Assessment of a laundry facility and design specifications for laundry carts
- AN ERGONOMIC ASSESSMENT –

Date: November 30, 2000, January 3, 2001
Location: Mission, B.C.
Facility: Pleasant View Care Home
Contact: Jennifer Wilson

Objectives:
1. To provide specifications to improve laundry cart designs
2. To identify and analyze all tasks for risks of injury and to provide appropriate recommendations/solutions to reduce, or eliminate, potential risks.

Executive Summary:
An ergonomic assessment was performed at Pleasant View Care Home to determine risks of injury to laundry staff, and to develop design specifications for new laundry carts. Existing laundry carts are viewed as large, heavy, bulky, and hard to maneuver, and staff have noted shoulder discomfort. Management is sensitive to workplace safety, and has requested to have their laundry carts redesigned in an attempt to reduce risks of injury.

Laundry work was assessed to analyze tasks and identify risks. Various methods and tools of analyses were employed to quantitatively and qualitatively assess tasks, workers and their working environment. Awkward postures, repetitive motions and forceful exertions were evident in many tasks and were almost always concentrated in the lower back or shoulders. Cart delivery was thoroughly analyzed and design specifications were developed to reduce awkward postures, pushing forces, difficult maneuvers and visibility constraints.

Subsequent to the assessment, engineering and administrative controls were determined. The detailed assessment revealed that cart operation is not the only risk; many laundry tasks contribute to musculoskeletal stress and possible injury. New cart designs have been mocked up and feedback from staff with has been incorporated into the design specifications. Recommendations include changes in cart design as well as adaptations in other tasks with risks of injury. New carts and task recommendations should help to reduce and/or alleviate risks of injury and discomfort when performing laundry work.
Introduction:
An application for $22,200 was submitted to OHSAH by the Director of Support Services. Pleasant View Care Home’s proposal was two-fold: to assess laundry tasks and develop design specifications, and to request funding for the construction/remodeling of the carts. The ultimate goal is to reduce risk of injury to laundry workers. The facility performed an internal risk assessment in October 1999 that identified cart pushing as “an activity that involved awkward posture, repetition, high forces and static postures”. Other tasks were also identified as having risks of injury. The risk assessment, combined with concerns over worker safety and staff returning to work from shoulder injuries (injuries were not related to work activities) created the need for changes.

Methods:
Various tools and methods were used to gather information and to develop appropriate recommendations:
User Profile: developed through informal interviews, anthropometric measures, working environment, work schedules, injury records
Task Analysis: hierarchical and descriptive task analyses were developed from observations of tasks, subtasks and duration of tasks, informal interviews, and video analysis
Platform Capabilities and Constraints: assessing user characteristics, physical environment, ergonomic guidelines, and work rate requirements - necessary in development of cart design specifications

Procedure:
The initial site visit took place on November 30, 2000. The assessment began with a tour of the laundry room and a meeting with the laundry worker on shift. She agreed to participate, completed an signed consent form, and was instructed to perform her work as normal while her tasks were observed, videotaped and photographed. Times to complete tasks and their sequence were recorded. Two other laundry workers agreed to answer questions on how they thought the carts could be redesigned to make them easier to use. They provided important user profile information and general comments on the working environment. From the information collected, a descriptive task analysis and a hierarchical task analysis were developed. Risks were identified from nine major tasks and recommendations made to reduce the risks of injury.
Existing carts and their problems were assessed in detail, and related to anthropometric measures (physical proportions of the workers) and the demands of the laundry tasks. Design modifications and specifications were determined. Workers were asked to comment on the changes and to provide any additional recommendations for cart improvement. User feedback was incorporated into the existing designs and final sketches were drawn. A local metal smith will be contacted to determine the feasibility and cost to make the design changes. Finished templates have been included in Appendix I.
Results:

User Profile:

Number of staff:
• 1 laundry worker
• 3-4 housekeepers

Work Schedule:
• Laundry worker: Monday – Friday (7:00am to 3:00pm)
• Housekeepers: alternating Saturdays and Sundays (7:00am to 3:00pm)

Breaks:
• Two 15-minute coffee breaks (9:30am and 1:45pm)
• One 30-minute lunch break (11:30am)

Experience:
• 4 to 13 years

Injury records:
• Three housekeepers have had shoulder injuries that were *non-work-related* but relevant to this assessment because they all experience shoulder discomfort when using the laundry carts. The most recent of these injuries was in August 1999 (Strained-rotator cuff)

Anthropometrics: (Measures were made with shoes – 1 inch heels)

