ERGONOMICS IN THE OPERATING ROOM SETTING

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• I do not endorse any specific vendor or manufacturer of patient handling equipment or devices.
• I have no financial relationships or interests to disclose.

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Ergonomics definition
From the Board of Certification in Professional Ergonomics:
Ergonomics is a body of knowledge about human abilities, human limitations and human characteristics that are relevant to design. Ergonomic design is the application of this body of knowledge to the design of tools, machines, systems, tasks, jobs and environments for safe, comfortable and effective use.

Anthropometry
The measurement of living human individuals for the purposes of understanding human physical variation
There are two types of measurements:
• Static – distance of bones between joint centers
• Dynamic-distance measured when the body is in motion

A way to reduce wear and tear on the human body
## Anthropometry

### Defining the Population
- The designer needs to consider the gender (male, female or both) and race of the people who are going to be performing the work or using the tool.
- The designer selects the percentile that best suits the situation being considered.
- Often designing for a changing workforce means designing or accommodating a more inclusive population.

### Anthropometric Design

#### Design for Extreme
- **Height** – design clearance for tall people – doorways
- **Reach** – designed to be reached by short (vertically challenged) people – light switch

#### Design for Average
- Public seating – designed to accommodate the median of the population

#### Design for Range:
- Adjustable car seat – leg and arm length, seated eye height
- Headset – head diameter
- Wristwatch Band – wrist circumference

## CULTURAL DIFFERENCES

Different cultures sit differently

## Why have an Ergonomics Program?

**GOOD ERGONOMICS IS GOOD ECONOMICS!**
- Ergonomics reduces work-related injuries
- Ergonomics improves performance and increases productivity!
- Studies indicate the most frequent reason for absenteeism is musculoskeletal pain

## Important features of an Ergonomics Program

- Safety should be a Core Value
- Visible Management commitment always #1
- For success to be sustainable, there must be a culture change institution-wide
- Employees must feel a part of the process
- Do not assume that if you purchase equipment, staff will use it

## Ergonomics = Preventive Medicine

1. Understand ergonomics principles and be able to apply the principles during a workplace walkthrough
2. Incorporate evaluation of risk factors in H&P
3. Request employer’s obtain ergonomics evaluations when appropriate
4. Encourage employers to institute a workplace ergonomics program
Statistical Analysis of Injury Data / BENCHMARKING DATA

**Statistical analysis** of injury data elements should be compiled. Important data elements include date/time of injury, type of injury, body region, job title, hospital/unit location, severity (OSHA), injury source, injury activity, root cause, cost.

**OHSN (Occupational Health Safety Network):**
A new voluntary and secure electronic occupational health surveillance system developed by NIOSH. First version is limited to the healthcare sector. Focuses on non-infectious occupational safety and health issues among healthcare personnel. Website: cdc.gov/niosh/topics/ohsn/plan.html

What makes hospitals such hazardous workplaces?

**Unique risks:**
- Hospital workers lift, reposition, and transfer patients who have limited mobility. Other unique risks include needlesticks and violence.

**Unique culture:**
- Caregivers feel an ethical duty to “do no harm” to patients. Some will put their own safety and health at risk to help a patient.

**They are not assembly lines:**
- Employees must react to unpredictable events with split-second decisions.

Source: OSHA.gov

The true cost of injuries

**Direct Costs:**
- Compensation
- Payment
- Workers comp costs

**Indirect Costs:**
- Replacing employee
- Loss in productivity
- Investigation time
- Overtime pay
- Staff morale
- Break up work team

Source: OSHA.gov, DOL

**Estimated costs of replacing a nurse:**
- $27,000 to $103,000
- Estimated costs include separation, recruiting, hiring, orientation, and training.
- Some estimates also account for lost productivity while a replacement is being hired and trained.
- Injuries and stress are common reasons why nurses leave the profession.

Source: OSHA.gov

Workplace Injuries and Illnesses Come at a High Cost

- **$15,860:** the average workers’ compensation claim for a hospital injury between 2006 and 2011, according to a national survey of roughly 1,000 hospitals.
- Another data source suggests an average cost of $22,300 for claims involving lost time, compared with $900 for non-lost-time claims.

