An Ergonomic Assessment of Healthcare Rehabilitation Workers

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OSH 663

Who are Healthcare Rehabilitation Workers?

Rehabilitation Therapists

- Physical Therapists (PTs)
- Occupational Therapists (OTs)

Rehabilitation Assistants

- Physical Therapist Assistants (PTAs)
- Occupational Therapists (OTAs)

Who are Healthcare Rehabilitation Workers?

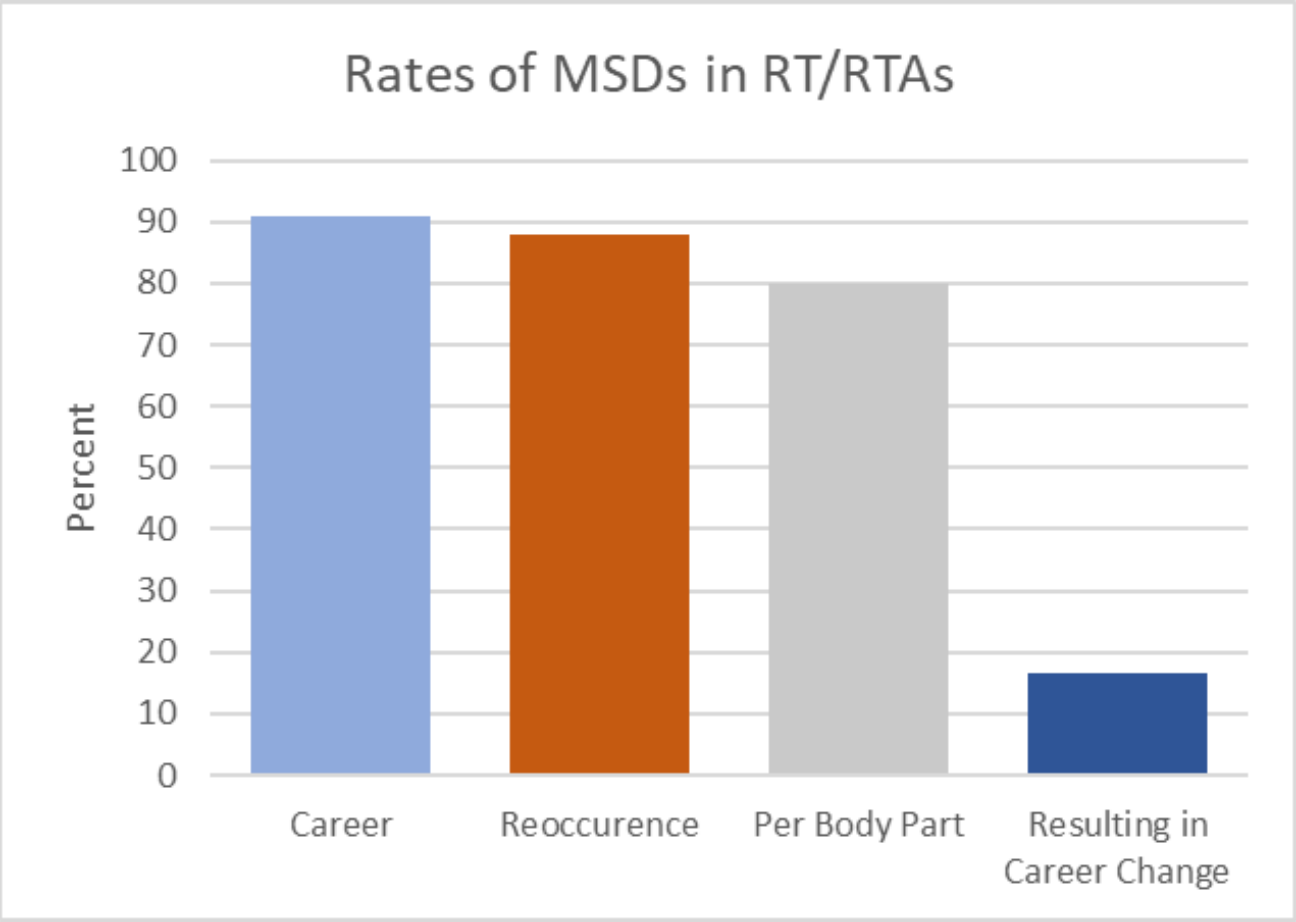
They prevent the onset, symptoms, and progression of limitations/impairments resulting from diseases, disorders, conditions, and injuries.[1]

Common Activities[1]

- Lifting
- Transferring
- Gait (walking) therapy

What are Musculoskeletal Disorders (MSDs)?