<table>
<thead>
<tr>
<th>Measure</th>
<th>User #1</th>
<th>User #2</th>
<th>User #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>68 in</td>
<td>66 in</td>
<td>66 in</td>
</tr>
<tr>
<td>Weight</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Eye height</td>
<td>64 in</td>
<td>61.5 in</td>
<td>62 in</td>
</tr>
<tr>
<td>Acromion process</td>
<td>55 in</td>
<td>56 in</td>
<td>54 in</td>
</tr>
<tr>
<td>Elbow</td>
<td>42 in</td>
<td>41 in</td>
<td>41 in</td>
</tr>
<tr>
<td>Hip</td>
<td>38 in</td>
<td>37 in</td>
<td>36 in</td>
</tr>
<tr>
<td>Knee</td>
<td>21 in</td>
<td>16 in</td>
<td>19 in</td>
</tr>
</tbody>
</table>

Environmental Conditions

Note: Information was obtained during interviews with staff (no direct measures were recorded).
• Room temperature is ‘fairly comfortable’ – might be a little cool in the morning and warmer in the afternoon
• Air conditioning is provided in the summer and there is a window that can also be opened
• Lighting is adequate for the tasks performed
• Humidity is comfortable (washers/dryers are separated from the folding area by a wall)
• Floors are made of a smooth, hard linoleum
• Rubber gloves and aprons are worn when handling dirty laundry

Task Analysis:

Note: Observed from: 8:30am to 2:18pm = 348 min
348 min – 30 min (lunch) – 15 min (coffee) = 303 min (total observed time)

Descriptive task analysis:
A laundry worker wears gloves and pushes a dirty laundry bin out of the laundry room and through the hallways to pick up dirty laundry from bins. The worker bends at the waist and reaches into a bin to grab dirty laundry. Dirty laundry is lifted out and transferred to the main dirty laundry bin. Three to five bins are emptied
per trip. The laundry worker then pushes the dirty laundry bin back to the laundry room to separate the dirty laundry. Dirty laundry pickup takes approximately 3 to 5 minutes to complete. The pick-up is performed several times each day.

In the laundry room, the dirty laundry bin contents are emptied on to the floor. The laundry worker bends at the waist and reaches into the dirty laundry bin and grabs a bag or a piece of loose laundry (i.e. large linens, comforters). Bags are turned upside-down and emptied into the bin. Loose pieces of clothing are then picked out of the bin, untangled and thrown into separate piles on the floor (categorized by whites, colors, heavily soiled undergarments, bed sheets, etc.) This task is repeated until the dirty laundry bin is empty and all of the dirty laundry has been separated into piles on the floor.

Loading washing machines involves bending at the waist and reaching into the washer to pull out washed laundry. Wet laundry is placed into a clean laundry bin and transferred to a dryer. Wet laundry is then lifted out of the clean laundry bin and inserted into the dryer. Cleaned and dry laundry is pulled out of dryers and dropped into a clean laundry bin and moved to the folding area. Dryers are turned on and the washers are filled with subsequent loads. Piles of dirty laundry are picked up from the floor and stuffed into the machine. More than one pile is usually placed into one machine at a time.

Clean laundry is folded while the machines are completing their cycles. Clean laundry varies from personal resident clothing to bed sheets and towels. Folding personal resident clothing is time-consuming because it requires sorting and storing each resident’s clothes into specific baskets. Folding bed sheets and towels requires more static and repetitive shoulder flexion/abduction because the pieces of laundry are larger. The cycle of laundry pick-up, sorting dirty laundry, transferring laundry to the washer, to the dryer and to the folding area is repeated continuously throughout the day.

At 9:00 am, clean resident laundry is delivered to 57 resident rooms with Cart #4, a cart that offers limited visibility when pushed from behind due to the laundry baskets and racks. The laundry worker thus stands beside Cart #4 and pushes and pulls the cart to maneuver it through the hallways to resident rooms. Each resident’s laundry basket is lifted off the cart and transferred to the room. This entire process is completed 57 times (once for each resident) and takes approximately 15 to 20 minutes. Once back in the laundry room, the laundry worker continues with the regular cycle of tasks. Clean personal clothing is delivered again at approximately 12:00 pm with Cart #3 to 19 residents in the dementia wing. The same process of delivery is used for Cart #3 and Cart #4. Differences are summarized in Appendix I.

In the afternoon, the last laundry delivery is performed. This delivery consists of bed linens and larger laundry. Cart #1 is used for this delivery. Clean linen is lifted off of Cart #1 and placed on to shelves in the linen rooms. Clean linen is delivered to 3 to 5 linen rooms and takes approximately 15 to 20 minutes to complete. This represents a typical day for laundry workers at Pleasant View Care Home.

