Defining Risk:

- “Environmental, behavioral or biological factor confirmed by temporal sequence that directly increases probability a disease will occur... if absent / removed, reduces that probability”

- Job features that “pose a biomechanical stress to the worker”

- Must affect the involved tissue with sufficient exposure

(Melhorn, 2014)
Our Patients and Work:

- Identify / prioritize issues that require abatement and safety interventions
- Help determine causation
- Assist with return to work / managing employee return to work restrictions

Why worry about risk??

- Identify / prioritize issues that require abatement and safety interventions
- Help determine causation
- Assist with return to work / managing employee return to work restrictions
**Musculoskeletal Disorders:**

- **Muscle:** Fatigue
- **Tendon / ligament:** Strain
- **Nerve:** Compression
The Big question….

- Musculoskeletal Disorder (MSD): “is this related to the job…..” (directly and indirectly)
  - How do we answer the question?
  - Are we applying science / evidence?
  - Are we helping or hurting our patients with our answer?
- “physicians (and nurses) have the power to increase or decrease illness / disability with their words” – Ring, 2007

Steps to determine causation:

1. Identify evidence of disease
2. Review and assess the available epidemiologic evidence for a causal relationship
3. Obtain and assess the evidence of exposure
   - Best actual measurements of employee
   - Least reliable: job title or self report of exposure
4. Consider other relevant factors
5. Judge the validity of testimony
6. Form conclusions about work-relatedness of the disease
  (Melhorn et al, 2014)
Patient description: Perception is reality……

Or is it?

- Hand therapists: direct observation better than self report (Catalano et al, 1999)
- “overall, workers and supervisors overestimated the presence of risk in assessing jobs” (Winnemuller et al, 2004)
- Self assessment by means of questionnaire is not a reliable method to measure duration of computer use… typically overestimated total use by 1.6 hours” (Heinrich, et al, 2005)

“If there is no science to guide our response, do not speak as if there is”
Louis, 1992
Understanding work tasks and injury risk

Defining Risk:

- “Environmental, behavioral or biological factor confirmed by temporal sequence that directly increases probability a disease will occur... if absent / removed, reduces that probability”

- Job features that “pose a biomechanical stress to the worker”

- Must affect the involved tissue with sufficient exposure

(Melhorn et al., 2014, p.10)
Industrial Risk Factors

Occupational Risk Factors: Most Common

- Postures: Awkward, Static, Sustained
- Force
- Contact stress
- Repetition (?)
- Vibration
- Temperature

(NIOSH, 1997)

“Not all MSDs are related to work activities. Many MSDs are related to non-work activities, genetic causes, age, and other factors. MSDs may also result from accidents such as trips or falls.”

- OSHA Nursing home guidelines
MSD’s occur:
“When time between successive exertions or work period is insufficient for recovery and adaptation, and affected tissue becomes irritated or inflamed.”

- Armstrong, 1992

IE: Lack of *Recovery Time*

---

**Soft Tissue injury principles**

*Primary variables:*

1. **Intensity of Exertion**: force to perform task / exertion one time:
   - Characterized as % maximum strength

2. **Duration of Exertion**: How long the exertion is applied
   - Duration of exertion + recovery = one exertional cycle

3. **Duration of recovery**: Time between exertions when tissue is not stressed
   - (Moore & Garg, 1995)
**Risk Factors: Extreme Postures**

- **Extreme:** Non-Neutral position or motion that overuses end range positioning or consistently deviates from the midrange position of function
  - Kieler, 1998

**Risk Factor: Extreme Posture**

- **OSHA:** Wrist: flexion > 20°, extension > 30° more than 2-4 hours
- **Washington State:** Wrist > 45° with repetition/force more than 2-4 hours
Shoulder Postures

- ANSI: flexion / abduction
  - Neutral: 0-45
  - Non-neutral: 45-90,
  - Extreme: >90
- OSHA: elbow above mid torso, arm unsupported
- Washington state:
  - Caution: Work over head > 2 hours
  - Hazard: work overhead > 4 hours