- Injuries and disorders affecting the bodies movement or musculoskeletal system[2]
  - Muscles
  - Tendons
  - Ligaments
  - Nerves
  - Discs
  - Blood Vessels
- Ergonomic Risk Factors
  - Force
  - Repetition
  - Poor Posture
- Individual Risk Factors
  - Poor Work Practices
  - Poor Fitness
  - Poor Health Habits
  - Age



Column:

1. Percent population experiencing an MSD in their career.[3]
2. Percent population experiencing reoccurring MSD in their career.[3]
3. Percent population experiencing MSD in at least one body part in 365-day interval.[3]
4. Percent population changing career as a result of an MSD.[1]

Prevalence of MSDs in RT/RTAs

Purpose of the Study

- To characterize ergonomic and biomechanical risk factors associated with gait therapy sessions comprised of:
  - Transfer techniques
    - Sit to Stand Transfers (STS)
    - Bed to Wheelchair Transfer (BTW)
  - Assisted Gait Therapy (AGT)
- Each session was comprised of a transfer followed by an AGT.

Subject ID	0220030520	0225030520	1035030520	1050030520		Average	SD
Age	27	23	25	48		30.8	11.6
Male/Female	F	M	F	F		-	-
Height$_{(cm)}$	157.5	177.8	162.6	157.5		163.8	9.6
Weight$_{(kg)}$	54.9	68.0	81.6	58.5		65.8	11.9
Hand Length $_{(cm)}$	17.1	19.1	16.5	16.8		17.4	1.1
Hand Width $_{(cm)}$	7.6	9.5	8.1	7.6		8.2	0.9
Max Grip Strength $_{(N)}$	72.7	106.3	80.0	53.3		78.1	21.9
Max Push $_{(N)}$	7.0	10.0	7.0	6.0		7.5	1.7
Max Pull $_{(N)}$	9.0	8.0	8.0	7.0		8.0	0.8