Note: Each cart is delivered on alternating days. Carts not mentioned above would be delivered the next day.
## Hierarchical Task Analysis

<table>
<thead>
<tr>
<th>Main Tasks</th>
<th>Dirty laundry pick-up</th>
<th>Sort dirty laundry</th>
<th>Dirty laundry into washer</th>
<th>Wet laundry into dryer</th>
<th>Clean laundry out of dryer</th>
<th>Fold clean laundry</th>
<th>Personal laundry delivery</th>
<th>Linen delivery</th>
<th>Hang shirts on racks</th>
<th>Miscellan eous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of working shift</td>
<td>22 min</td>
<td>28 min</td>
<td>8.5 min</td>
<td>9 min</td>
<td>12.5 min</td>
<td>125.5 min</td>
<td>46 min</td>
<td>15 min</td>
<td>36.5 min</td>
<td></td>
</tr>
<tr>
<td>% of working shift</td>
<td>7.26%</td>
<td>9.24%</td>
<td>2.81%</td>
<td>2.97%</td>
<td>4.13%</td>
<td>41.42%</td>
<td>15.18%</td>
<td>4.95%</td>
<td>12.05%</td>
<td></td>
</tr>
</tbody>
</table>

### Subtasks

1. Push bin through hallways
2. Stop bin in front of dirty laundry bins
3. Transfer dirty laundry to bin
4. Repeat steps 1-3 until all dirty laundry is picked up
5. Push bin back to the laundry room

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2. Stop bin in front of dirty laundry bins
3. Transfer dirty laundry to bin
4. Repeat steps 1-3 until all dirty laundry is picked up
5. Push bin back to the laundry room

1. Lift pile of laundry off of bin
2. Walk with pile to the washer
3. Push laundry into washer
4. Continue filling washer with laundry until it is full
5. Close washer door
6. Set washing cycle

1. Lift pile of laundry off of bin
2. Walk with pile to the washer
3. Push laundry into washer
4. Continue filling washer with laundry until it is full
5. Close washer door
6. Set washing cycle

1. Open washer door
2. Position bin under open washer door
3. Reach into washer and pull out wet laundry
4. Continue pulling wet laundry out until washer is empty
5. Push bin to dryer
6. Position bin under open dryer door
7. Lift wet laundry out of bin
8. Push wet laundry into dryer
9. Continue filling dryer until bin is empty
10. Close dryer door
11. Set dryer cycle

1. Open washer door
2. Position bin under open washer door
3. Reach into washer and pull out wet laundry
4. Continue pulling wet laundry out until washer is empty
5. Push bin to dryer
6. Position bin under open dryer door
7. Lift wet laundry out of bin
8. Push wet laundry into dryer
9. Continue filling dryer until bin is empty
10. Close dryer door
11. Set dryer cycle

1. Pick clean laundry out of bin or off of table
2. Fold laundry (# of folds varies depending on a) personal laundry or linen laundry and b) size of laundry piece)
3. Folded laundry is placed on appropriate cart
4. Repeat steps 1-3 until all laundry is folded and placed on carts

1. Push cart through hallways
2. Stop cart in front of resident’s bedroom
3. Lift resident’s laundry basket off of cart
4. Open resident’s door
5. Unlock and open resident’s closet door
6. Transfer laundry from basket to shelves in closet
7. Close and lock resident’s closet door
8. Close resident’s bedroom door
9. Repeat steps 1-8 until all laundry is delivered
10. Push cart back to laundry room

1. Pick hanger up from cart
2. Pick up shirt
3. Insert hanger into shirt
4. Straighten shirt collar, smooth shirt
5. Hang shirt on cart (usually requires moving already hung shirts to make space for new shirts)
6. Repeat steps 1-5 until all shirts are hung

1. Clean counter tops
2. Sort and organize unmarked laundry
3. Sweep floors
4. Tidy shelves
## Cart Information (staff comments):