Source: OSHA.gov, DOL

Illness and Injury rates 1989 - 2011

- In 2011, U.S. hospitals recorded 58,860 work-related injuries and illnesses that caused employees to miss work. In terms of lost-time case rates, it is more hazardous to work in a hospital than in construction or manufacturing. “Days away from work” include only the more severe injuries, and they do not account for injuries where an employee continues to work, but on modified duty. Thus, the problem is even larger than the graph suggests.

Source: Bureau of Labor Statistics

Injuries: hospitals vs other industries

This graph compares hospitals with selected other industries in terms of injuries and illnesses resulting in days away from work in 2011. It shows rates in terms of cases per 10,000 FTEs.

On average, U.S. hospitals recorded 6.8 work-related injuries and illnesses for every 100 full-time employees in 2011. That is almost twice the rate for private industry as a whole.

Source: Bureau of Labor Statistics
Top Five Causes of Injury Among Hospital Workers

<table>
<thead>
<tr>
<th>Cause</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overexertion and muscular strain</td>
<td>43%</td>
</tr>
<tr>
<td>Puncture and laceration</td>
<td>15%</td>
</tr>
<tr>
<td>Contact with objects</td>
<td>13%</td>
</tr>
<tr>
<td>Exposure to substances</td>
<td>8%</td>
</tr>
<tr>
<td>All other causes</td>
<td>1%</td>
</tr>
</tbody>
</table>

Hospital Injuries Resulting in Days Away from Work, by Type

- Sprains and strains: 14%
- Burns: 11%
- Fractures: 7%
- Gaps and punctures: 5%
- Multiple trauma: 3%
- Somersaults: 10%
- Sudden death: 1%

Risk Factors which may lead to Musculoskeletal Disorders

- Force
- Awkward Posture
- Repetition
- Duration
- Vibration
- Contact Stress
- Environmental Factors
- Personal Factors
- Home/Leisure

When performing an ergonomics assessment look for these risk factors. Addressing the risk factors will assist in determining the proper solutions.

Risk Factor: Forceful Exertions

- Tasks requiring forceful exertions place higher loads on muscles, tendons, ligaments and joints
- Influenced by:
  - Weight
  - Bulkiness of load
  - Use of awkward posture
  - Slipperiness of load (requiring increased grip force)
  - Presence of vibration
  - Use of pinch grip rather than power grip

Risk Factor: Awkward Postures

Avoid Awkward Postures!!
Awkward Posture and Strength

- Grip strength is related to wrist position
  - Neutral – 100% strength
  - 45 degrees dorsiflexion – 80% strength
  - 45 degrees wrist extension – 60% strength

Risk Factor: Repetitive Motions

Motions repeated frequently (e.g. every few seconds for prolonged periods) e.g. 8 hour shift

Risk Factor: Duration

Amount of time the worker is exposed to the risk factor
Influenced by:
- Job tasks requiring the use of the same muscles causing sustained muscle contraction.
- Static postures maintained by the surgical staff

Risk Factor: Vibration

Occurs when a specific part of the body comes in contact with a vibrating object.
Whole body vibration – can occur when operating heavy duty vehicles or large machinery
Hospital staff: floor buffing machines, bone saws etc.

Personal Factors

- Poor posture
- Excess weight
- Lack of exercise
- Lack of rest
- Improper nutrition
- Smoking
- Underlying medical conditions
- Stress
- Job satisfaction

Other Risk Factors to consider

- Cold temperatures
- Insufficient rest breaks for recovery
- Machine paced work
- Unfamiliar or unaccustomed work
Manual Lifting

- Manual lifting is the primary cause of back injury in healthcare workers
- Most common manual lifts exceed the NIOSH recommended weight limit for lifting (RWL).

NIOSH Lifting Equation
- A tool for assessing the physical stress of manual lifting tasks
- Applies to standing, two-handed, smooth lifting and lowering of stable objects in areas without space constraints under ideal conditions.