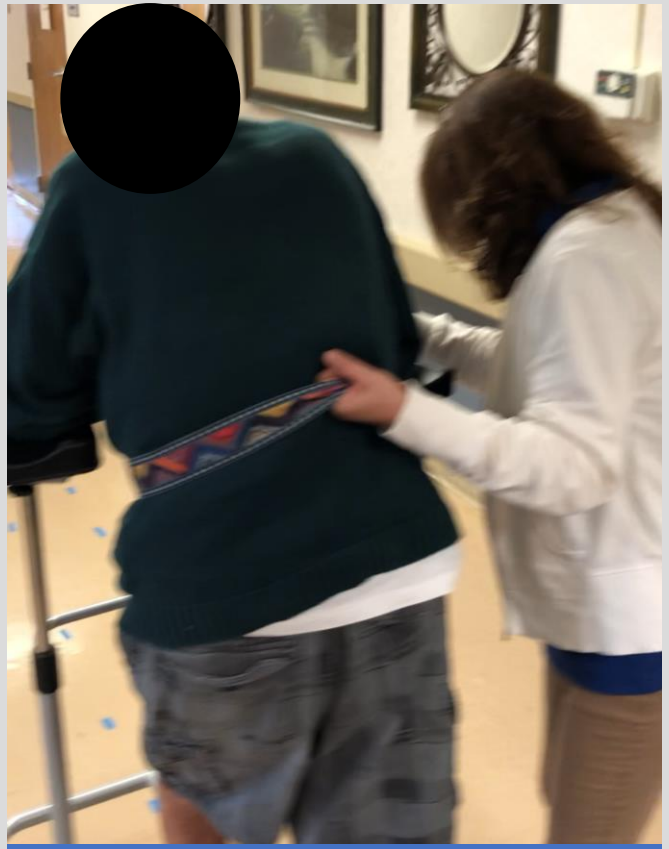
Anthropometric Data

Tasks

- Each RT/RTA performed or assisted in one GTS comprised of a transfer followed by an AGT session.
- Process consisted of:
    1. Retrieve Patient
    2. Perform Transfer: STS or BTW
    3. Assisted Gait Therapy Session (AGT)
    4. Return Patient

Tasks (cont.)

STS Transfer



AGT

Exposure Assessment Analysis Tools

Strain Index (SI)

Rapid Entire Body Assessment (REBA)

3DSSPP Software

Strain Index

- A semi-quantitative tool used to evaluate development of upper extremity MSDs.[4]
- Factors and
  - Intensity of Exertion: changes in posture, expression, changes in force application.
  - Duration of Exertion: time of exertion(s) over total length of activity.
  - Efforts per minute: average efforts per minute.
  - Hand and Wrist Posture: neutral, non neutral, deviations, and near extreme.
  - Speed of work: extremely relaxed, relaxed, normal, rushed, excessive.

Strain Index Data

Strain Index				
Subtask	***Average (L)***	***SD (L)***	***Average (R)***	***SD (R)***
Bed Transfer	22.5	11.0	30.4	17.0
STS Transfer	5.3	6.7	3.7	3.1
Gait Therapy	8.0	7.5	14.0	16.6

Note:	
SI < 3	Safe
SI between 3 and 5	Uncertain
SI > 7	Hazardous

REBA

- REBA is an ergonomic tool used to analyze body postures associated with patient handling in the healthcare industry.[5]
- Posture analysis tool accounting for:
  - Force/load
  - Repetition
  - Coupling
  - Stability

REBA Employee Assessment Worksheet

Task Name: Date:

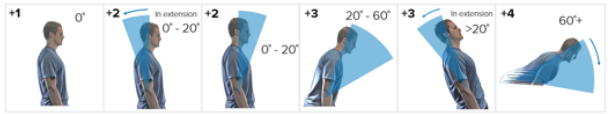
A. Neck, Trunk and Leg Analysis

Step 1: Locate Neck Position

Neck Score

Step 1a: Adjust...
If neck is twisted: +1
If neck is side bending: +1

Step 2: Locate Trunk Position



Step 2a: Adjust...
If trunk is twisted: +1
If trunk is side bending: +1

Trunk Score

Step 3: Legs

Adjust:

Leg Score

Step 4: Look-up Posture Score in Table A

Using values from steps 1-3 above,
Locate score in Table A

Posture Score A

+

Step 5: Add Force/Load Score

If load < 11 lbs. : +0
If load 11 to 22 lbs. : +1
If load > 22 lbs.: +2
Adjust: If shock or rapid build up of force: add +1

Force / Load Score

=

Step 6: Score A, Find Row in Table C

Add values from steps 4 & 5 to obtain Score A.
Find Row in **Table C**.

Score A

Scoring
1 = Negligible Risk
2-3 = Low Risk. Change may be needed.
4-7 = Medium Risk. Further Investigate. Change Soon.
8-10 = High Risk. Investigate and Implement Change
11+ = Very High Risk. Implement Change

Scores

Table A	Neck											
	1				2				3			
	Legs	1	2	3	4	1	2	3	4	1	2	3	4
Trunk Posture Score	1	1	2	3	4	1	2	3	4	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

Table B	Lower Arm					
	1			2		
	Wrist	1	2	3	1	2	3
Upper Arm Score	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Table C	Score B											
Score A	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Table C Score + Activity Score = REBA Score

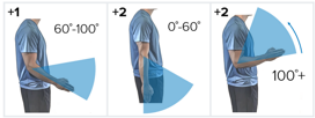
B. Arm and Wrist Analysis

Step 7: Locate Upper Arm Position:

Step 7a: Adjust...
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

Upper Arm Score

Step 8: Locate Lower Arm Position:



Lower Arm Score

Step 9: Locate Wrist Position:

Wrist Score

Step 9a: Adjust...
If wrist is bent from midline or twisted : Add +1

Step 10: Look-up Posture Score in Table B

Using values from steps 7-9 above, locate score in Table B

Posture Score B

+

Step 11: Add Coupling Score

Well fitting Handle and mid range power grip, ***good: +0***
Acceptable but not ideal hand hold or coupling acceptable with another body part, ***fair: +1***
Hand hold not acceptable but possible, ***poor: +2***
No handles, awkward, unsafe with any body part, ***Unacceptable: +3***

Coupling Score

=

Step 12: Score B, Find Column in Table C

Add values from steps 10 &11 to obtain Score B. Find column in **Table C** and match with Score A in row from step 6 to obtain Table C Score.

Score B

Step 13: Activity Score

+1 1 or more body parts are held for longer than 1 minute (static)
+1 Repeated small range actions (more than 4x per minute)
+1 Action causes rapid large range changes in postures or unstable base

Original Worksheet Developed by Dr. Alan Hedge. Based on Technical note: Rapid Entire Body Assessment (REBA), Hignett, McAtamney, Applied Ergonomics 31 (2000) 201-205

REBA Data

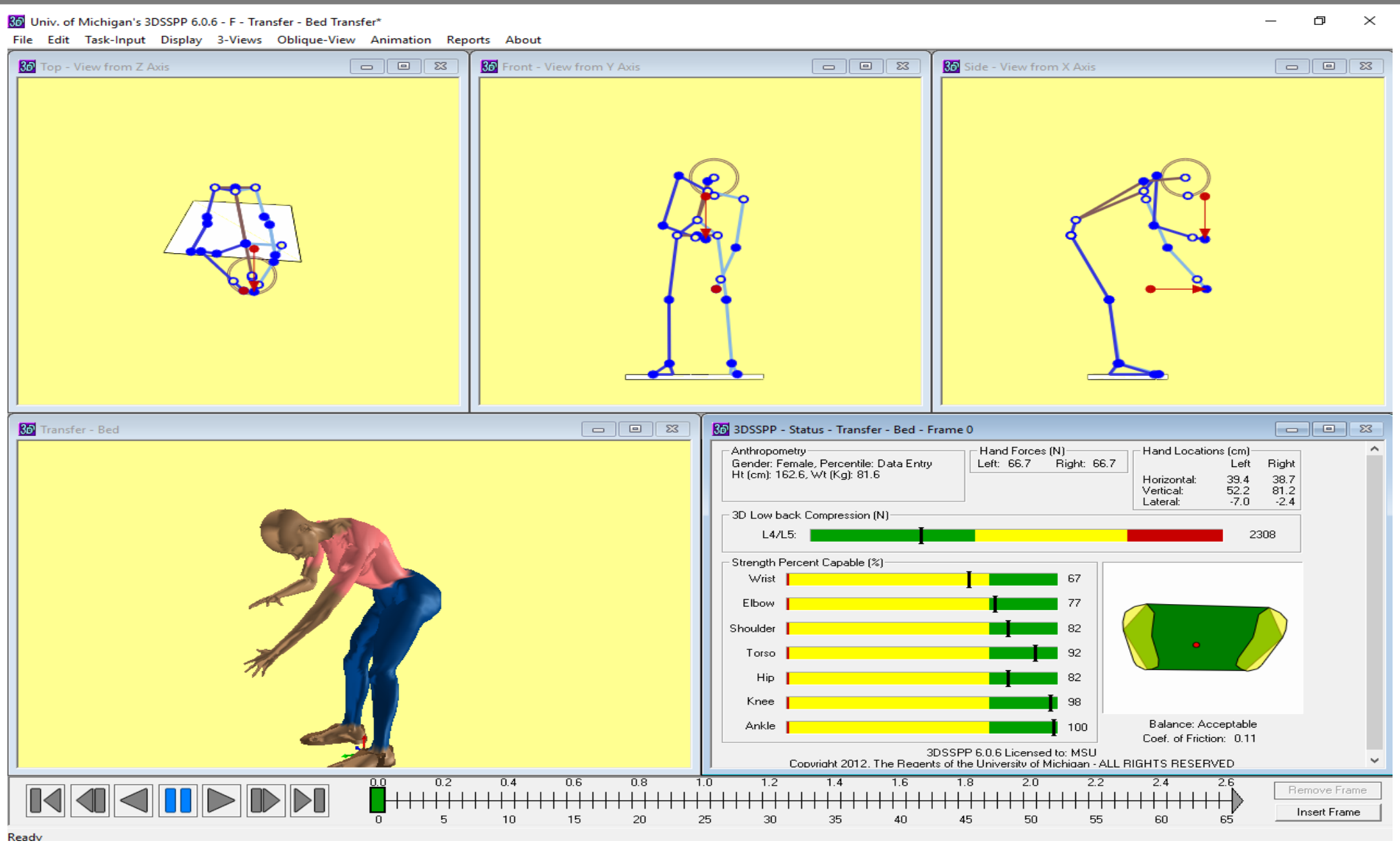
REBA Analysis		
Task	***Average***	***SD***
AGT	8.71	2.6
Bed Transfer	8.67	1.5
STS Transfer	6.00	2.0