<table>
<thead>
<tr>
<th>Cart/ Bin</th>
<th>User Comments</th>
<th>Initial Force</th>
<th>Sustained Force</th>
</tr>
</thead>
</table>
| Cart #1   | Heavy & hard to push  
Cannot see over cart  
Difficult to stop  
Hard to maneuver | 39.15 N (1/2 full) | 20.18 N (1/2 full) |
| Cart #2   | Heavy to push when full  
Wheels vibrate  
Not as difficult as Cart #1  
Difficult around corners | 20.71 N (1/2 full) | 11.10 N (1/2 full) |
| Cart #3   | Top is too high  
Bottom shelf is difficult to reach  
Easy to control | Not recorded | Not recorded |
| Cart #4   | Hate using it  
Really hard to reach through  
Bottom shelf hard to reach  
Has more visibility than some of the other carts  
Too heavy to push  
Usually full  
(Note: One user commented it was easy to use and push) | 33.29 N (full) | 22.19 N (full) |
<table>
<thead>
<tr>
<th>Cart #5</th>
<th>Bottom bar gets in the way of your feet</th>
<th>Heavy to push</th>
<th>Too high, lots of high lifting</th>
<th>Hangers swing when being pushed</th>
<th>19.44 N</th>
<th>12.78 N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cart #6</td>
<td>No comments</td>
<td></td>
<td></td>
<td></td>
<td>Not recorded</td>
<td>Not recorded</td>
</tr>
<tr>
<td>Dirty laundry bin</td>
<td>Lots of bending to use</td>
<td>Too low</td>
<td>Good maneuverability</td>
<td>A handle would be good</td>
<td>Not recorded</td>
<td>Not recorded</td>
</tr>
<tr>
<td>Clean laundry bin</td>
<td>Lots of bending to use</td>
<td>Raise the bottoms</td>
<td></td>
<td></td>
<td>Not recorded</td>
<td>Not recorded</td>
</tr>
</tbody>
</table>

**Discussion:**

**User profile:**

Three staff were interviewed and their relevant anthropometrics measured. The existing carts were found not to be the appropriate sizes for them. Clean and dirty laundry bins were too low for the workers, requiring constant bending and shoulder flexion to push. Handles were not provided on most carts, and those that did have handles were too low for the workers. In addition, some handles and cart edges placed contact stress on the palm and fingers of the hands. Carts #1 through #5 were found to be too high for the workers to properly see over.

Injury records revealed that three of the housekeepers have had shoulder injuries within the last few years but that none of these injuries were caused directly by laundry work. Cart delivery has been found to cause some shoulder discomfort to these workers due to awkward shoulder postures.
Cart redesign is needed to ensure awkward postures are minimized and to enable previously injured workers to perform cart delivery without discomfort.

**Environmental Conditions:** All staff reported no environmental concerns.

**Task Analysis:**
A hierarchical task analysis revealed nine major tasks, outlined here with risks involved:

<table>
<thead>
<tr>
<th>Task</th>
<th>Risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dirty laundry pick-up</td>
<td>Awkward postures, static postures, contact stress</td>
</tr>
<tr>
<td>2. Sort dirty laundry</td>
<td>Awkward postures, repetitive motions</td>
</tr>
<tr>
<td>3. Dirty laundry into washer</td>
<td>Awkward postures, forceful exertions</td>
</tr>
<tr>
<td>4. Wet laundry into dryer</td>
<td>Awkward postures, static postures, forceful exertions, repetitive motions</td>
</tr>
<tr>
<td>5. Clean laundry out of dryer</td>
<td>Awkward postures, static postures, forceful exertions, repetitive motions</td>
</tr>
<tr>
<td>6. Fold clean laundry</td>
<td>Awkward postures, static postures, forceful exertions, repetitive motions, long duration</td>
</tr>
<tr>
<td>7. Clean laundry delivery</td>
<td>Awkward postures, forceful exertions, long duration, contact stress</td>
</tr>
<tr>
<td>8. Hang shirts on racks</td>
<td>Awkward postures, repetitive motions</td>
</tr>
<tr>
<td>9. Miscellaneous</td>
<td>No risks observed</td>
</tr>
</tbody>
</table>

Awkward postures, repetitive motions and forceful exertions were almost always concentrated in the shoulder and lower back and were common to several tasks. Task cycle times of less than 30 seconds were defined as repetitious (Ergonomic Design for People at Work, 1986). The literature also states that a combination of risk factors has been noted to have a more severe effect on the risk of injury than just one risk factor alone.

Thus, the shoulders and low back could be at risk for the development of signs and symptoms of MSI over time due to cumulative stress loads and inadequate rest breaks.

**Platform Capabilities:**
Staff must be capable of pushing every cart because there is only one worker on per shift. Staff must be able to perform all laundry tasks (i.e. folding, hanging shirts, pushing carts, lifting dirty laundry, etc.). Pushing forces must be within acceptable limits, as outlined by Snook and Ciriello (1991) for the population studied. Carts must be easy to maneuver through hallways, around individuals and into tight or constrictive spaces.

**Platform Constraints:**
The distances over which the carts must be pushed cannot be reduced, task sequence cannot be changed and rotating tasks will not provide substantial shoulder and low back stress relief. Work rates must stay constant to ensure clean laundry is always provided. Cart size can only be reduced slightly because of the large quantity of laundry that must be delivered (smaller loads would increase frequency of transfers). Visibility when pushing carts will always be somewhat limited

Cart operation is a major concern to both staff and management. Staff believe the physical demands from operating carts is high and presents risk of injury. Most workers commented though that if they had the choice,
they would prefer to use the current carts because smaller, lighter carts would require extra deliveries. Increased delivery time would result in less time available to perform other tasks. The greatest impact would be on folding laundry, which is currently performed for almost half of the shift (41.42%).

