Low Back Disorders and Patient Handling

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Most Frequent Nonfatal Occupational Injuries and Illness Requiring Days Away from Work, 2011 (BLS 2012)

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Incidence Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>All occupations</td>
<td>0.7</td>
</tr>
<tr>
<td>Landscaping and groundskeeping</td>
<td>1.6</td>
</tr>
<tr>
<td>Janitors and cleaners, except</td>
<td>2.0</td>
</tr>
<tr>
<td>custodians, custodial workers</td>
<td>2.5</td>
</tr>
<tr>
<td>Registered nurses, general</td>
<td>2.0</td>
</tr>
<tr>
<td>Maintenance and repair workers</td>
<td>2.3</td>
</tr>
</tbody>
</table>

*Incidence rate per 10,000 full-time employees

National Statistics Relative to Patient Handling Risk, 2011 (BLS 2012)

LBP Prevalence/Risk and Patient Handling

Review Study of Low Back Pain (LBP) Prevalence

Work-related back pain in nurses
Hignett, S.

- LBP point prevalence = 17%
- LBP annual prevalence = 40-50%
- LBP lifetime prevalence = 35-80%

The cumulative weight lifted by a nurse in one typical 8-hour shift is equivalent to 1.8 tons (Tuohy-Main, 1997)

LBP Prevalence/Risk and Patient Handling

Work-relatedness of low back pain in nursing personnel: A systematic review
Yassi, A and Lockhard, K.

- Systematic review of literature
- Considered 987 studies; 89 studies met eligibility criteria
- Bradford Hill considerations used (Mix of 21 longitudinal, 36 cross-sectional, 23 biomechanical/ergo, and 9 review studies)
- Conclusions
  - Patient handling confers the highest risk; other duties confound dose-response
  - Associations were strong, consistent, temporally possible, plausible, coherent, and analogous to other exposure-outcomes.
  - Risk OR=1.2-5.5 depending on LBP definition
**Recent Studies Indicating LBP Prevalence/Risk and Patient Handling**

Patient transfers and assistive devices: Prospective cohort study on the risk for occupational back injury among healthcare workers


- Prospective cohort study of work-related LBP risk factors in healthcare workers
- 5017 female eldercare workers in Denmark
- Daily patient transfers incr. LBP risk (OR = 1.75)
- Attributable fraction risk estimate = 36%

**Current State of LBP Treatment**

- A precise diagnosis is unknown in 80% to 90% of patients with low back pain (Deyo & Weinstein, 2001)
- Few diagnosed through imaging (10-15%)
- Spend $90 Billion per year treating back problems in the U.S. (about the same as we spend on cancer) (JAMA, 2011)
- Cost of treatment increased 65% in 8 years (Martin, et al., 2008)
- Less than 50% of surgeries are successful (Weinstein, 2006)
- Value of prevention

**Low Back Pain Risk Factor Environment**

Social & Org. Factors

Individual Factors

Physical Factors

(NRC/IOM, 2001)

**Biomechanical Implications**

Expanded OSHA 300 log as metric for bariatric patient-handling staff injuries


- Patients with BMI > 35 = < 10% of patients
- Handling patients with BMI > 35 associated with:
  - Turning and Repositioning patient implicated in:
    - 31% of cases
    - 29.8% injuries
    - 27.9 % lost time
    - 37.2% restricted time
  - Usually performed using biomechanics and NOT equipment

**Biomechanics is More than Strength**

- Biomechanics is more than just strength.
**Traditional Biomechanical Logic**

Load – Tolerance Relationship and Risk

![Diagram](image)

**Intervertebral Disc**

- The primary source of low back pain is suspected to be the disc (Nachemson, 1976; Videman and Batte, 1996; An, 2004)
- Noxious stimulation of the disc produces symptoms of low back pain
- Annular tears and reduced disc height are associated with low back pain (Videman et. al., 2003)
- Mechanical load can be the stimulus for pain (Marras, 2008)
- Disc problems are very common in those reporting LBP (Cheung, et al., 2009)