Scoring

1	Negligible Risk
2-3	Low Risk: Change may be needed.
4-7	Medium Risk: Further investigate, change soon.
8-10	High Risk: Investigate, implement change.
11+	Very High Risk: Implement change

3DSSPP

- Program by University of Michigan used to predict the back compressive force of the L5/S1.
- Determines percentages of a given population with sufficient strength capability in their elbows, shoulders, torso, hip, knees, and ankles to perform lifting tasks.[6]
- Concessions made for each task.
  - Assumed loads of 15 lbs where subjects are handling patients.


Univ. of Michigan's 3DSSPP 6.0.6 - F - Transfer - Bed Transfer*
File Edit Task-Input Display 3-Views Oblique-View Animation Reports About
Top - View from Z Axis
Front - View from Y Axis
Side - View from X Axis
Transfer - Bed
3DSSPP - Status - Transfer - Bed - Frame 0
Anthropometry
Gender: Female, Percentile: Data Entry
Ht (cm): 162.6, Wt (Kg): 81.6
Hand Forces (N)
Left: 66.7 Right: 66.7
Hand Locations (cm)
Left Right
Horizontal: 39.4 38.7
Vertical: 52.2 81.2
Lateral: -7.0 -2.4
3D Low back Compression (N)
L4/L5: 2308
Strength Percent Capable (%)
Wrist 67
Elbow 77
Shoulder 82
Torso 92
Hip 82
Knee 98
Ankle 100
Balance: Acceptable
Coef. of Friction: 0.11
3DSSPP 6.0.6 Licensed to: MSU
Copyright 2012. The Regents of the University of Michigan - ALL RIGHTS RESERVED
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6
0 5 10 15 20 25 30 35 40 45 50 55 60 65
Remove Frame
Insert Frame
Ready

3DSSPP Data

3DSSPP						
Joint	**AGT Avg**	**AGT SD**	**BTW Avg**	**BTW SD**	**STS Avg**	**STS SD**
Wrist	73	24	76	12	94	2
Elbow	97	1	92	13	88	9
Shoulder	94	4	66	37	74	22
Torso	98	1	91	8	94	5
Hip	93	8	82	6	92	8
Knee	95	7	97	4	89	12
Ankle	95	10	97	3	85	24

Scoring

3432.45 N	Lifting Index of 1 for 99% male, 75% female population.
6364.09 N	Results in lower back pain in 99% females, 75% males.