WCB Risk Identification Checklist:
WCB of BC Draft Code of Ergonomics (1994) Risk Identification Checklist was used to indicate the possibility of any adverse health effects or potential risks. The following present concern:
- Forceful physical handling as a part of the job
- Laundry manipulated in pinch grips
- Work involves repetitive motions
- Work is fast-paced and controlled by machine process
- Workers stand continuously for more than three hours of a shift
- Some tasks require the worker to assume a static posture
- Some tasks require the worker to use awkward or extreme movements
- Reaches cause workers to bend or reach beyond a comfortable range
- Handles for carts are inappropriate in size and shape
- Operating some carts causes contact stress

Force measures:
Initial force measures were greatest when pushing Cart #1 (Linen cart) and sustained forces were highest when pushing Cart #4 (Personal laundry delivery cart). Pushing forces were compared to Snook Tables (Snook and Ciriello 1991) that outline recommended maximum pushing forces for both women and men under a variety of circumstances.

Worst possible pushing scenarios were used from Snook Tables to compare with actual values collected during trials. The handle height of 135cm (highest available) was chosen because workers are required to grasp the top bar of some carts, placing them in an awkward position. A population percentile of 90 was used, meaning that the recommended pushing forces should be suitable for 90 percent of the female population. A farthest possible pushing distance of 61m was used. Pushing frequency of once every 5 minutes was used, even though this greatly exceeded the actual frequency of pushing in an 8-hour shift.

Cart #1 initial pushing force was recorded as 39.15 N. Snook Tables maximum allowable initial pushing forces are 127.53 N. Actual initial forces are well below this, indicating pushing forces are within limits outlined by Snook. Cart #4 sustained pushing force was recorded as 22.19 N, compared to allowable limits of 39.24 N from Snook Tables. Sustained pushing forces are also below allowable limits.

Initial and sustained forces were found to be below recommended maximum allowable load limits. This does not preclude risk of injury or associated fatigue when pushing and maneuvering the cart - it merely suggests that according to ergonomic guidelines, the pushing task itself is not above recommended limits (Snook and Ciriello 1991).

Snook Tables don’t consider maneuverability issues, frequency of stopping, carts with no handles, awkward wrist postures, poor visibility, or workers experiencing shoulder discomfort. Low pushing force may indicate, however, that pushing force is not the greatest issue, but that maneuverability, awkward holds and poor visibility may be more important. For example, poor cart maneuverability may make pushing the cart more difficult than recorded forces could indicate. The fact that all four wheels are freely rotating on all carts may be the cause of pushing difficulty because force is required to steer the cart as well as push the cart. This additional force could not be recorded with the force gauge. In this case, then, pushing forces alone were not determined to be a sufficient indicator of pushing difficulty.
Risks and Recommendations:

1. Risks – Dirty laundry pick-up:

*Static back flexion while pushing bins*

Bin #1 and Bin #2 are used for dirty laundry pick-ups. These bins are too low to the ground for the workers using them. This forces the workers into a flexed back position to push the cart. Static back flexion can lead to the development of signs and symptoms of MSI over time.

*Static shoulder flexion while pushing bins*

The low bins used for dirty laundry pick-up also force the worker to flex their shoulders to hold on to the bin. Though the bin does provide some relief of this awkward posture by allowing the arms to be partially supported, this position is not optimal. Over time, static shoulder flexion can lead to the development of signs and symptoms of MSI.

*Static neck extension while pushing bins*

Pushing the bins in a stooped-over position forces the neck into extension because the worker must still look straight ahead to steer the bin and see where she is going. Over time, static neck extension can lead to the development of signs and symptoms of MSI.

*Excessive back flexion while emptying dirty laundry baskets*

Dirty laundry baskets are narrow and tall. Emptying dirty laundry from the bottom of these baskets requires the worker to bend more than 90 degrees to reach the laundry. This awkward posture can lead to the development of signs and symptoms MSI.