Risk Factor: Static Postures

- Holding position > 1 minute (McAtamney 1993)
- Total duration, Frequency, Recovery time: critical information
- Unable to change or adjust

Example:
- Hold tool
- Hold posture
**Risk Factor: Force**

- “the biomechanical involvement necessary to carry out a given motion”
  - (Rodgers, 1998)

- “The higher the force, the lower the frequency the task can be performed to allow adequate recovery”
  - (Occhipinti, 1998)

- Critical to define objectively vs. patient perception!

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**How much force?**

- Rodgers (1988): *repetitive operations*: 20% weakest operator’s maximal pinch

- OSHA, Washington State, RULA:
  - **Pinch** unsupported object 2 lbs or more /per hand, or with force of 4 lbs. or more, more than specified time per shift
  - **Grip** unsupported object 10 lbs or more /per hand, or with force of 10 lbs. or more, more than specified time per shift
  - **Max lift/carry** – Liberty Mutual materials handling tables
So how much required strength?

- Rodgers (1983): repetitive operations: 20% weakest operators maximal pinch
- Snook & Ciriello: pinch (summarized, Ergonomics Today, 1/7/02)

<table>
<thead>
<tr>
<th>Repetition Rate</th>
<th>% of Female Industrial Population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90%</td>
</tr>
<tr>
<td>2 / min.</td>
<td>2 lb.</td>
</tr>
<tr>
<td>5 / min.</td>
<td>2 lb.</td>
</tr>
<tr>
<td>20 / min.</td>
<td>1 lb.</td>
</tr>
</tbody>
</table>

Strength:

- Maximum: varies with individuals
- What job requires is constant
  - Measure when possible
  - Review associated postures!  (Rodgers, 1995)
Measuring force:

(Winnemuller, 2004)

Effort Scales in Job Assessment

Psychophysical scale (Borg, 1970)

<table>
<thead>
<tr>
<th>Light</th>
<th>Moderately weak</th>
<th>Weak</th>
<th>Moderate</th>
<th>Somewhat strong</th>
<th>Strong</th>
<th>Heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Strain Index, (Moore & Garg, 1995)

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Rating Criterion</th>
<th>Observation</th>
<th>Observations</th>
<th>Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity of Exertion</td>
<td>Light</td>
<td>Barely noticeable or relaxed effort [0-2]</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Somewhat Hard</td>
<td>Noticeable or definite effort [3]</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hard</td>
<td>Obvious effort; Unchanged expression [4-5]</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very Hard</td>
<td>Substantial effort; Changed expression [6-7]</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Near Maximal</td>
<td>Uses shoulder or trunk for force [8-10]</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>
**Risk Factor: Contact Stress**

- Sharp edges
- Tool length
- Tool contour
- Wrist rest
- Deep pressure

**Risk Factor: Repetition**

- Little data to show as sole cause and then only with high rate and prolonged exposure (*Melhorn et al., 2014*)

- Usually a problem in combination with force or posture (*Melhorn et al., 2014*)

- Reduction in force or repetition may decrease CTD occurrence (*Gallagher et al., 2015*)
Repetition defined

• No single metric: affected by: posture, motion, force (Garg et al, 2011)

• Definitions and issues:
  • Cycle time of 30 sec. or more than 50% time in same fundamental motion (Armstrong et al., 1987)
    • Moore & Garg, 1994: this definition “over-classified jobs not associated with morbidity”
    • Colombini, 1998: could under-classify job with identical fundamental motions within longer cycle and with additional risk factors associated with job performance

Cycle time: 30 seconds: Low Force + Repetition

Cycle time: 2 minutes, Low force, Repetition + Posture
Other Definitions

- ANSI: varies with joint
  - Shoulder: >90 motions per hour, combinations
  - Wrist / Hand: 900 motions per hour, combinations

- OSHA: motions repeated frequently for prolonged periods (several hours) without any break or over an entire work shift

- Washington State: same motion every few seconds, 6 hours with no other risk factor

Repetitive Task versus motion?