BTW Transfer Results		
	Average	**SD**
SI (R)	22.5	11
SI (L)	22.5	11
REBA	8.7	1.5
3DSSPP$_{(N)}$	2411.5	146.4

BTW Transfer Analysis

Body Position	*Degrees*
Neck	5°
Trunk	43°
Legs	3°
Upper Arm	64°
Lower Arm	24°
Wrist	5°

BTW Transfer Analysis

- SI scores greater than 7 determined to be hazardous for both right and left hand.
  - Influencing factors: intensity of exertion, duration of exertion, and efforts per minute.
    - Due to patients in sample's inability to support majority of their body weight.
- REBA score greater than 8 suggests high risk involving investigation and implementation of change.
  - Due to trunk flexion between 20-60 degrees.
  - Abduction greater than 20 degrees.

BTW Transfer Analysis (cont.)

- 3DSSPP indicated BTW transfers to be safe.
  - Females
    - 53 percent population have sufficient strength in the shoulder.
    - 69 percent population have sufficient strength in the wrist joint.
- Overall: postural analysis indicates BTW transfer tasks to have highest risk of injury.

STS Transfer Results		
	Average	**SD**
SI (R)	3.7	3.1
SI (L)	5.3	6.7
REBA	6.0	2.0
3DSSPP$_{(N)}$	1523	706.4

STS Transfer Analysis

Body Position	***Degrees***
Neck	46°
Trunk	20°
Legs	25°
Upper Arm	13°
Lower Arm	129°
Wrist	7°

STS Transfer Analysis

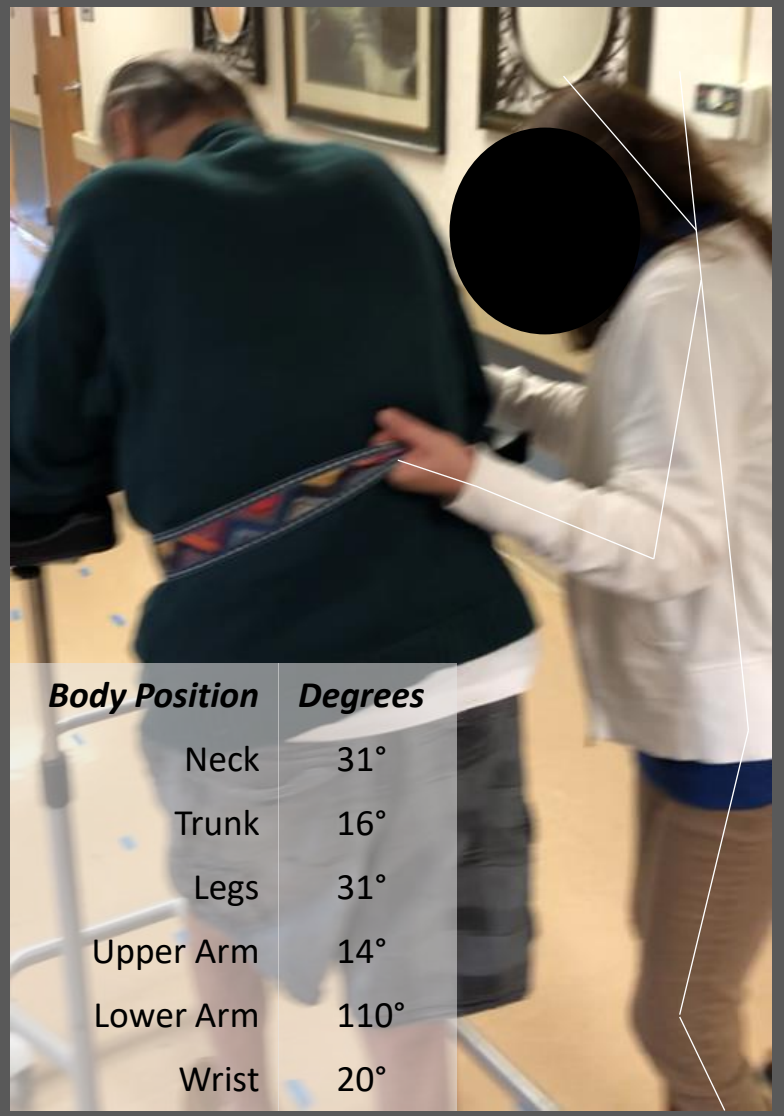
- SI scores greater than 5 indicate uncertainty in risk for this task.
  - Handedness of subjects is predicted to contribute to differences in values as the dominant hand tended to be used to lift patient, less dominant to stabilize the subject.
  - Of note: difference in average scores falls within both SDs.
- REBA score between 4-7 indicates medium risk. Further investigation is needed and change soon.
  - Influencing factors:
    - Average trunk score of 3.0 (flexion greater than 20 degrees).
    - Upper arm score of 2.25 (flexion greater than 20 degrees).