*Shoulder flexion while emptying dirty laundry baskets*

Emptying the dirty laundry baskets also forces the worker to use excessive shoulder flexion to lift the laundry from the bottom of the basket. Due to the height of the basket, the worker can only reach the bottom by extending their arms as far as possible and flexing at the back. Over time, this awkward posture can lead to the development of signs and symptoms of MSI. Excessive back flexion and shoulder flexion also pose increase risk of acute injuries.
Recommendations – Dirty laundry pick-up:

- New cart design will help to reduce static back flexion, static shoulder flexion and static neck extension
- Dirty laundry baskets should be addressed for possible design changes to reduce back flexion and shoulder reaching needed to remove dirty laundry. From observations, bags only appeared to be half to three-quarters full, therefore suggestions may include raising dirty laundry baskets in the halls to reduce bending and reaching.
- Proper body mechanics should be used at all times to reduce risks of injury when lifting (i.e. bending at the knees instead of the waist to reduce stress on the lower back)

2. Risks – Sorting dirty laundry:

Repetitive back flexion while emptying dirty laundry bin
To separate the dirty laundry into piles (i.e. lights, darks, heavily soiled, etc.) requires repetitive back flexion. The worker bends at the waist and reaches for a piece of laundry, and then throws it into a pile on the floor. This motion is repeated every few seconds for up to a five-minute period. Repetitive back flexion can lead to the development of signs and symptoms of MSI.

Repetitive shoulder flexion while emptying dirty laundry bin
Workers hold dirty laundry in a 90 degree flexed shoulder position and then shake it to untangle it. This motion is repeated every few seconds for up to a five-minute period. Linens require excessive shoulder flexion because of their larger size. Repetitive shoulder flexion can lead to the development of signs and symptoms of MSI over time.

Recommendations – Sorting dirty laundry:

- New cart design will help to reduce risk of injury to the lower back and shoulders from repetitive back flexion and reaching. Workers will also be able to adopt a better lifting stance with the new cart design, lifting more with their legs and less with their backs.
- Separating dirty laundry is repetitive and requires awkward postures. It is suggested that instead of having one dirty laundry basket in the hallways for staff to fill, there be three to four color-coded bags that are only filled with specific laundry (personal whites, personal colors, linen whites, linen colors, etc.). Cooperation from staff to sort dirty laundry would greatly reduce the need to sort dirty laundry in the laundry room. Time required to perform this task would not be substantial, but risk of injury from sorting would be reduced.
- Sorting dirty laundry into new dirty laundry bins instead of on to the floor can reduce repetitive back flexion and reaching. Emptying dirty laundry onto the floor results in additional lifting of laundry when loading the washers. From observations, it appeared that laundry is usually sorted into four or five piles,
but that more than one pile is loaded into the same washer. Separating dirty laundry into two or three dirty laundry bins, positioning a dirty laundry bin in front of washer, and then loading the washer would reduce task repetitiveness, distance traveled, and excessive bending and reaching to lift dirty piles of laundry from the floor.

- Using one free hand to hold onto the side of cart to support the weight of the upper body will help to reduce stress on the low back.

3. Risks – Dirty laundry into washer:

*Repetitive back flexion while lifting dirty laundry off of the floor*

Dirty laundry is placed on the floor around the washer. Picking up each load of dirty laundry requires repetitive back flexion. Repetitive back flexion can lead to the development of signs and symptoms of MSI.

*Forceful pushing and excessive reaches to place dirty laundry into the washer*

Loads of dirty laundry are pushed into the washers until they are full. Inserting laundry into the washer requires the worker to bend at the waist to be level with the door, and to push the laundry into the washer. Increasing force is required to fill the washer as more dirty laundry is placed in it. Forceful pushing combined with static back flexion can over time lead to the development of signs and symptoms of MSI.

**Recommendations – Dirty laundry into the washer:**

- Raising washer height would help to reduce low back flexion when loading with dirty laundry.
- Repetitive back flexion and shoulder flexion from lifting dirty laundry off of the floor can be reduced with the use of dirty laundry bins for sorting (as described previously).
- Dirty laundry is usually pushed from an angled stance into the washers. Positioning oneself directly in front of the washer, bending at the knees, and using proper body mechanics will help to reduce risk of injury from awkward pushing of dirty laundry into the washer. Washers are sometimes loaded too full, requiring more forceful pushing of dirty laundry into the washer. Reducing the sizes of the loads would help to reduce forceful pushing and excessive reaches to push the dirty laundry completely to the back of the machine to make room for extra laundry.
4. Risks – Wet laundry into dryer:

*Forceful pulling and gripping to remove wet laundry from the washer*
*Static back flexion and excessive reaches to remove wet laundry from the washer*

Removing wet laundry from the washer requires static back flexion to be level with the washer and excessive reaching into the washer. Wet laundry can also be tangled and heavy to lift. This requires the worker to grip the laundry and forcefully pull it out. Signs of exertion were noted on the face of the worker. Over time, awkward, static postures and forceful gripping and pulling can lead to the development of signs and symptoms of MSI.