- Repetitive task sequence
- Repetitive motion
Vibration

- Hand held power tools (10-40 Hz): palm sanders, jig saws, grinders, chainsaws, jack hammers, percussive tools
  - Not battery operated, electric with motor away from handle, or in power equipment (vacuum cleaners, loaders, graders, backhoes) (Bovenzi et al, 2015)

- Vibration affects nerve function but also:
  - May result in higher hand force to hold tool
  - Require static hold

- Low association with vibration and carpal tunnel syndrome (Harris-Adamson, 2015, Melhorn et al., 2014)
Keyboard Definitions

- OSHA: Intensive keying as in data entry, more than 4 hours per shift.

- ANSI: > 15,000 keystrokes / hour, more than 4 hours / shift

- Washington State: > 7 hours intensive keying or > 4 hours intensive keying + wrist posture > 45°

Evidence for MSD causation:

- High prevalence Upper limb/neck pain in general population (as high as 50%) (Burton et al, 2009)

- Personal risk and occupational risk associated with MSD’s

- Most MSD’s multifactorial

- Combination of risk factors higher association than single risk factor exposure (Melhorn, 2014)
Task analysis:

- Define the work cycle (s) and work element
- Identify motions / forces
- Identify frequency
- Identify duration of exposure within cycle

Washington State Checklist

### LOW BACK

<table>
<thead>
<tr>
<th>Posture</th>
<th>Overall: None</th>
<th>Caution</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working with the back bent forward more than 30° (without support or the ability to vary posture)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 2 hours total per day</td>
<td>Caution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 4 hours total per day</td>
<td>Hazard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working with the back bent forward more than 45° (without support or the ability to vary posture)</td>
<td>More than 1 hour total per day</td>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>More than 2 hours total per day</td>
<td>Hazard</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### WEIGHTLIFTING

<table>
<thead>
<tr>
<th>Weightlifting</th>
<th>Overall: None</th>
<th>Caution</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifting object weighing more than 75 pounds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One or more times per day</td>
<td>Hazard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifting object weighing more than 85 pounds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 10 times per day</td>
<td>Caution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 20 times per day</td>
<td>Hazard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifting objects weighing above the shoulders, below the knees or at arms length more than 25 times per day</td>
<td>More than 10 pounds</td>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>More than 20 pounds</td>
<td>Hazard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifting objects weighing more than 10 pounds if done more than twice per minute</td>
<td>More than 2 hours total per day</td>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>More than 4 hours total per day</td>
<td>Hazard</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### HANDS AND WRISTS

<table>
<thead>
<tr>
<th>Pinch Grip</th>
<th>Overall: None</th>
<th>Caution</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinching an unsupported object(s) weighing 2 or more pounds per hand, or pinching with a force of 4 or more pounds per hand</td>
<td>More than 2 hours total per day</td>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>More than 4 hours total per day</td>
<td>Hazard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pinching Caution plus wrist deviation</td>
<td>More than 3 hours total per day</td>
<td>Hazard</td>
<td></td>
</tr>
<tr>
<td>Pinching Caution plus highly repetitive motion</td>
<td>More than 3 hours total per day</td>
<td>Hazard</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grip Grip</th>
<th>Overall: None</th>
<th>Caution</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gripping an unsupported object(s) weighing 10 or more pounds per hand, or gripping with a force of 10 or more pounds per hand (comparable to clamping light duty automotive/jumper cables)</td>
<td>More than 2 hours total per day</td>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>More than 4 hours total per day</td>
<td>Hazard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gripping Caution plus wrist deviation</td>
<td>More than 3 hours total per day</td>
<td>Hazard</td>
<td></td>
</tr>
<tr>
<td>Gripping Caution plus highly repetitive motion</td>
<td>More than 3 hours total per day</td>
<td>Hazard</td>
<td></td>
</tr>
</tbody>
</table>
### Repetitive Motion of Hands