**Intervertebral Disc**

- Nucleus pulposus
- Anulus fibrosis
- Intervertebral disc
- Endplate

**Disc Degeneration**

- ![Images](image)

**How Cumulative Trauma Develops in the Spine**

- Vertebral Endplate

**Disc Nutrition Pathways**

- Vertebral Body
- Vertebral Endplate
- Disc
How Cumulative Trauma Develops in the Spine

Vertebral Endplate

Microfractures

Vertebral Body

Vertebral Endplate

Disc

Scar Tissue Development

Vertebral Endplate

 Scar Tissue

Vertebral Body

Vertebral Endplate

Disc

Compression

3400-6400 N Limit (NIOSH, 1981)

Anterior/Posterior (A/P) Shear

750-1000 N Limit (McGill, 1994; Yingling, 1999)

Lateral Shear

750-1000 N Limit (Miller, 1986)

Spine Tolerance Limits

Spine Loads Results from the Reaction of Internal Forces to External Forces

Internal Force

External Force

Biomechanical Modeling of the Low Back

Can we assess specific spine tissue loads in-vivo?

How Cumulative Trauma Develops in the Spine

Disc Degeneration and Cumulative Trauma

Scar Tissue

Vertebral Endplate

Disc

Vertebral Body

How Cumulative Trauma Develops in the Spine

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Laboratory Assessment of Push-Pull

Assessment of Spine Forces Based Upon Task

Spine Loads at Different Levels

Assessment of Specific Tissue Loads

Our Early Patient Lifting Studies

Patient Lifting Origins/ Destinations

- Bed to/from wheelchair with arms
- Bed to/from wheelchair with one arm removed
- Portable commode chair to/from hospital chair

A comprehensive analysis of low-back disorder risk and spinal loading during the transferring and repositioning of patients using different techniques.

Keywords: Patient handling, Spinal loads, Biomechanics, LBD.

Although spine injuries suffer from low-back injuries to an alarming extent worldwide, there has been limited research quantifying the risk for the specific tasks performed by the patient handlers. This paper aims to fill a gap in the literature by presenting a comprehensive biomechanical model to simulate the risk of LBD of 17 participants performing several common patient lifting tasks. Eight of the participants were female and the rest male. Several patient scenarios were executed, as well as simulating a 30 kg patient in bed.
Patient Transfer Techniques

- 1 person hug
- 2 person hook and toss
- 2 person gait belt

Pre-Lifting during Patient Handling

Spine Compression as a Function of Transfer Task

<table>
<thead>
<tr>
<th>Transfer Task</th>
<th>One-Person</th>
<th>Two-Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheelchair to Bed</td>
<td>2000</td>
<td>3000</td>
</tr>
<tr>
<td>Bed to Wheelchair</td>
<td>4000</td>
<td>5000</td>
</tr>
<tr>
<td>Wheelchair to Chair</td>
<td>6000</td>
<td>7000</td>
</tr>
<tr>
<td>Commode to Chair</td>
<td>8000</td>
<td>9000</td>
</tr>
</tbody>
</table>

Spine Compression as a Function of Transfer Technique

<table>
<thead>
<tr>
<th>Transfer Technique</th>
<th>One-Person</th>
<th>Two-Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hug</td>
<td>2000</td>
<td>3000</td>
</tr>
<tr>
<td>Hook &amp; Belt</td>
<td>4000</td>
<td>5000</td>
</tr>
<tr>
<td>Left Side Two Person</td>
<td>6000</td>
<td>7000</td>
</tr>
<tr>
<td>Right Side Two Person</td>
<td>8000</td>
<td>9000</td>
</tr>
</tbody>
</table>