*Repetitive back flexion and forceful lifting of wet laundry into the dryer*
*Excessive reaching to insert wet laundry into the dryer*

Wet laundry is placed into a clean laundry bin and then pushed over to the dryers where it is positioned directly beneath a dryer door. The worker then bends to lift the wet laundry and pushes it into the dryer. Wet laundry can be heavy. Back flexion increases as the worker reaches farther into the bin to lift the wet laundry. This motion is repeated several times a minute until all of the wet laundry is in the dryer. Excessive reaching is also required to reach over the bin and insert the wet laundry into the dryer. Over time, repetitive back flexion and forceful lifting combined with excessive reaching can lead to the development of signs and symptoms of MSI.
Recommendations – Wet laundry into dryer:

- New bin design will reduce back flexion and the distance required to lift wet laundry from the bin into the dryer.
- Raising dryer height would help to reduce low back flexion when loading and unloading.
- Reducing load size will help to reduce forceful pulling and gripping because wet laundry will be less tangled.
- Power grips are recommended over pinch grips whenever pulling wet laundry out of the dryer. A power grip involves using the entire hand instead of just the fingers, which utilizes only about 25% of power grip strength (Ergonomic Design for People at Work, pg. 350, 1986). Use the entire hand to grasp wet laundry by grabbing thicker amounts instead of single layer pieces of laundry.
- Use proper body mechanics. Stand directly in front of the washer door, facing it, and bend at the knees to position the body at a proper height for unloading the washer. This will reduce risk of injury from standing at an angle, pulling across the body, and using a static back flexed position.
- Positioning the body as close to the washer as possible will reduce excessive reaches. Most workers were observed pulling laundry out from an angle, restricting their ability to be as close to the machine as possible.
- Repositioning the bin so that the worker’s body is between the bin and the washer will reduce static back flexion and excessive reaching. This can be achieved by positioning the bin slightly to the side rather than in front of the door. The current positioning requires the worker to reach over the cart.
- Excessive reaching into the dryer can be reduced by repositioning the body in front of the dryer and not working from an angle, and by also ensuring that the bin is not directly between the worker and the dryer (same positioning as for removing wet laundry from the washer).

5. Risks – Clean laundry out of dryer:

**Forceful pulling and gripping to remove clean laundry from the dryer**  
**Static back flexion and excessive reaches to remove clean laundry from the dryer**

The same steps for removing wet laundry from the washers are used for removing clean laundry from the dryers. Risks are similar with one noticeable difference; dry laundry is not as heavy or tangled as wet laundry, therefore less pulling and forceful gripping is required. Nonetheless, pulling at and gripping laundry is still performed when emptying the dryers.
When the worker pulls out clean laundry from the dryer, linens and personals are partially folded and sorted. Laundry (i.e. linen) is held in the air, untangled and shaken, and then draped over the side of the bin. While this saves time when folding laundry, it requires repetitive shoulder abduction/flexion to hold the laundry. Over time, this movement can lead to the development of signs and symptoms of MSI.

**Recommendations – Clean laundry out of dryer:**
- Same as for wet laundry out of the washer

6. **Risks – Folding clean laundry:**

*Repetitive excessive shoulder abduction/flexion while folding laundry*

Folding laundry requires the worker to hold laundry at approximately shoulder level (shoulders abducted) and then to fold. This task is performed every 10 to 40 seconds for up to 30 consecutive minutes. The repetitiveness of this task, along with awkward postures, can, over time, lead to the development of signs and symptoms of MSI.

*Repetitive pinch grips while picking pieces of laundry*
Laundry is usually very thin, thickness almost always less than 1 cm thick. Workers use a pinch grip to grasp the corners and maintain this grip while they fold the laundry. This task is performed every 10 to 40 seconds for up to 30 consecutive minutes. The repetitiveness of this task can, over time, lead to the development of signs and symptoms of MSI. Pinch grips are approximately 25% the strength of power grips.
Recommendations – Folding clean laundry

- When folding large pieces of linen, workers use excessive shoulder abduction/flexion to hold the piece of laundry in the air to fold. Notice from the above picture, linen is still draped in the bin. No matter how high the piece of linen is held, it will always be draped in the bin. Therefore, workers should not be as concerned with holding pieces of linen high in the air for folding. Instead, hold the linen at a lower shoulder level and then proceed to fold, this would reduce shoulder abduction/flexion.

- The positioning of the current folding table is not optimal. Repositioning the folding table and/or purchasing a smaller mobile table would help to increase usage. A folding table helps to reduce required shoulder flexion by allowing laundry to rest on the table instead of in the worker’s hands.

