell researchers why they felt that way. The majority of these responses fell into three categories:

1) **Difficulties with portability and transport of the devices.** With the exception of the walking transfer belt, the other devices were perceived as too bulky and/or too heavy for personal transport from client to client. This was particularly the case for home care workers who use the bus for their work transport.
Table 5. Perceived physical stress ratings for bathtub transfers

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Manual Transfer</th>
<th>Portable Side Rail</th>
<th>Transfer Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder</td>
<td>*2.4 ± **0.63</td>
<td>1.3 ± 0.41</td>
<td>2.0 ± 0.60</td>
</tr>
<tr>
<td></td>
<td>***8 - 0</td>
<td>6 - 0</td>
<td>7 - 0</td>
</tr>
<tr>
<td>Upper Back</td>
<td>2.5 ± 0.60</td>
<td>1.8 ± 0.50</td>
<td>2.2 ± 0.56</td>
</tr>
<tr>
<td></td>
<td>8 - 0</td>
<td>8 - 0</td>
<td>7 - 0</td>
</tr>
<tr>
<td>Lower Back</td>
<td>2.9 ± 0.67</td>
<td>2.7 ± 0.54</td>
<td>3.2 ± 0.70</td>
</tr>
<tr>
<td></td>
<td>8 - 0</td>
<td>7 - 0</td>
<td>9 - 0</td>
</tr>
<tr>
<td>Whole Body</td>
<td>2.8 ± 0.62</td>
<td>2.3 ± 0.54</td>
<td>2.9 ± 0.66</td>
</tr>
<tr>
<td></td>
<td>8 - 0</td>
<td>9 - 0</td>
<td>8 - 0</td>
</tr>
<tr>
<td>Knees</td>
<td>2.4 ± 0.55</td>
<td>2.0 ± 0.49</td>
<td>2.3 ± 0.50</td>
</tr>
<tr>
<td></td>
<td>8 - 0</td>
<td>8 - 0</td>
<td>7 - 0</td>
</tr>
</tbody>
</table>

Likert Scale: 0=no stress, 9=extremely high stress
* = Mean
** = Standard Deviation
*** = Range

Table 6. Perceived physical stress ratings for toilet transfers

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Manual Transfer</th>
<th>Walking Transfer Belt</th>
<th>Booster Seat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder</td>
<td>*2.7 ± **0.65</td>
<td>2.1 ± 0.69</td>
<td>2.0 ± 0.62</td>
</tr>
<tr>
<td></td>
<td>***9 - 0</td>
<td>9 - 0</td>
<td>9 - 0</td>
</tr>
<tr>
<td>Upper Back</td>
<td>2.9 ± 0.70</td>
<td>2.6 ± 0.65</td>
<td>2.6 ± 0.63</td>
</tr>
<tr>
<td></td>
<td>8 - 0</td>
<td>9 - 0</td>
<td>8 - 0</td>
</tr>
<tr>
<td>Lower Back</td>
<td>3.1 ± 0.75</td>
<td>2.9 ± 0.67</td>
<td>2.6 ± 0.66</td>
</tr>
<tr>
<td></td>
<td>8 - 0</td>
<td>9 - 0</td>
<td>8 - 0</td>
</tr>
<tr>
<td>Whole Body</td>
<td>3.1 ± 0.70</td>
<td>3.1 ± 0.61</td>
<td>2.2 ± 0.55</td>
</tr>
<tr>
<td></td>
<td>8 - 0</td>
<td>9 - 0</td>
<td>8 - 0</td>
</tr>
<tr>
<td>Knees</td>
<td>3.3 ± 0.71</td>
<td>2.7 ± 0.55</td>
<td>2.3 ± 0.57</td>
</tr>
<tr>
<td></td>
<td>9 - 0</td>
<td>9 - 0</td>
<td>8 - 0</td>
</tr>
</tbody>
</table>

Likert Scale: 0=no stress, 9=extremely high stress
* = Mean
** = Standard Deviation
*** = Range
Table 7. Statistical differences between conditions for bathtub

<table>
<thead>
<tr>
<th></th>
<th>Manual &amp; Side Rail</th>
<th>Manual &amp; Transfer Board</th>
<th>Side Rail &amp; Transfer Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder</td>
<td>yes *(.029)</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Upper Back</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Lower Back</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Whole Body</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Knees</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

* = Significance

Table 8. Statistical differences between conditions for toilet

<table>
<thead>
<tr>
<th></th>
<th>Manual &amp; Transfer Belt</th>
<th>Manual &amp; Booster Seat</th>
<th>Transfer Belt &amp; Booster Seat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder</td>
<td>none</td>
<td>yes *(.008)</td>
<td>none</td>
</tr>
<tr>
<td>Upper Back</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Lower Back</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Whole Body</td>
<td>none</td>
<td>yes *(.020)</td>
<td>yes *(.031)</td>
</tr>
<tr>
<td>Knees</td>
<td>none</td>
<td>yes *(.010)</td>
<td>none</td>
</tr>
</tbody>
</table>

* = Significance
### Table 9. Device/client compatibility rating for bathtub

<table>
<thead>
<tr>
<th>Client Condition</th>
<th>Manual Transfer</th>
<th>Portable Side Rail</th>
<th>Transfer Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can Bear Weight</td>
<td>*8.3 ± <strong>0.25</strong></td>
<td>7.9 ± 0.50</td>
<td>7.7 ± 0.55</td>
</tr>
<tr>
<td></td>
<td><strong>9 - 6</strong></td>
<td>9 - 0</td>
<td>9 - 0</td>
</tr>
<tr>
<td>Can Not Bear Weight</td>
<td>1.3 ± 0.44</td>
<td>3.6 ± 0.69</td>
<td>5.2 ± 0.66</td>
</tr>
<tr>
<td></td>
<td>7 - 0</td>
<td>9 - 0</td>
<td>9 - 0</td>
</tr>
<tr>
<td>Heavy</td>
<td>1.7 ± 0.46</td>
<td>4.3 ± 0.72</td>
<td>4.6 ± 0.75</td>
</tr>
<tr>
<td></td>
<td>8 - 0</td>
<td>9 - 0</td>
<td>9 - 0</td>
</tr>
<tr>
<td>Contracted</td>
<td>1.3 ± 0.43</td>
<td>2.6 ± 0.64</td>
<td>3.5 ± 0.68</td>
</tr>
<tr>
<td></td>
<td>6 - 0</td>
<td>8 - 0</td>
<td>9 - 0</td>
</tr>
<tr>
<td>Combative</td>
<td>2.4 ± 0.52</td>
<td>2.9 ± 0.58</td>
<td>3.1 ± 0.60</td>
</tr>
<tr>
<td></td>
<td>9 - 0</td>
<td>7 - 0</td>
<td>8 - 0</td>
</tr>
<tr>
<td>With Equipment</td>
<td>3.0 ± 0.72</td>
<td>4.9 ± 0.80</td>
<td>6.2 ± 0.60</td>
</tr>
<tr>
<td></td>
<td>9 - 0</td>
<td>9 - 0</td>
<td>9 - 0</td>
</tr>
</tbody>
</table>

Likert Scale: 0=does not work at all, 9=works perfectly
* = Mean
** = Standard Deviation
*** = Range