Patient Repositioning Techniques

Spine Compression as a Function of Repositioning Technique

<table>
<thead>
<tr>
<th>Repositioning Technique</th>
<th>One Person</th>
<th>Left Side Two Person</th>
<th>Right Side Two Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hook</td>
<td>2000</td>
<td>3000</td>
<td>4000</td>
</tr>
<tr>
<td>Sheet &amp; Shoulder Hook</td>
<td>5000</td>
<td>6000</td>
<td>7000</td>
</tr>
<tr>
<td>Left Side Two Person</td>
<td>8000</td>
<td>9000</td>
<td>10000</td>
</tr>
<tr>
<td>Right Side Two Person</td>
<td>11000</td>
<td>12000</td>
<td>13000</td>
</tr>
</tbody>
</table>
Implication from our First Study

- Risk associated with one- or two- caregiver patient lifting
  - Conclusion - There is no safe way to lift a patient manually!
  - The magnitude of spine loading is so great that any benefit of using proper body mechanics is negligible
- Suggestion – Must employ patient lifting device

Body Mechanics?

Physical therapists vs. nurses in a rehabilitation hospital: comparing prevalence of work-related musculoskeletal complaints and working conditions
- Compared LBP rate in 26 PTs vs. 54 nurses in a Rehab. Hospital
- LBP was more prevalent in PTs than nurses
- Conclusion: should initiate a “no-lift” policy

Patient Handling Interventions

The Effect of Ergonomic Interventions in Healthcare Facilities on Musculoskeletal Disorders
Kaveh Fujishiro, et al.

- Intervention Effectiveness (prospective observation of 100 units)

Patient Handling Change in MSD Rates per Intervention (baseline to follow-up)

<table>
<thead>
<tr>
<th>Type of Intervention</th>
<th># Units Decreased or no change</th>
<th>Number of Units Increased</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce Bending</td>
<td>12 (75%)</td>
<td>4 (25%)</td>
<td>0.056</td>
</tr>
<tr>
<td>Zero Lift</td>
<td>32 (72.7%)</td>
<td>12 (27.3%)</td>
<td>0.002</td>
</tr>
<tr>
<td>Reduce Carrying</td>
<td>7 (87.5%)</td>
<td>1 (12.5%)</td>
<td>0.031</td>
</tr>
<tr>
<td>Multiple Interventions</td>
<td>26 (81.3%)</td>
<td>6 (18.7%)</td>
<td>0.001</td>
</tr>
<tr>
<td>All</td>
<td>77 (77.0%)</td>
<td>23 (23.0%)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

(Fujishiro et al. 2005)

Our Previous Studies

- Risk associated with one- or two- caregiver patient lifting
  - Conclusion - There is no safe way to lift patient manually!
  - Suggestion - Employ Patient Lifting assistance device
- Intervention Effectiveness (prospective observation of 100 units)
  - Conclusion – Often observe significant reduction in risk
  - Not all interventions created equally!
  - 23% of lift interventions had increased reporting
Lifting Transformed into Pushing and Pulling

Pushing and Pulling

Pushing/Maneuvering Patients

Patient Lift Devices

Experimental Conditions

Patients

Lift system
- Ceiling based
- Floor based – large wheel vs. small wheel
  - Large wheels (5 inch diameter rear; 4 inch diameter front)
  - Small wheels (3 inch diameter rear; 2 inch diameter front)

Floor Surface
- Hard Floor
- Carpet

Patient weight
- 125 lb (56.8 Kg)
- 160 lb (72.7 Kg)
- 360 lb (163 Kg)
Course Path and Required Control

Ceiling Lift Trial and Analysis

Floor Based Lift used on Carpet

Floor Based Lift used on Carpet

Risk Exposure Quantification: Patient Handling
Risk Exposure Quantification: Patient Handling

Results:
Spine Load Magnitudes

Compression as a Function of Vertebral Level

Lateral Shear as a Function of Vertebral Level
A/P Shear as a Function of Vertebral Level