STS Transfer Analysis (cont.)

- 3DSSPP indicated STS transfers to be safe to the lower back.
  - Average percentage of female strength was 74.2 percent.
  - Further investigation needed, as 10% patients body weight was assumed to be the load.
    - Variable patient anthropometry will increase risk to shoulder joint

AGT Transfer Results		
	Average	**SD**
SI (R)	14.0	16.6
SI (L)	8.0	7.5
REBA	8.7	2.6
3DSSPP$_{(N)}$	1440.0	660.2

AGT Analysis



Body Position	***Degrees***
Neck	31°
Trunk	16°
Legs	31°
Upper Arm	14°
Lower Arm	110°
Wrist	20°

AGT Analysis

- SI scores greater than 7 indicate the tasks to be hazardous.
  - Handedness of subjects is predicted to contribute to differences in values as the dominant hand tended to be used to lift patient, less dominant to stabilize the subject.
  - Of note: difference in average scores falls within both SDs.
- REBA score between 8-10 indicates high risk. Indicates the need to investigate and implement change.
  - Influencing factors:
    - Average trunk score of 3.1 (flexion greater than 20 degrees).
    - Upper arm score of 2.7 (flexion greater than 20 degrees).

AGT Analysis (cont.)

- 3DSSPP revealed the task to be safe from injury for the lower lumbar region.
  - Average percentage of female population with sufficient strength in the wrist was 73.4 percent.

Discussion

- Ergonomic exposure assessment tools are in congruence.
- STS
  - Has highest risk lower back and shoulders (3DSSPP).
  - BTW transfers have highest risk of injury.
- AGT
  - Has higher risk compared to STS transfers (SI and REBA).
  - Greatest risk to wrist.

Limitations of this Study

Variability of Subjects

- Sample size
  - n=4
  - Only one male subject.
- Availability of subjects.
  - Patient care
  - Work environment

Variability of Patients

- Height
- Weight
- Strength

Limitations of Assessment Tools

Strain Index

- Only accounts for upper extremities.
- The main factor (intensity of exertion) is based on qualitative assessments of the task.

REBA

- Only evaluates jobs with long cycles or that are non-cyclical.
- Only evaluates one side (left or right) at a time.

3DSSPP

- Weights programed to apply to hands
  - Frequent lifting using elbow nook, and shoulder.
- Does not account for dynamic movement and exertion.