### Table 10. Device/client compatibility rating for toilet

<table>
<thead>
<tr>
<th>Client Condition</th>
<th>Manual Transfer</th>
<th>Walking Transfer</th>
<th>Booster Seat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can Bear Weight</td>
<td>7.1 ± 0.63</td>
<td>6.8 ± 0.74</td>
<td>7.3 ± 0.59</td>
</tr>
<tr>
<td></td>
<td>9 - 0</td>
<td>9 - 0</td>
<td>9 - 0</td>
</tr>
<tr>
<td>Can Not Bear Weight</td>
<td>3.1 ± 0.60</td>
<td>4.8 ± 0.61</td>
<td>5.7 ± 0.52</td>
</tr>
<tr>
<td></td>
<td>8 - 0</td>
<td>9 - 0</td>
<td>9 - 2</td>
</tr>
<tr>
<td>Heavy</td>
<td>3.1 ± 0.73</td>
<td>3.8 ± 0.64</td>
<td>5.3 ± 0.62</td>
</tr>
<tr>
<td></td>
<td>9 - 0</td>
<td>9 - 0</td>
<td>9 - 0</td>
</tr>
<tr>
<td>Contracted</td>
<td>2.9 ± 0.56</td>
<td>3.7 ± 0.59</td>
<td>4.5 ± 0.66</td>
</tr>
<tr>
<td></td>
<td>8 - 0</td>
<td>9 - 0</td>
<td>9 - 0</td>
</tr>
<tr>
<td>Combative</td>
<td>2.7 ± 0.54</td>
<td>2.6 ± 0.46</td>
<td>4.1 ± 0.75</td>
</tr>
<tr>
<td></td>
<td>7 - 0</td>
<td>8 - 0</td>
<td>9 - 0</td>
</tr>
<tr>
<td>With Equipment</td>
<td>4.9 ± 0.63</td>
<td>6.1 ± 0.62</td>
<td>6.9 ± 0.64</td>
</tr>
<tr>
<td></td>
<td>9 - 0</td>
<td>9 - 0</td>
<td>9 - 0</td>
</tr>
</tbody>
</table>

Likert Scale: 0=does not work at all, 9=works perfectly
* = Mean
** = Standard Deviation
*** = Range
Table 11. Statistical differences between conditions for the bathtub

<table>
<thead>
<tr>
<th>Client Condition</th>
<th>Manual &amp; Side Rail</th>
<th>Manual &amp; Transfer Board</th>
<th>Side Rail &amp; Transfer Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can Bear Weight</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Can Not Bear Weight</td>
<td>yes *(.001)</td>
<td>yes *(.000)</td>
<td>yes *(.041)</td>
</tr>
<tr>
<td>Heavy</td>
<td>yes *(.003)</td>
<td>yes *(.005)</td>
<td>none</td>
</tr>
<tr>
<td>Contracted</td>
<td>yes *(.005)</td>
<td>yes *(.001)</td>
<td>none</td>
</tr>
<tr>
<td>Combative</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>With Equipment</td>
<td>yes *(.017)</td>
<td>yes *(.001)</td>
<td>none</td>
</tr>
</tbody>
</table>

* = Significance

Table 12. Statistical Differences between Conditions for the Toilet

<table>
<thead>
<tr>
<th>Client Condition</th>
<th>Manual &amp; Transfer Belt</th>
<th>Manual &amp; Booster Seat</th>
<th>Transfer Belt &amp; Booster Seat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can Bear Weight</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Can Not Bear Weight</td>
<td>yes *(.039)</td>
<td>yes *(.005)</td>
<td>none</td>
</tr>
<tr>
<td>Heavy</td>
<td>none</td>
<td>yes *(.010)</td>
<td>yes *(.020)</td>
</tr>
<tr>
<td>Contracted</td>
<td>none</td>
<td>yes *(.011)</td>
<td>none</td>
</tr>
<tr>
<td>Combative</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>With Equipment</td>
<td>none</td>
<td>yes *(.038)</td>
<td>none</td>
</tr>
</tbody>
</table>

* = Significance
Table 13. Ranking of conditions for compatibility of device with client into high, moderate and low compatibility groupings for the Bathtub

<table>
<thead>
<tr>
<th>Client Condition</th>
<th>Manual Transfer</th>
<th>Portable Side Rail</th>
<th>Transfer Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can Bear Weight</td>
<td>high</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Can Not Bear Weight</td>
<td>low</td>
<td>low</td>
<td>moderate</td>
</tr>
<tr>
<td>Heavy</td>
<td>low</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>Contracted</td>
<td>low</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Combative</td>
<td>low</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>With Equipment</td>
<td>low</td>
<td>moderate</td>
<td>high</td>
</tr>
</tbody>
</table>

Table 14. Ranking of conditions for compatibility of device with client into high, moderate and low compatibility groupings for the Toilet

<table>
<thead>
<tr>
<th>Client Condition</th>
<th>Manual Transfer</th>
<th>Transfer Belt</th>
<th>Booster Seat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can Bear Weight</td>
<td>high</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Can Not Bear Weight</td>
<td>low</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>Heavy</td>
<td>low</td>
<td>low</td>
<td>moderate</td>
</tr>
<tr>
<td>Contracted</td>
<td>low</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>Combative</td>
<td>low</td>
<td>low</td>
<td>moderate</td>
</tr>
<tr>
<td>With Equipment</td>
<td>moderate</td>
<td>high</td>
<td>high</td>
</tr>
</tbody>
</table>
### Table 15. Participants overall bathtub device preferences (n=20)

<table>
<thead>
<tr>
<th></th>
<th>Portable Safety Rail</th>
<th>Padded Transfer Board</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Excellent</td>
<td>9</td>
<td>47</td>
</tr>
<tr>
<td>Good</td>
<td>7</td>
<td>37</td>
</tr>
<tr>
<td>Fair</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Poor</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Missing Data</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

### Table 16. Participants overall toilet device preferences (n=20)

<table>
<thead>
<tr>
<th></th>
<th>Walking Transfer Belt</th>
<th>4-inch Raised Seat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Excellent</td>
<td>15</td>
<td>75</td>
</tr>
<tr>
<td>Good</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Fair</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Missing Data</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

### Table 17. Home care workers likelihood of bathtub device use (n=20)

<table>
<thead>
<tr>
<th></th>
<th>Portable Safety Rail</th>
<th>Padded Transfer Board</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Spend Own Money For Device?</td>
<td>N</td>
<td>(%)</td>
</tr>
<tr>
<td>Use If Employer Bought For HCW?</td>
<td>N</td>
<td>(%)</td>
</tr>
<tr>
<td>Use If Client Owned?</td>
<td>N</td>
<td>(%)</td>
</tr>
</tbody>
</table>

### Table 18. Home care workers likelihood of toilet device use (n=20)

<table>
<thead>
<tr>
<th></th>
<th>Walking Transfer Belt</th>
<th>4-inch Raised Seat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Spend Own Money For Device?</td>
<td>N</td>
<td>(%)</td>
</tr>
<tr>
<td>Use If Employer Bought For HCW?</td>
<td>N</td>
<td>(%)</td>
</tr>
<tr>
<td>Use If Client Owned?</td>
<td>N</td>
<td>(%)</td>
</tr>
</tbody>
</table>
2) **Concerns about hygiene.** For all four devices, participants voiced concerns about hygiene, disease, and infection, should the same device be used on assorted clients.