- Staff should take 30 second breaks after every 5 minutes of consecutive laundry folding, or when they start to feel mild shoulder discomfort, to stretch the fingers, hands, arms and shoulders. The breaks only need to be brief, but these types of breaks have been shown to reduce symptoms of physical discomfort (Sundelin, 1993).

- Folding laundry should be rotated with other tasks as much as possible to reduce the duration of consecutive folding. (It should be noted, however, that this would only provide partial relief.)

- Staff should be made aware of proper body mechanics (i.e. keep the arms and elbows as close to the body as possible) while folding laundry to ensure awkward postures are minimized.

- Staff should consciously grasp edges of laundry with their entire hands (power grips) instead of just with their fingers. This can be done by grasping larger amounts of the edges, and bundling it up in the hand so that the entire hand is involved in gripping.

- Workers are required to stand on hard surfaces for their entire shift. Anti-fatigue matting could be used in the folding area to reduce muscle fatigue and lower back stress.

7. Risks – Clean laundry delivery:

See Appendix I.

8. Risks – Hang shirts on racks:

See Appendix I (Cart #2 and #5).

**Racks on the walls require excessive shoulder flexion to hang clothes**

Racks are located on the walls and provide a temporary storage space for miscellaneous or unidentifiable laundry. Every time laundry is hung or removed, it requires excessive shoulder flexion to reach the existing...
height of the bars. This task is performed infrequently, but it still adds to cumulative shoulder stress throughout the shift.

**Recommendations – Hang shirts on racks**
- Lower the height of all racks on the walls. Racks should be well below shoulder level and they should allow workers to easily access them without excessive shoulder flexion.

9. Risks – Miscellaneous (i.e. sort shelves, sweep floors, etc.):

Physical demands vary with tasks. No risks were observed.

**General recommendations for all tasks:**
- Workers should always be aware of proper body mechanics when lifting and pushing. Accidents may be more likely to occur if the worker is in an awkward position. Posters and signs with helpful reminders may be placed on some walls to help keep workers “aware”.
- Consciously try to avoid extreme deviations of the wrist at all times.
- Workers should stretch at the beginning of their shifts and in between periods of heavy work (stretching helps to circulate blood through the muscles, it lubricates the joints, and it prepares the body for strenuous activities). Stretching does not have to be long in duration or consist of a large number of different stretches to be of benefit. Stretching posters may also be placed on the walls and workers can start with a very simple, short program, and then gradually build. Stretching books and posters can be found at almost any bookstore.
- Rotator cuffs are used for shoulder stabilization when reaching. Increased rotator cuff strength would help to reduce risk of injury from repetitive reaching during laundry tasks. Workers should be taught how to perform strengthening exercises for the rotator cuffs.
- Workers should be taught how to identify the differences between “occasional soreness” from work and “discomfort or pain” from cumulative stress build-up. If workers can identify discomfort or pain before it turns into a more serious condition, preventative measures can be taken to correct the situation before it gets out of hand. It should be noted that any type of soreness could be a possible indicator for injury, therefore workers should always be aware of pain they may be feeling, and what steps to take if they believe they are at risk of injury.
Conclusion:

Laundry tasks consist of: 1) picking up dirty laundry, 2) sorting dirty laundry, 3) dirty laundry into the washer, 4) wet laundry into the dryer, 5) clean laundry out of the dryer, 6) folding clean laundry, 7) clean laundry delivery, 8) hanging shirts on racks and 9) miscellaneous small tasks (i.e. cleaning countertops, sweeping floors, etc.). Most tasks involve awkward postures, static postures, repetition, and forceful exertions of the lower back and shoulder muscles. Some tasks by themselves do not pose an overly high risk of injury, but the cumulative effect of repetitive and/or awkward tasks combined with other tasks of similar risk factors could lead to increased risk of the development of signs and symptoms of MSI.

Three of the laundry staff have had shoulder injuries in the past, making it difficult for them to perform clean laundry delivery. Design specifications have been provided to reduce awkward postures, difficult laundry deliveries and risks of injury from operating the carts. Risks of injury have also been identified from all laundry tasks and appropriate recommendations have been given to reduce or eliminate these risks of injury.

Pleasant View Care Home’s initial proposal focused on redesigning laundry carts in an attempt to reduce risks of shoulder injury. Analysis of tasks and subtasks revealed that many of the major tasks involved the shoulders and placed stress on that area. But, to reduce total risk of injury to the shoulders and other body parts, implementation of all recommendations, not just recommendations for cart redesign, are required.

Upon implementation of the recommendations, laundry workers will be asked to participate in the evaluation of the intervention. Evaluation is important in determining the effects of the recommendations and how new cart designs have impacted workers.