<table>
<thead>
<tr>
<th>Repetition Caution</th>
<th>More than 2 hours total per day</th>
<th>Caution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeating the same motion with the elbows, wrists, or hands (excluding keying activities) with little or no variation every few seconds</td>
<td>More than 6 hours total per day</td>
<td>Hazard</td>
</tr>
<tr>
<td>Repetition Caution plus high, forceful exertions with the hand(s) and wrist deviation</td>
<td>More than 2 hours total per day</td>
<td>Hazard</td>
</tr>
</tbody>
</table>

### Keying

<table>
<thead>
<tr>
<th>Keying</th>
<th>More than 4 hours per day</th>
<th>Caution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive keying</td>
<td>More than 7 hours per day</td>
<td>Hazard</td>
</tr>
<tr>
<td>Intensive keying with wrist deviations</td>
<td>More than 4 hours per day</td>
<td>Hazard</td>
</tr>
</tbody>
</table>

### Hand Impacts

<table>
<thead>
<tr>
<th>Hand Impacts</th>
<th>More than 10 times per hour</th>
<th>Caution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using the hand (heel/base of palm) as a hammer more than 2 hours per day</td>
<td>More than 1 time per minute</td>
<td>Hazard</td>
</tr>
</tbody>
</table>

### Hand-Arm Vibration

<table>
<thead>
<tr>
<th>Hand-Arm Vibration</th>
<th>More than 2 hours per day</th>
<th>Caution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using grinders, sanders, jigsaws or other hand tools that typically have moderate vibration levels</td>
<td>More than 4 hours per day</td>
<td>Hazard</td>
</tr>
<tr>
<td>Using impact wrenches, carpet strippers, chain saws, percussive tools (jack hammers, scalers, riveting or chipping hammers) or other tools that typically have high vibration levels</td>
<td>More than 30 minutes per day</td>
<td>Caution</td>
</tr>
<tr>
<td></td>
<td>More than 1 hour per day</td>
<td>Hazard</td>
</tr>
</tbody>
</table>
Computer workstation Considerations

Components:

- The chair
- The desk surface / angles
- The keyboard / tray
- The keyboard & mouse
- The monitor
- Telephone
- Overall layout

The Sit/Stand issue: Electric height adjustable

Start positions

Sit/stand positions
Desk Top Standing workstations

Problem:
- Add height to sitting station on 29” high desk
- Limits usable surface standing
- Can’t adjust components separately

Standing Recommendations:
- **Standing**: (Cornell University Ergonomics Web, 2016)
  - More tiring / requires 30% more energy than sitting
  - Increases cardiovascular load
  - Paces strain on circulatory system, legs and feet
  - Increases risk of: varicose veins
- **Therefore**: (Hedge, 2014)
  - 5 hours sitting, 2 hours standing, .5 hours moving (approx.): (20 min. sit, 8 min stand, 2 min move)
  - Stretching is very important (Koehne, 2015, Hedge, 2014)
Standing issues / data:

- 40-60 minutes per day most commonly chosen (Robertson, 2013)
- Tend stand closer to keyboard/mouse/desk edge (Lin, 2016)
- Must be able to adjust monitor and get optimal wrist position
- Training: regress to all sit without
- Flooring, footwear impact
- Most important: change posture regularly
- Ideally: change in tasks reminds

Office Evaluation: Rapid Office Strain Assessment (ROSA)

Job Discussion / Analysis from the clinic:

- Divide job into tasks
- Determine % of time in each task
- Identify tasks that are perceived as difficult
- Evaluate all tasks > 10% of shift or perceived as difficult

(Rodgers, 1995)

Thank You