3) **Issues of liability.** Many participants stated concerns over whether or not they were qualified to determine if a given device was appropriate for their clients. They said they would need prior approval by their agency before using a given device with a client. Participants also stated liability concerns related to hygiene and potential disease transmission from client to client, should a device be used on multiple clients.

The above concerns resulted in a consensus from the participants, i.e., **each client should have their own device.**

5. **Discussion**

5.1. **Risk factors that expose a home care worker to MSI**

Each risk factor identified in the literature applied to home care workers transferring clients in the bathroom setting. The ergonomic layout of the work environment is predetermined and typically very small leading to high risk postures being assumed by the home care worker during transfers. In particular, the bathtub transfer requires the home care workers to bend asymmetrically and rotate their trunks. Lack of training in proper lift and transfer techniques seemed plausible as there wasn’t any consensus amongst the professionals we consulted regarding best practices.

It is not surprising that the most common causes cited for back injury amongst health care professionals were related to client handling. In the worst case scenario outlined in this study the compressive force on the L5/S1 disc of home care workers was estimated to be well over the safe compressive force limit established by NIOSH (21). The model used to convert the moments into estimated compressive load on the L5/S1 joint is presented in Lindh, 1980. The transfer aids tested did nothing to reduce the loads and in some cases potentially increased them. Without the use of devices or other methods that reduce the loads on the home care worker (such as employing two home care workers), strength requirements will continue to be greater than home care worker strength.

The risk factors identified in the literature and observed in this study must be taken into consideration when using existing transfer aids or designing new devices.
5.2. Evaluation of existing transfer devices

The following sections discuss the findings of this study.

5.2.1. External moments on the lumbo sacral joint (L5/S1) (biomechanical data)

Bathtub
The main focus of this study was to evaluate the effectiveness of transfer devices in terms of reducing risk of MSI to home care workers, particularly MSI of the lower back. This study showed that under the worst case scenario the transfer devices used in the bathtub either increased the maximum moment on the L5/S1 joint (transfer board) or did not change the maximum moment (portable side railing) as compared to the manual (no device) transfer condition.

Transfer Board
The transfer board device tested was found to increase the risk of injury to a home care worker under the tested condition. This is because the home care worker assumes a higher risk position while using the transfer board. The device is typically used when a client has reduced leg strength, increasing the risk of injury to the worker who must bear a greater proportion of the client’s weight. Transfer boards are useful for aiding clients with limited leg strength in bathing, however they may contribute to home care worker’s injury risk factors under worst care scenarios.

Portable Side Railing
The portable side railing is used by able-bodied clients to provide a stable hand hold while transferring into and out of the bathtub. The data indicates that the position of the home care worker is equivalent during a manual transfer and a transfer using the portable side railing at the maximum risk position. If the portable side railing is not secured correctly and moves while it is bearing some of the client’s weight, the home care worker may be required to suddenly bear some of the weight of the client, which increases their risk of injury.

Toilet
During toilet transfers the two devices tested either showed a small significant increase (transfer belt) or no significant change (booster seat) in the moment applied to the L5/S1 joint.

Booster Seat
Although the difference wasn’t significant, there was a trend toward a decrease in the moment with the use of the booster seat.

Transfer Belt
The transfer belt potentially increased the moment applied to the L5/S1 joint as compared to the manual transfer. The transfer belt provides a mechanism of coupling
the home care worker and the client that may increase client safety but may simultaneously increase the risk of injury to the home care worker.

5.2.2. Perceived physical stress rating

Few statistically significant differences were found between devices with respect to participant’s perceived physical stress ratings. The ratings were done for a range of the body’s joints. Where differences were found, they typically were between the manual transfer and one of the devices. In these cases, the difference in the mean rating was never greater than 2 points on the 9 point Likert scale. Though significant in the statistical sense, these differences amount to a slight shift in intensity of stress along a spectrum of increasing and decreasing stress, as opposed to a jump in degree of stress perceived. All of the reported stresses were well within the no stress to medium stress spectrum of the stress scale.

For the bathtub transfers only one condition resulted in a significant difference. This was in the shoulder and was between the manual and portable side rail. In doing the bathtub transfers, none of the subjects perceived any of the transfers as being more stressful on the lower back than on other parts of the body, other than for the lower back when using the transfer board in the bathtub. Despite the actual value of the mean being higher when using the transfer board, the difference was not significantly different.

In the case of the toilet the highest reported stress was in the knees when using the manual transfer method. This rating was significantly higher than the stress rating for the booster seat, but not significantly higher than that for the transfer belt. As the biomechanics of the body are similar when doing the manual transfer method and when using the transfer belt, this result is not surprising.

In each of the cases where a significant difference was found in doing the toilet transfers, the manual method was rated as producing higher stresses. In the case of the whole body stress rating for the toilet, the transfer belt was rated as producing higher stresses than the booster seat. As discussed with the knee above, this is likely due the biomechanical similarity between the latter two transfer methods.

It is interesting to note that the toilet transferring activities resulted in more significant differences in stress ratings than for the bathtub, though instinctively one might feel that the bathtub posed a greater risk than the toilet. In general stress ratings for all of the body parts, across devices, were rated as not particularly stressful. All mean stress ratings, for both toilet and bathtub were below the moderate stress level range (4-6). There are two possible explanations for this.

First, the bathtub transfers were carried out without having water in the bathtub, which is presumed to be an important factor contributing to injury in the bathroom setting. The lack of water, in all likelihood, increased the feeling of security the participants felt whilst doing the bathtub transfers. This in turn would have effected the stress rating results
and is one explanation as to why most of the bathtub’s stress ratings were in the same range as the toilet transfers. The biomechanical analysis would have been unaffected by the lack of water, as calculations were done for the worst case (full weight bearing) scenario – which is the condition occurring when a client slips in a wet bathtub.

Second, in discussion with the consultants who helped to develop the lift and transfer protocol, there is some indication that the workers themselves may not be fully cognisant of their own body’s biomechanics while doing lifts and transfers. This means that the workers are not able to focus specifically on the actions of various muscle groups and joints and isolate the feedback the body gives as to the position and stability of that joint in the same manner that athletes do when creating a mind-muscle link. The use of body awareness, based on the body’s proprioceptive mechanisms, help athletes in positioning and moving their body correctly in response to the environment. To teach an athlete the correct method of hitting, for example, a golf ball will not ensure that the athlete is actually able to do so with any level of competence. The athlete must also train his or her body awareness to allow them to respond to feedback from the body’s proprioceptive mechanisms on an ongoing basis and to correct their technique in response to it. With training, this becomes subconscious and automatic.

Proprioceptive awareness helps the body in adjusting body mechanics to adapt to changing levels and forms of mechanical stress. This may explain the lack of congruence between the physiological stress rating results and the biomechanical data. It is possible that as workers are placed in biomechanically awkward or dangerous positions, they are unable to discern that they are at risk and are therefore unable to respond by changing their body’s biomechanics correspondingly to reduce the risk. Training in transfer methods does not deal with this particular issue, which is supported by this study. Training for technique and the carrying out of the transfers was carefully controlled in this study. Significant differences were measured as to the moments exerted on the lower back when comparing different transfer devices and yet the participants were not able to report any comparable differences in their perceived physical stress ratings. This aspect of safe transfer devices and methods bears further investigation.