Controls - Transfers

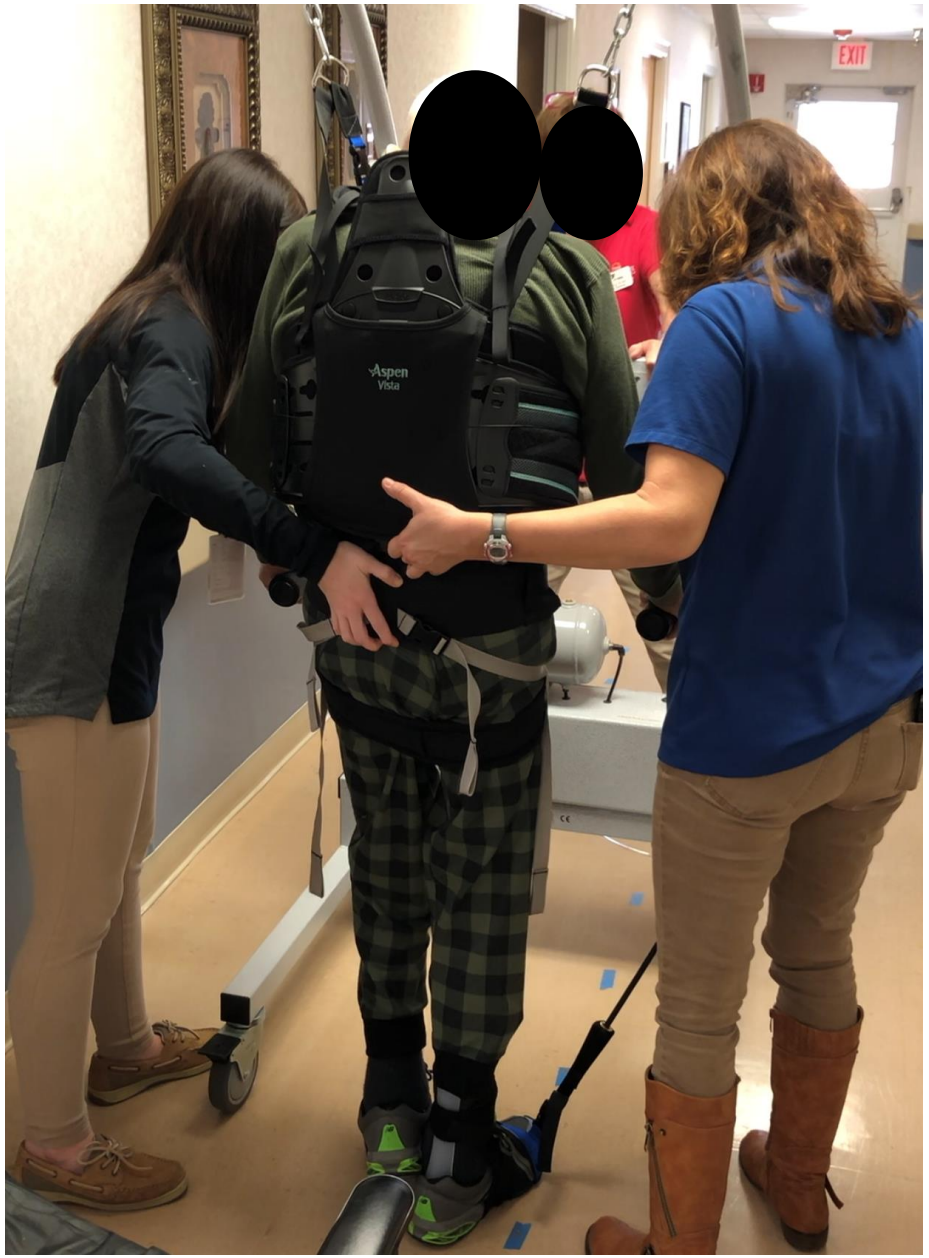
- Engineering
  - *Mechanical patient lifts* reduce force/load exerted on RT/RTAs and limit awkward postures.
  - Increased benefits for patients over STS relying solely on RT/RTAs.
- Administrative
  - *Two person lifts* may not only used on less mobile patients.
    - Not cost effective for all, decrease in work culture moral and increase stress.[7]
  - *Distribution of patients* amongst rehabilitation staff.

Controls - AGT

- Engineering
  - *Intelligent Controlled Assistive Rehabilitation Elliptical (SportsArts)* and
  - *Lokomat Robotic Gait System (Hocoma, Inc).*
    - Reduce force/load and awkward posture.
    - Allow for mass repetition and aerobic conditioning/strength training patients will benefit from instead of limitations of RT/RTA's fatigue.[1]
  - COST[1]

Controls – AGT (cont.)

- Engineering
  - *Overground body support systems* stabilize patient's trunk and provide support for lower extremities.
  - Protects RT/RTA's lower back, the most common injury next to shoulder and wrist.[8]
- Administrative
  - *Group therapy – multiple RTs/RTAs assist with gait training.*



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