Revised NIOSH Lifting Equation
- Provides methods for evaluating asymmetrical lifting tasks, a more diverse range of tasks and lifts of objects with less than optimal couplings between the object and the workers hands
- Does not apply to:
  - lifting unstable loads (center of mass varies during lift activity) or space restrictions,
  - Based on assumption that manual handling activities other than lifting are minimal and do not require significant energy expenditure

NIOSH Lifting Equation - RWL

Recommended Weight Limit (RWL)
- RWL is the principle product of the NIOSH Lift Equation
- RWL = the weight of the load that nearly all healthy workers could perform over a substantial period of time (e.g. 8 hours) without an increased risk of developing low back pain.

The Ergonomic Challenge

The adult human form is an awkward burden to lift or carry. Weighing 200 pounds or more, it has no handles, it is not rigid, and it is susceptible to severe damage if mishandled or dropped.

(Lancet, 1965)

High Risk Tasks: Operating Room

The Challenge:
Surgical teams come in many sizes and shapes but the team needs to work together on one surface in a small space

High Risk Tasks: Operating Room

- Standing long periods of time
- Lifting and holding patient’s extremities
- Holding retractors for long periods of time
- Transferring patients on and off operating room tables/beds
- Changing, lifting and moving equipment
- Repositioning patients on operating room beds
Minimally Invasive Surgery (MIS)

Physician and Staff Risk Factors

- Static postures - static postures have been demonstrated to be more disabling and harmful than dynamic postures are since muscles and tendons build up lactic acid and toxins when held for prolonged periods in same postures
- Repetitive motions
- Duration
- Awkward positions
- Forceful exertion

ENVIRONMENTAL CHALLENGES

- Overcrowding due to lack of space for equipment/staff
- Lead aprons
- Trip hazards due to wires, equipment
- Uneven floor surfaces (thresholds)
- Carpeting vs. smooth surface
- Ramps

Goal: To Eliminate or Minimize Risk Factors

Hierarchy of controls:

- Engineering Controls
- Administrative Controls
- Work Practice Controls

Engineering Controls

- Mechanical lifts, motorized beds
- Height adjustable tables/containers
- Adjustable tools, furniture, equipment
- Arranging objects/supplies within power zone
- When possible, proactive design with attention to ergonomics considerations

- Engineering controls are similar to the principles of human factors engineering which makes it easy to do the right and safe thing and hard to do the wrong thing.

Open vs Laparoscopic Surgery (MIS)

Open
- Surgeons work in line with visual axis
- Three-dimensional direct vision
- Direct tactile feedback
- Greater degree of freedom

MIS
- Two-dimensional vision
- Some loss of depth perception
- Loss of tactile feedback
- Views surgical field on a video monitor
- Loss of peripheral vision
- 4 degrees of freedom of movement
- More static posture
- Instruments available only in standard size

Physical Issues Reported by Surgeons Performing MIS

- Neck pain
- Shoulder pain due to abduction of scapula "laparoscopic shoulder"
- Backache
- Hand finger joint pain
- Tenosynovitis
- Burning eyes
- Stress exhaustion
- Hand muscle injury
- Reports of thenar neuropathy due to use of awkward thumb grips in case of laparoscopic pistol grip instruments
- Female surgeons who wore size 5.5-6.5 reported more cases of discomfort in shoulder, neck and upper back than men wearing the same size glove


Minimally Invasive Surgery (MIS)

Main tasks that influence surgeons posture:
1. Monitor position
2. Foot pedal use
3. Operating table height
4. Hand-held instrument design
5. Static body posture


Date of submission: 27/03/2010, Date of acceptance: 16/06/2010

Source of Support: Nil, Conflict of Interest: None declared.

High Risk OR Tasks:
Minimally Invasive Surgery (MIS)

Physicians:
Laparoscopy equipment:
- Monitor position dictates body posture
- Instrument design – axial handles are held with ulnar wrist deviation, angled ring handles are held with radial wrist deviation
- Simultaneous handling of instruments with different designs lead to awkward positioning
- Foot switches to operate electric cutting, coagulation and suction
- Height of OR tables frequently too high for MIS

Possible solutions:
- Additional monitor with adjustable monitors
- 15-15x magnification on the recording camera and the output to the display
- Redesign / size selection of instrument handles
- Adjust table height to prevent shoulder elevation


Source of Support: Nil, Conflict of Interest: None declared.