Finally, it should be noted there was some time lag between the participants completing the transfers and doing the rating forms. This may have impacted on the results such that the reported stresses are somewhat different than those actually experienced at the time of doing the transfers.

5.2.3. Device/client compatibility ratings

The study team member that had acted as the client throughout the study had been instructed to act as a client who is able to bear weight. For this condition, the average means rated for each of the transfer methods as being highly compatible with this client type. This was true for both the manual method as well as for all the devices. There was also no statistically significant difference between the rankings of any of the transfer methods for this client type. In the case of a client that can bear weight this
result is to be expected as, for these clients, the home care worker acts more to guide the client through the activity, as opposed to actively assisting.

For clients that can not bear weight (eg. paraplegics), the mean rankings fell within the low to moderate compatibility groupings. The manual method of transfer for both the toilet and the bathtub were felt to be inappropriate for clients who can not bear weight on their lower limbs. This was especially the case for the bathtub, where a mean ranking of 1.3 was given for the manual transfer method. For the bathtub the portable side rail was also given a low ranking (3.6) for use with this client group. There was a statistically significant difference between each of the transfer methods used in the bathtub. The best device was considered to be the transfer board, with a ranking of 5.2. The portable side rail and manual transfer were both given a rankings in the low range. The 3.6 of the side rail was however significantly higher than the manual transfer’s ranking of 1.3. In the toilet transfers the transfer belt and the booster seat were both given moderate rankings of 4.8 and 5.7 respectively. For the toilet, both the transfer belt and the booster seat were ranked as being significantly better than the manual method. No significant difference was found between the transfer belt and the booster seat. In summary, for clients that can not bear weight, both devices studied were considered to be better than the manual method, with the transfer board being the best of the two. Neither however was considered to be ideal. For the toilet, both devices were ranked as better than manual, with neither being measurably better than the other.

For clients that are extremely heavy, the manual transfer method received a low ranking for both the bathtub (1.7) and the toilet (3.1). The portable side rail and the transfer board both were ranked as moderate (4.3 and 4.6 respectively) in their ability to aid in transferring heavy clients. They were both considered to be significantly better than the manual method, with no significant difference between the devices. For the toilet both the manual and the transfer belt received low rankings (3.1 and 3.8 respectively), with no significant difference between the two devices. The booster seat was ranked significantly higher than the manual transfer and the transfer belt. For both the bathtub and toilet the devices that were perceived as having being able to provide the most aid were those devices that were fully able to bear the weight of the client – the transfer board and the booster seat.

As with the previous client type, the bathtub received a lower ranking (1.7) than the toilet (3.1) when using the manual method, presumably reflecting the added risk of water in the bathtub setting.

For contracted clients, those having restricted motion of one or more joints in a limb, all of the devices were given low rankings for the bathtub. These were 1.3 for the manual method, 2.6 for the portable side rail and 3.5 for the transfer board. The rankings of the side rail and the transfer board were both significantly higher than that of the manual method. There was no significant difference between the two devices. For the toilet, the manual was given a low rating and the transfer belt and booster seat both fell into the moderate range. However, the difference between the transfer belt and the manual
method was not significant. The booster seat was significantly higher than the manual method, thought no difference was found between it and the transfer belt. Again, for clients having restricted range of motion the transfer board and the booster seat were perceived as being the most compatible. These are the two devices that are able to bear the weight of the client.

For combative clients all but one of the transfer methods received a low ranking. The one device that did not was the booster seat for the toilet. It received a moderate ranking. Despite the fact that this device received a moderate range ranking, the actual mean was not statistically higher than either the transfer belt or the manual transfer method. The fact that none of the transfer methods for either bathtub or toilet were considered to be significantly any of the others is, in all likelihood, arising from the fact that combative clients are very difficult to predict and control, regardless of what device or method is used. In all other client groups the client is compliant participant in the transfer, usually attempting to actively assist with the transfer. In the case of combative clients the risk from injury is greatly increased by the non-compliance. This factor is difficult to effect using a transfer device.

For the final client group, those using devices such as canes, walkers or orthoses, the devices were all considered to be an asset in doing the transfers. For the bathtub the manual transfer was ranked the lowest (3.0) and was the only transfer with a low compatibility rating for this client group. Both the side rail and the transfer board were ranked significantly better than the manual transfer. The transfer board was ranked a very highly compatible (6.2), though the difference between its mean and the moderate mean of the side rail (4.9) was not significant. For the toilet the manual transfer method was ranked as being moderate. The transfer belt and the booster seat were both ranked as being in the highly compatible range. A significant difference was found between the booster seat and the manual method. No significant difference was found between the transfer belt and the booster seat or between the transfer belt and the manual method. Again, those devices that bore some of the clients weight were perceived as being significantly better than the manual method.

Across all of the transfer methods, for both the bathtub and the toilet, the trend, was that the manual method was ranked as least compatible and the device providing the most support (transfer board and booster seat) were ranked as the most compatible. In each of these cases the device ranked the highest is able to support some of the body weight of the client. This can be helpful in doing transfers as the device takes some of the load of the client. However, in cases where the client slips the device may not be able to take enough of the load to prevent injury to the home care worker. This may explain why injuries occur even when devices are used.
5.2.4. Interview data, participant overall device preference and likelihood of use

The interview data in this study represents some of the most comprehensive qualitative data we are aware of on home care workers’ perceptions of transfer devices. All the stakeholders that have an interest in successful client transfers (home care workers, home care clients, clinical and administrative staff from home care agencies, health care providers, WCB, device manufacturers, and researchers) can learn from the comments provided by the 20 home care workers in this study.

First, we learned much about these home care workers’ perceptions of the devices, as well as their likely behaviours with such devices in the field. Most revealing were participants’ concerns about **portability and transport**, **hygiene**, and **liability** of using such devices. Clearly, from this data, with the exception of a walking transfer belt which is quite compact, these participants are not interested (or willing) to carry such transfer devices with them from client to client. Many of the respondents stated that they use the bus for work, and are already “fully loaded” with purses, bags, etc. To add a raised toilet seat or tub transfer board to their items for personal transport was unacceptable to the majority of the participants. There is also an issue of stigma. A number of participants made comments such as “Do you really think I want to be seen on the bus carrying a raised toilet seat?” Sensitivity to these perceptions and needs of home care workers is important, especially considering it is not a high paying or high status occupation.

Participants were equally concerned with problems of, hygiene, bacteria, and disease transmission, in the event they should use such devices on multiple clients. It should be noted that discussions of having the time and proper methods to clean a device between clients did not seem to alleviate this concern. It was also clear that the participants feel such transfer devices are quite personal. Interesting, when asked how they would feel if a client had her/his own transfer device, participants’ concerns about hygiene were much less, and they were quite prepared to keep the device clean for an individual client.