L3 A/P Shear as a Function of Required Control

Significant Effects

### Significant Effects

<table>
<thead>
<tr>
<th></th>
<th>Lateral Shear</th>
<th>Compression</th>
<th>A/P Shear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Handling System (System)</td>
<td>0.003*</td>
<td>0.015*</td>
<td>0.060</td>
</tr>
<tr>
<td>Patient Weight (Weight)</td>
<td>0.124</td>
<td>0.069</td>
<td>0.057</td>
</tr>
<tr>
<td>Required Control over System (Control)</td>
<td>0.006*</td>
<td>0.105</td>
<td>0.000*</td>
</tr>
<tr>
<td>System*Weight</td>
<td>0.015*</td>
<td>0.189</td>
<td>0.133</td>
</tr>
<tr>
<td>System*Control</td>
<td>0.106</td>
<td>0.002*</td>
<td>0.001*</td>
</tr>
<tr>
<td>Weight*Control</td>
<td>0.496</td>
<td>0.695</td>
<td>0.497</td>
</tr>
<tr>
<td>System<em>Weight</em>Control</td>
<td>0.154</td>
<td>0.081</td>
<td>0.076</td>
</tr>
</tbody>
</table>

### Summary of Patient Push Findings

- A/P shear is a mechanism of risk when pushing patients
- Floor based risk increases with increased required control
- Controlling lift in confined space (bathroom) poses greatest risk
- Turning (gradual or sharp turn) poses next greatest risk
- Pushing without turning has minimal risk (but greater than ceiling lift)
- No increased risk with ceiling lift as a function of control
- Operating floor based lifts on carpet or with small wheels greatly magnifies risk
- Small wheels and carpet together create hazardous conditions when control is required.

L3 A/P Shear as a Function of Patient Weight

*Not statistically significant*
Social & Org. Factors
Individual Factors
Physical Factors

Non-Physical Factors Affect Spine Loading:

Individual & Psychosocial Factors

Study Procedure
1. Un-Stressed Session - Perform Lift Tasks
2. Experiment Interruption / Experimenters Called Out of Room
3. Stressed Session - Perform Same Lift Tasks

Spine Loading Response to Psychosocial Stress

Variability of biomechanical responses to psychosocial stress among 25 subjects

Differences in Spinal Loads Between Personality Traits in Response to Psychosocial Stress

% Increase

Compress
Lat Shear

Extraverts
Introverts
Musculoskeletal Control and Tissue Load

Pain From the Brain: Central Sensitization

Wellness and Wellbeing

Five Core Interconnected Dimensions of Wellbeing

Wellbeing can offset the effects of age in health-related costs

Thriving Employees have 62% Lower Health-Related Costs Compared to those Who are Suffering
Turnover Costs: 35-52% Lower for Thriving Employees

![Graph showing turnover costs](image)

(Thrivograph, 2010)

Health Care Costs are Directly Related to the Number of Thriving Dimensions

![Graph showing health care costs](image)

(Thrivograph, 2010)

Pathways to Spine Tissue Force Generation

- Auditory
- Visual
- Tactile
- Muscle/Ligament Tension

Antagonist Contraction
Antagonist Cocontraction Leads to Increased Tissue Load

Conclusions

- Low back forces and pain are initiated by spine loading due to a mix of:
  - Physical Work
  - Psychosocial and Organizational
  - Individual Factors
- Appreciation for trunk muscle coactivity is the key to understanding loading conditions

Conclusions

- There is no safe way to lift a patient manually (loads are too great for body mechanics to make a difference)
- There is surveillance evidence that interventions can help control risk
- Lifting devices can help but the degree of control required greatly influences risk
- Use ceiling lifts if at all possible
- When using floor mounted lifts –
  - Use extreme caution when turning and controlling patient within the bathroom (this is where the risk occurs)
  - Use extreme caution when using these systems on carpet
  - Don’t use small wheels with floor based systems!

Thank You!

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