Improved physical ergonomics of laparoscopic surgery

Figure 1. New designs for laparoscopic products that satisfy the new ergonomic guidelines and allow a better posture for surgeons and assistants.
A. New design for a deesctor forsc
B. New design for a grasping forceps
C. New design for a grasping forceps
D. New design for a needle holder
E. New design for a holding support for atraumatic
F. New design for a needle holder
G. New design for a foot pedal
H. Overview of all new products in the OR to support the reduced posture of surgeons and assistants.

M.A. van Voden, J.J. Jakiłowicz and U. Rassertern

High Risk OR Tasks:
Minimally Invasive Surgery (MIS)

OR Team Risks:
- Camera holder – frequently needs to hold camera to side of field
- Overcrowding – awkward positions
- Equipment set up
- Slips, trips and falls due to wires

Possible solutions:
- Wireless technology to minimize trip hazard
- Proactive OR design to address equipment placement

M.A. van Voden, J.J. Jakiłowicz and U. Rassertern
### High Risk Tasks: Operating Room

<table>
<thead>
<tr>
<th>Risk factor/Hazard</th>
<th>Possible Solutions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static positioning: prolonged standing, holding retractors for long periods, trunk flexion, and neck flexion</td>
<td>Scrub nurse stand for no more than 4 hours/day in static position. (strategy adopted in the Netherlands)</td>
</tr>
<tr>
<td>Micro breaks</td>
<td></td>
</tr>
<tr>
<td>Sitting on draped stool</td>
<td></td>
</tr>
<tr>
<td>Floor mats</td>
<td></td>
</tr>
</tbody>
</table>

### High Risk Tasks: Operating Room

<table>
<thead>
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<th>Risk factor/Hazard</th>
<th>Possible Solution:</th>
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</thead>
<tbody>
<tr>
<td>Lead aprons</td>
<td>Look for companies who make lightweight aprons or aprons in 2 pieces – vest and skirt</td>
</tr>
</tbody>
</table>

Source: OR Manager, Vol. 21 No. 7 2005

### Robotic surgery

**The wave of the future?**

**Pros**
- Decreased surgical team fatigue
- Smaller incisions
- Less post-op pain
- Faster return to normal activities
- Less scarring

**Cons**
- Cost – hefty purchase and maintenance cost
- Possible patient complications due to patient positioning
- Specialized training
- Prolonged duration of surgery

### Patient Handling in the Operating Room

<table>
<thead>
<tr>
<th>Risk Factor:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient handling: lateral transfers on and off OR tables</td>
</tr>
<tr>
<td>Repositioning on OR tables</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Possible solutions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friction reducing devices</td>
</tr>
<tr>
<td>Air assisted devices</td>
</tr>
<tr>
<td>Ceiling lifts</td>
</tr>
</tbody>
</table>
Supine-to-Supine Transfer: Various Devices

Supine-to-Supine Transfer: Friction Reducing Device

Supine-to-Supine Transfer: Air-Assisted Lateral Transfer Device

Prone-to-Prone Transfer: Ceiling Lift & Sling

Recommendations

- Based on weight:
  - One nurse can safely log roll a patient weighing up to 75 lbs.
  - Two caregivers are required if the patient weighs more than 75 lbs, but not more than 150 lbs.
  - Three caregivers are needed if the patient weighs more than 150 lbs but not more than 234 lbs.

Ergo Tool #3: Lifting & Holding Legs, Arms, & Head
Ergo Tool #7: Specific Recommendations for Common OR Equipment