Many participants had “liability” concerns about using transfer devices, which was somewhat surprising, given the relatively mild litigation climate in Canada relative to other countries. However, this also reveals “safety insight” on the part of the participants. There is injury incidence data that shows that a number of assistive devices are involved in injuries to older adults and other persons with disabilities. An improperly prescribed or improperly used transfer device could very well lead to injury for home care workers and/or clients. Many of the participants felt that their home care agency (employer) had an important role to play in this regard, e.g., by stating that they would want agency approval prior to using any such devices. To their further credit, many participants recognized that they were not qualified to determine if a particular device was appropriate for a given client. Participants also viewed risk of liability in terms of the above discussed hygiene and disease transmission, i.e., what if they were using the device on more than one client and a client contracted a virus associated with
the hygiene of the device? A related question on this issue is what do home care workers do when they show up at a client’s home and she/he has acquired a new transfer device on their own? Does the home care worker have the same concerns about appropriate prescription and use, even though they (or their agency) were NOT responsible for that device coming into the client’s home? Unfortunately, the present study was not able to address these important questions.

One reasonable conclusion presented by the participants that would help alleviate many of their concerns about device transport, hygiene, and liability is for each client to own their own device(s). This was reflected in 85-100% of participants saying they would use such devices if the client had their own device which stayed at their own home. However, it is worth noting that just because a client owns a device does not mean it will be used properly, nor that it will necessarily reduce risk of injury for the home care worker or the client.

A second and significant source of information came from participants’ specific comments regarding the installation, use, maintenance, safety, and design features of each device. In a sense, we asked participants to pretend they were a device designer and manufacturer, and as shown in the results, these home care workers were quite willing and capable to take on that role. It is important to point out that participants’ did not always agree on a device or its performance, which should be expected. One potential use of this data would be to select a number of the comments and turn them into “design performance hypotheses”. These hypotheses in turn could be the basis for a number of tests toward the goal of assuring the performance of a given device along certain dimensions and/or to eventually use the results of such test data to improve future manufacturing of the device.

This type of “iterative” panel testing and re-design is a well-established method for the manufacture of many products. For example, many participants voiced concern about whether the stitching on the walking transfer belt was strong enough. Simple fatigue tests could be performed to affirm or negate that hypothesis. Likewise regarding participants’ perceived surface slipperiness or friction for both the raised toilet seat and the padded tub transfer board. Simple and effective performance tests could also be devised to determine if those surfaces do perform effectively under various circumstances. Given participants’ concerns about device sanitation, one could also consider a series of tests to determine if bacteria and other potential disease transmissions are a valid concern for such devices. In a sense, such testing would take the place of “standards” which currently do NOT exist for the majority of assistive devices, including the four studied here. Making sure that an assistive device meets some standards (formal or informal) seems a reasonable goal, especially when one considers that many of these devices are NOT covered by medical insurance. Clients, who often are on limited incomes, often spend out of pocket dollars to purchase such devices, thus their durability is of importance.

In addition to content for potential performance tests, the interview data was also a source of some creative thinking for device improvement and development. For
example, when asked what an ideal portable tub safety rail would consist of, one participant suggested an entirely different approach, i.e., a bar similar to a car’s roll bar that would straddle the width of the tub. Granted, there might be some application challenges to such a design, but it might be worth considering. Likewise for the tub transfer board, where one participant questioned whether or not one could design a board (with some type of cranking mechanism) that would allow the home care worker to bath the client WITHOUT having to be on one’s knees?

There is an established history of assistive devices being developed based on the specific needs of users, often even from a small number of users. In our opinion, the development of effective assistive devices could benefit greatly from giving more users the opportunity to comment in detail on the performance, design features, and other perceptions related to a device (as was done in the present study). As a general principle, we believe assistive device manufacturers should engage in such user feedback practices to a greater extent.

Finally, with regard to participants’ overall device preferences, it can be concluded that all of the devices were rated favorably (good to excellent). It was interesting to note that the walking transfer belt received the most favorable overall performance ratings. One could argue that of the four devices studied here, it is the device that is the most portable, has the least amount of hygiene concerns, and would be the least likely to create liability concerns. This may explain participants’ preference for this device. However, it should be reiterated, that because a device is liked or preferred does not mean it may reduce potential injury during transfers.

6. Performance requirement for optimal transfer device

The purpose of a transfer device is to reduce the risk of injury to both the home care worker and the client during a transferring activity. As such, the performance requirements for a transfer device must address the risk factors that expose a home care worker to MSI injury. They must also encompass usability and cost criteria. The following list of performance requirements was developed with feedback from the home care workers as well as with input from the research team.

Optimal performance requirements – minimize/eliminate risk factors

- Reduce loads of the worker to a safe level
- Enhance ergonomic layout of work environment
- Minimize awkward postures of the worker
- Eliminate lifting by the worker
- Minimize stooping of the worker
- Ensure strength required to use the device is not greater than strength of worker
- Minimize range of motion experienced by the worker
- Minimize asymmetrical postures of the worker
- Minimize trunk rotation of the worker
- Reduce the distance of centre of mass of the load (due to both the client and the posture of the home care worker) to the lumbo sacral joint (L5/S1) of the worker
• Minimize risk of injury to worker and client if client collapses unexceptedly
• Ensure safety of the client without added load applied to the worker
• Non-slippery
• Assists with client stability
• Allows a firm grip on the client if necessary

Optimal performance requirements – usability
• Easy to clean
• Easy to use
  • Easy to assemble and take apart
  • Easy to install
  • Easy to lock securely in place
• Be as non-institutional in appearance as possible
• Inexpensive to any stakeholder (client, home care worker, employer, health care system)
• Light weight
• Multi-functional (transfers in other rooms, environments)
• Useable in universal design settings and on different fixtures (i.e. can be safely secured to different bathtubs and toilets)
• One size fits all
• Incorporates other features (i.e. soap dish)
• Allows a client to have a bath (i.e. sit in the base of the tub)
• Compact for storage and transportation
• Portable
• Durable and good craftsmanship
• Comfortable for the client to use, maintains dignity, ergonomic
• Does not offer a false sense of security to either the home care worker or the client
• No modifications required to the client’s home
• Pleasing in appearance
• Useful for different client level of disability
• Acceptance by both home care worker and client

7. Opportunities for Innovation

7.1. Device development and commercialization

• Need exists for an affordable device that assists a client on and off the toilet and in and out of the bathtub that meets the performance requirements listed in Section 6.

• One of the key performance requirements that must be met to substantially reduce risk of injury to a home care worker is to reduce loads on the L5/S1 joint to safe limits under the highest risk conditions. For example if a client collapses, the device must hold the client’s weight – it must not be carried by the home care worker.
Although lift devices were not evaluated in this study it is well known that they do reduce the loads on the home care worker. An opportunity for innovation exists in the adaptation of lift systems currently used in home and institutions to be less expensive and feasible to use in the home setting.

To encourage Canadian innovation for a more effective transfer and/or lifting device a “province wide” competition could be organized. Through programs such as SOLUTIONS, the student design exposition for assistive devices, or PROTOGÉ, the student mentoring program for assistive device prototypes, and with support from WCB and the Ministry of Health, students and entrepreneurs throughout the Province could be enlisted to design and create a more effective transfer device. Contest criteria for the device could be established by the BCIT Health Applied R&D Program, and certain resources from BCIT could made available for contest entrants. A healthy monetary first prize should be awarded for the winning design and/or prototype.

The residential design and construction industries need to be involved in the development of an effective transfer solution. Bathrooms designs should accommodate and/or facilitate safer and more effective transfer devices and techniques.

7.2. Training for home care workers

Home care workers need to be trained to assess their clients on a day-by-day basis to determine their clients’ ability to support themselves, particularly in case of degenerative disease.

Home care workers need to be trained to think about their own safety, as well as the safety of their clients, during transferring activities, and training in body awareness may very well need to be a part of this education.

In cases where home care workers have determined that they and/or their client are at risk of injury during a transferring activity, they must be trained to use other methods to safely conduct the transfer. Obviously other viable options must be made available to the home care worker by their employer such as calling for another home care worker or using a lift device.

8. References


Appendix 1: Perceived physical stress rating and Device/client compatibility form
## FORM 2B: TOILET TRANSFER/DEVICES
*(PHYSICAL STRESS & CLIENT COMPATIBILITY)*

ID Number: _______________

### TRANSFER CONDITION

<table>
<thead>
<tr>
<th>MANUAL TRANSFER</th>
<th>Physical Stress Rating</th>
<th>BODY PART</th>
<th>0=no stress</th>
<th>9=extreme stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Client Compatibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<table>
<thead>
<tr>
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<th>Physical Stress Rating</th>
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<td>Device Client Compatibility</td>
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<table>
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<tbody>
<tr>
<td>Device Client Compatibility</td>
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# FORM 2A: BATHTUB TRANSFER / DEVICES

(PHYSICAL STRESS & CLIENT COMPATIBILITY)

ID Number: _________________________

## TRANSFER CONDITION

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<td>Upper Back</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Lower Back</td>
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<td></td>
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<tr>
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<td></td>
<td>Whole Body</td>
<td></td>
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</tr>
<tr>
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<td></td>
<td>Knees</td>
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<td>Device</td>
<td>Device Client Compatibility</td>
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<td></td>
<td>Client cannot bear weight</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heavy Client</td>
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<td></td>
</tr>
<tr>
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<td></td>
<td>Contracted Client</td>
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<tr>
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<td></td>
<td>Combative Client</td>
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<td></td>
</tr>
<tr>
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<td></td>
<td>Client With equipment</td>
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<td>Device</td>
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<td>Client can bear weight</td>
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<td></td>
<td>Combative Client</td>
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<td>Client With equipment</td>
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<tr>
<td></td>
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<td>Whole Body</td>
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<tr>
<td></td>
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<td>Knees</td>
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<tr>
<td>Device</td>
<td>Device Client Compatibility</td>
<td>0=not compatible</td>
<td>9=extremely compatible</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Client can bear weight</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>Client cannot bear weight</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Heavy Client</td>
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<td></td>
<td></td>
<td>Combative Client</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Client With equipment</td>
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</table>
Appendix 2: Qualitative analyses of interview data
TOILET TRANSFERS – Padded Walking Transfer Belt

Installation, Ease of Use, or Maintenance

The home care workers responded positively to the installation, ease of use, and maintenance of the walking transfer belt used in the study. The most prevalent comments were that it is easy to use (especially due to the buckle mechanism, and the loops(handles), easy to wash, is made of comfortable and effective fabric, was easily adjustable, and would be easy to transport. This was one of the few devices in the study where subjects referred to it as a “perfect design, or best design seen”. Of the 32 responses to this question, 31 were positive. One participant felt that “Multiple Sclerosis, osteoporotic, and arthritic clients might have trouble holding on to the small straps”.

Safety

Seven of the 20 participants felt the transfer belt was safe, or stated they had no safety concerns regarding the product. Safety concerns that were voiced included:

1) Is the stitching on the handles and straps strong enough?
2) Should the clasp be purposefully difficult for the client to release?
3) Could the fastener clip break or come apart or pinch fingers?
4) Will belt loosen if angle is wrong (client could fall)?
5) Women with large breasts may be hurt by the belt
6) Client and home care workers should both wear belts

Design Feature Likes/Dislikes

The responses to design features (likes and dislikes) of the transfer belt were generally positive, and mirrored the responses regarding installation, ease of use, and maintenance, i.e., the loops, material, colour, padding, and clasping system for the belt were seen as functioning well. Two participants wondered if a “heavy duty” version of the belt was available for heavier clients?

Size, Weight, Shape

Here again, most responses (20 of 23) to the size, weight, and shape of the belt were positive. Two respondents felt the belt could be wider, while one participant wondered if there were different size belts to match the client?

Ideal Design

When asked how what is needed to be the “ideal” walking transfer belt design, the following comments were recorded:
1) Padded grip straps of non-slip material
2) Something to stop the belt from riding up on client
3) Improved stitching
4) One-size-fits-all needed
5) Velcro instead of plastic clasp
6) Tied closure instead of plastic clasp

TOILET TRANSFERS – 4” Raised Toilet Seat

Installation, Ease of Use, or Maintenance

Twenty-nine of the 39 responses had a positive perception of the installation, ease of use, or maintenance of the study’s raised toilet seat. Of the 9 critical comments, three were concerned with hygiene and difficulty to clean the device, two found the device simply “hard to use”, three found the fastening screws slippery, reverse threaded, or inadequate, and one respondent felt the clients would prefer a padded seat/device. One participant had a neutral comment, i.e., “the built in splash guard can be good or bad”.

Safety

Ten of the 21 responses stated no concerns with regard to the safety of the raised toilet seat. However, a number of responses did raise the following safety concerns with this device:

1) Should check security and proper installation frequently (client might tip) (n=5)
2) The plastic surface and smooth edges may be slippery
3) Plastic screw device might fail
4) Not safe for heavy or old client

Design Feature Likes/Dislikes

A total of 27 design feature comments were received, 16 were classified as “likes”, while 11 were classified as “dislikes”. A summary of these responses is as follows:

Likes
1) Material (smooth, similar as toilet seat)
2) Clamps (ability to tighten)
3) Very secure
4) Adjustable (to different sized toilets)
5) Easy to remove and clean
6) Good height
7) Narrow rim (underside lip) easier to clean than deep rim
8) Heavy duty plastic for heavy client

Dislikes
1) Clamps/screws limited availability (replacement), too hard to operate (adjust), fragile, and may strip over time (n= 4)
2) Clamp slots may hold dirt
3) Under edge lip should be less sharp and level (to avoid bacteria and urine deposits)
4) Seat is too high
5) Plastic may break or wear out
6) May not be compatible with some toilet shapes
Size, Weight, Shape

Eighteen of the 22 responses to this dimension were positive, i.e., participants thought the size, weight, and shape of the raised toilet seat were fine. A number of positive comments focussed on the importance of the seat’s shape to accommodate various client types (skinny, heavy, male, female, etc.). Three responses stated that the seat could be higher, and that a seat’s effectiveness depends on the client characteristics and the shape of a given toilet bowl.

Ideal Design

When asked to describe features for the ideal raised toilet seat, participants offered several suggestions that mirrored their responses for other dimensions. These are summarized below.