<table>
<thead>
<tr>
<th>Description</th>
<th>One Caregiver</th>
<th>Two Caregivers</th>
<th>Powered Transport Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital bed - unoccupied</td>
<td>29.8 lbs.</td>
<td>6.2 lbs.</td>
<td>&gt;200 ft.</td>
</tr>
<tr>
<td>Specialty equipment carts</td>
<td>39.3 lbs.</td>
<td>6.1 lbs.</td>
<td>&gt;200 ft.</td>
</tr>
<tr>
<td>OR stretcher - occupied (200 lbs.)</td>
<td>40.0 lbs.</td>
<td>7.9 lbs.</td>
<td>&gt;200 ft.</td>
</tr>
<tr>
<td>Bed - occupied (300 lbs)</td>
<td>50.0 lbs.</td>
<td>10.8 lbs.</td>
<td>&gt;200 ft.</td>
</tr>
<tr>
<td>Specialty OR beds - unoccupied</td>
<td>69.7 lbs.</td>
<td>22.5 lbs.</td>
<td>&lt;100 ft.</td>
</tr>
<tr>
<td>OR bed - unoccupied</td>
<td>61.3 lbs.</td>
<td>26.3 lbs.</td>
<td>&lt;25 ft.</td>
</tr>
<tr>
<td>OR bed - occupied (300 lbs.)</td>
<td>112.4 lbs.</td>
<td>40.5 lbs.</td>
<td>&lt;25 ft.</td>
</tr>
<tr>
<td>Specialty OR beds - occupied (300 lbs.)</td>
<td>154.2 lbs.</td>
<td>90.1 lbs.</td>
<td>&lt;25 ft.</td>
</tr>
</tbody>
</table>

Powered wheelchair mover

- Powered bed or wheelchair movers need to be thoroughly evaluated prior to purchase.
- Involve end-users in equipment selection
- Storage considerations
- Employee training should be part of competencies
- Ongoing training and initial employee orientation
- Consider standardizing motorized beds

**Ergo Tool #6: Lifting & Carrying Supplies/Equipment**

The Association for the Advancement of Medical Instrumentation, the organization that sets the standards for safety and efficacy of medical instrumentation suggests that instrument trays weigh a maximum of 25 lbs.
Cart / Stretcher / Bed Design

- Larger wheels are better
- Casters need to be well maintained
- Consider powered beds/stretchers, especially for bariatric units.
- Remove rugs from patient care areas.
- Watch out for thresholds – very hazardous

Computer Carts

Considerations when evaluating computer carts
- Cart footprint
- Ease of movement
- Ease of adjustability
- Sit to stand carts
- Keyboard and mouse platform on the same level
- Height adjustable monitors
- Employee ergonomics training

Emergency Evacuation

Air assisted transport device

The user on the top has many awkward positions. The users on the bottom are positioned properly for sitting or standing.
Material Handling for the Healthcare Worker

The Hospital of Central Connecticut
Offered by the departments of Employee Health and Health Promotion

Sterile Processing Department:
Proper Storage

- Organize storage to place heavier objects in the body’s power zone and lighter objects on the top and bottom of the shelves
- Provide safe, sturdy stepstools if needed for vertically challenged personnel.

Unsafe Storage  Correct Storage

Pushing and Pulling

Pushing is generally preferable to pulling. Pushing allows the employee to use large muscle groups and apply more force to the load. Pulling carries a greater risk of strain and injury.

Resources

NIOSH 1997 – Elements of Ergonomics Programs
OSHA Nursing Home guidelines 2003
www.NIOSH.gov
www.OSHA.gov

RESOURCES

- Published Ergonomic Guidelines – Cal-OSHA
- Oregon OSHA website
- American Nurses Association
- AORN
OSHA Data Sources – slides 17-20


3. Bureau of Labor Statistics. Case and Demographic Incidence Rates. Accessed September 2013. In this figure, "hospitals" represents NAICS 622, which covers all types of hospitals. "Construction" represents NAICS supersector GP1CON, and "professional and business services" represents NAICS supersector GP1PBC. Data are limited to private industry.


7. OSHA. 2012. 2011 National Survey of Safety and Health Practices. OSHA Directorate of Standards and Guidance, Office of Regulatory Analysis. This statistic comes from the response to the question, "At your establishment, do you have a system or program for managing employee safety and health?" A total of 598 hospitals responded to the survey, and the results have been weighted by establishment size. This question had a weighted response of 90.6 percent "yes."

Any Questions?

Thank You!

Musculoskeletal Disorders and Workplace Factors: A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity and Low Back – the most comprehensive compilation to date of the epidemiologic research on the relation between selected MSD’s and exposure to physical factors at work.