1. Seat should be higher (deeper) (n=6)
2. Clamping system could be improved, i.e., more durable, longer clamps, and additional clamp in front for stability
3. Provide handles/handrails for user
4. Seat of softer plastic
5. Wider seating surface
6. Shape that promotes better hygiene

BATHTUB TRANSFERS – Portable Safety Rail

Installation, Ease of Use, or Maintenance

Thirty-nine of 47 comments on this dimension were positive, i.e., the majority of participants felt the portable safety rail was easy to install, clean, and maintain. Concerns under this dimension included:

1) Fastening clamp too small, did not have “grip” on top portion, and was not clear which direction fastened or loosened clamp
2) Plastic material may be slippery, may hold smells, and may not stand up to chemicals or hot water
3) Device contains nooks and crannies for dirt
4) Drain hole too high (water will pool in device)

Safety

Regarding safety concerns for the device, 6 of the 20 respondents had none. Sixteen concerns about the safety of the portable safety rail were recorded, the majority (9 of 16) which focussed on the stability and security (holding ability) of the device, as it fastens to the side of the bathtub. Examples of these concerns were:

1) Risk of moving (fastener not big enough)
2) Clients might pull with full weight and it won’t hold
3) Proper fit on tub is critical for stability
4) Assess installation and security prior to each use
Other safety concerns with this device focused more on client behaviours:

1) Client may bump into metal fastener
2) Clients may be reluctant to let go and shift weight
3) Use of this device requires verbal commands (might be dangerous to clients with communication/understanding difficulties

Design Feature Likes/Dislikes

When asked about design features likes and dislikes, 19 of the 28 comments were positive. These likes centered on the following four features:

1) Device has comfortable contours (easy on arthritic joints)
2) Device is portable
3) The tightening mechanism functions well
4) Plastic material is sturdy, easy to clean, nice feeling to hand
5) Rubber padding on clamping mechanism should hold device in place and protect the tub

Disliked design features included the following:

1) Plastic handle area too bulky (prefer metal ones – better holding mechanism and smaller)
2) Handle area too small for both hands
3) Top handle should be square in shape to reduce risk of hand slipping
4) Inside metal clamp could attract those with dementia
5) Plastic clamp/fastener might break
6) Rubber padding on clamping mechanism (Dycem) might lose stickiness over time
7) Base of device (where it attaches to the tub) is too skinny

Size, Weight, Shape

Sixteen of the 25 comments on this dimension were positive, i.e., it was felt that the portable safety rail was a good size and shape, and light weight.

However, a number of concerns were recorded and stated that the device:

1) Should have a wider base
2) Should be taller
3) Was too heavy
4) Should be smaller (to fit into a bag)
5) Should have a bigger (stronger) fastening clamp/screw
6) Would not conform to some tubs with curved sides.

Ideal Design

When asked to describe an ideal portable safety rail, respondents reiterated their previous features and concerns, as summarized below.
1) Device must have better security, stability while under force, e.g., wider base, clamp screws on both sides of base, distribute tension on both top and bottom of device (n=8)
2) Gripping (handle) area for the client must be effective, including taller device height, and more surface contact with palm. One respondent also proposed that the device could “straddle” the entire tub, similar to a roll bar in a car.
3) Device could be non-white colour (better contrast with the tub)
4) Should fit in a bag for transport
5) Should be easily removable

**BATHTUB TRANSFERS – Padded Transfer Tub Board**

**Installation, Ease of Use, or Maintenance**

Of the 39 comments recorded for this device/dimension, 23 were positive, i.e., stated that it was easy to use, clean, and care for the transfer tub board.

There were 16 concerns voiced, as summarized below.

1) Not easy to install, primarily due to type and location of fastening mechanism (n=5)
2) Difficult to install and secure because board is straight and tub is curved (n=6)
3) Hygiene problems if padded cover rips or wears out (n=3)
4) Would need cleaning instructions
5) Do metal fasteners rust?

**Safety**

Six of the 20 participants had no safety concerns for this device.

Respondents’ safety concerns were as follows.

1) Unsafe if not installed correct/fastening is unsafe (n=4)
2) Could not see if foam touched edge of tub
3) Cannot check if fastening screws move or are in place – may break or come off (n=2)
4) Seating surface might be slippery after bathing (n=2)
5) Possibility of client slipping forward or backward – no backrest (n=3)
6) Home care workers’ knees and backs strained during installation/adjustment

**Design Feature Likes/Dislikes**

The following design feature likes and dislikes were recorded regarding the padded tub transfer board.

**Likes**

1) Padding - closed celled, durable, comfortable (n=10)
2) Fastening mechanism – good grip, two sides (n=4)
3) Drainage channels in board
4) Rounded edges (of board)
5) Craftsmanship

Dislikes
1) Fasteners underneath are inconvenient and unreliable (n=4)
2) Clamps should be curved
3) Would work better in older wider tubs
4) Confusing to install at first
5) Foam surface may be too sticky, or slippery, or crack over time (n=3)

Size, Weight, Shape

There were 25 total responses for this question; 17 were positive, i.e., stated the size, weight and shape of the tub transfer board was fine. Other responses here included:

1) Too big and heavy for transport on bus (n=3)
2) Difficult to secure to fiberglass tub
3) Depth seems to overwhelm the tub
4) Where will shower curtain go? Water will go on floor.
5) Seat depth could be wider

Ideal Design

When asked what features would be in an ideal tub transfer board, 27 comments were received, as summarized below.

1) This design is perfect (n=3)
2) Drainage holes or slots for water to run off (n=3)
3) Better fastening system, e.g., at side (not below) (n=3)
4) Non-skid texture, but not too sticky for client’s skin (n=3)
5) For durability, wood might be better
6) Should be warm to skin
7) Be more like a chair, with arms, back and handles (n=6)
8) Should stay in tub, no need for adjustment
9) Cranking mechanism so worker is not on knees to bath client
10)Molded in soap holder
11)Features “customizable” according to client’s features
12)Mechanism to raise client’s legs
Appendix 3: Transfer protocols
Each of the following methods described will be conducted such that the client will be transferred from a standing position to a seated position in the bathtub (4 separate conditions) or on the toilet (3 separate conditions). Each condition includes the ingress only with short rests (15 seconds) will be given between all transfers to minimize any fatigue effect.

**BATHTUB TRIALS: Condition 1- Manual Method**

**Step 1 (Standing)**

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<thead>
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<th>Position</th>
<th>Client</th>
<th>HCW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet</td>
<td>• on right side of floor tape marker • toes pointed towards taps</td>
<td>• left toes pointed towards taps, right toes angled towards tub for balance</td>
</tr>
<tr>
<td>Body</td>
<td>• standing position facing taps beside tub</td>
<td>• on left slightly behind client, facing taps</td>
</tr>
<tr>
<td>Hands</td>
<td>• does not apply</td>
<td>• place left hand under clients left arm distal from the elbow and support elbow • place right arm around clients back • place right hand on clients waist</td>
</tr>
</tbody>
</table>

**NOTE:** The home care worker will remain in contact with the client during the entire transfer in this position.

**Step 2 (Entering Tub)**

<table>
<thead>
<tr>
<th>Position</th>
<th>Client</th>
<th>HCW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet</td>
<td>• lift right leg and place right foot in tub • lift left leg and put left leg in tub • adjust footing after entering tub to gain balance</td>
<td>• same as above</td>
</tr>
<tr>
<td>Body</td>
<td>• same as above</td>
<td>• same as above</td>
</tr>
<tr>
<td>Hands</td>
<td>• same as above</td>
<td>• hold left arm with left hand as above to support and guide during tub entrance</td>
</tr>
</tbody>
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WCB LIFTING DEVICE STUDY - Lift and Transfer Protocol
BATHTUB TRIALS: Condition 1- Manual Method (cont’d)

Step 3 (Bending Position)

**(Mark a spot on right/left side of tub edge right and left hand are in the same spot.)**

<table>
<thead>
<tr>
<th>Position</th>
<th>Client</th>
<th>HCW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet</td>
<td>• facing taps inside tub</td>
<td>• same as above</td>
</tr>
<tr>
<td>Body</td>
<td>• bending slightly forward</td>
<td>• stand on right side of client</td>
</tr>
<tr>
<td></td>
<td>• bend knees</td>
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<tr>
<td>Hands</td>
<td>• place right hand on right tub edge</td>
<td>• place right hand on clients hip as a guide, not supporting weight</td>
</tr>
<tr>
<td></td>
<td>• place left hand on left tub edge</td>
<td></td>
</tr>
</tbody>
</table>

Step 4 (Kneeling / Rolling Hip Position)

<table>
<thead>
<tr>
<th>Position</th>
<th>Client</th>
<th>HCW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet</td>
<td>• go down on left knee</td>
<td>• spread for balance</td>
</tr>
<tr>
<td></td>
<td>• lean to left side</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• lower left hip</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• slide legs along bottom right hand side of tub into sitting position</td>
<td></td>
</tr>
<tr>
<td>Body</td>
<td>• facing towards the tub and client</td>
<td>• bend knees inward against side of tub</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hands</td>
<td>• secure left hand on left side of tub</td>
<td>• left hand holds clients left arm</td>
</tr>
<tr>
<td></td>
<td>• remove hands from tub edge once in sitting position</td>
<td>• right hand guides clients right hip</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• move hands to clients shoulders during the hip roll</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• guide clients back into sitting position</td>
</tr>
</tbody>
</table>

HCW Break: 15 seconds (HCW encouraged to stretch while waiting).

Complete self report questions after 4th trial has ended.
**BATHTUB TRIALS: Condition 2 - Portable Side Railing**

The home care worker will secure the portable side railing to the bathtub. The position of the portable Side Rail is marked with tape, so it is placed in the same position throughout the study.

Use the same steps as used for the Manual Method (Condition 1), but all client left hand positions will be modified such that in step 3 the client will place her left hand on the top of the portable rail. All other steps are identical to those stated for the Manual Method (Condition 1).

**HCW Break:** 15 seconds (HCW encouraged to stretch while waiting).

Complete self report questions after 4th trial has ended.

**NOTE:** Client cannot use portable side railing to pull herself into a kneeling position.

**BATHTUB TRIALS: Condition 3 - Bath Board**

The home care worker will secure the Bath Board to the bathtub (using marks to make sure board is in same position). This transfer condition is as follows:

**Step 1 (Standing Position)**

<table>
<thead>
<tr>
<th>Position</th>
<th>Client</th>
<th>HCW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet</td>
<td>• pointing towards doorway</td>
<td>• pointing towards tub</td>
</tr>
<tr>
<td>Body</td>
<td>• standing to left of floor tape marker</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• back to bath board</td>
<td>• standing in front of client, facing client</td>
</tr>
<tr>
<td>Hands</td>
<td>• place both hands the waist of the HCW</td>
<td>• place both hands on hips of client</td>
</tr>
</tbody>
</table>
### BATHTUB TRIALS: Condition 3 - Bath Board (cont’d)

**Step 2 (Sitting Position)**

<table>
<thead>
<tr>
<th>Position</th>
<th>Client</th>
<th>HCW (Wide Based Stance)</th>
</tr>
</thead>
</table>
| Feet     | • same as above | • braced apart  
• right foot by corner of wall and tub  
• left foot back towards toilet |
| Body     | • bend at knees and hips to be lowered onto bath board | • body angled to the right side  
• back straight  
• knees bent  
• pelvis neutral  
• bending slightly forward, lowering client onto edge of bath board  
• legs support weight of client |
| Hands    | • same as above | • same as above |

**Step 3 (Leg lift / Hip Slide)**

<table>
<thead>
<tr>
<th>Position</th>
<th>Client</th>
<th>HCW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet</td>
<td>• point towards taps after legs are in the tub</td>
<td>• same as above</td>
</tr>
</tbody>
</table>
| Body     | • turns when legs are placed in tub  
• facing taps when sliding to center of bath board | • hinging at hips to bend over clients legs |
| Hands    | • place on sides of body on bath board  
• use hands to turn body to face taps  
• use hands to slide body to center of bath board | • use both hands to lift right leg over tub edge into tube  
• repeat for left leg |

**HCW Break:** 15 seconds (HCW encouraged to stretch while waiting).

Complete self report questions after 4th trial has ended.

**NOTE:** HCW does **not** sit on toilet when moving clients legs and **does not** assist client to slide to center of bath board
**TOILET TRIALS: Condition 1 - Manual Method**

**NOTE:** The home care worker will remain in contact with the patient during the entire transfer in this position.

### Step 1 (Standing Position)

<table>
<thead>
<tr>
<th>Position</th>
<th>Client</th>
<th>HCW (Wide stance position)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet</td>
<td>• together pointing toward the wall across from the toilet</td>
<td>• pointed toward the client</td>
</tr>
</tbody>
</table>
| Body     | • standing position at front edge of toilet  
          • facing away from toilet | • faces towards toilet  
          • in front of client |
| Hands    | • on waist of HCW | • both hands around clients lower waist |

### Step 2 (Sitting Position)

<table>
<thead>
<tr>
<th>Position</th>
<th>Client</th>
<th>HCW (Wide Based Stance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Feet</td>
<td>• same as above</td>
<td>• - same as above</td>
</tr>
</tbody>
</table>
| • Body   | • bend loosely at knees and hips to be lowered  
          * For Performing Stand Position*  
          • lean upper body forward into HCW  
          *For Performing Stand Position*  
          • assist the patient to move her center of gravity forward, by rocking weight on heals and straighten legs in a smooth motion | • bend forward to assist in lowering client onto toilet in a sitting position  
          • assist the patient to move her center of gravity forward, by rocking weight on heels and straighten legs in a smooth motion |
| • Hands  | • same as above, but watch right elbow so it does not hit edge of sink | • same as above |

**HCW Break:** 15 seconds (HCW encouraged to stretch while waiting). Complete self report questions after 4th trial has ended.

Arms of HCW arm position varies and can be on the outside or inside of clients’ arms, depending on the situation (comfort, client cooperation etc.). An arm position was not chosen during the pilot testing.

***Important Note:** The client does not place her hands around the neck or shoulders of the HCW during the procedures. ***
**TOILET TRIALS: Condition 2 - Walking Transfer Belt**

One walking transfer belt will be placed on the patient and one will be placed on the home care worker. The transfer method will be as follows:

Use the same steps as used for the Manual Method (Condition 1), but all client and HCW hand positions will be modified such that in steps 1 and 2 the hands will be holding onto the belt side handles instead of around the waist. All other steps are identical to those stated for the Manual Method (Condition 1).

**HCW Break:** 15 seconds (HCW encouraged to stretch while waiting).

Complete self report questions after 4th trial has ended.

**TOILET TRIALS: Condition 3 - Booster Seat**

The HCW will secure the booster seat to the toilet.
Use the same steps as used for the Condition 1 Manual Method.