Intervention Studies in the Workplace to Prevent Musculoskeletal Disorders: Evidence Based Medicine

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Introduction Systematic Reviews Three RCTs Conclusions
Conclusions

Research Action

- Need for workplace RCTs, especially ‘Limited Evidence’ interventions
- Allow non-RCTs in systematic reviews
- Include intermediate risk factor measures in RCTs
- For RCTs attention to details ..... (CONSORT; Altman 2001)
  - Allocation concealment
  - Blinding
  - Intention-to-treat analysis
  - Contamination
  - Complete data on dropouts
Overhead Drilling

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Systematic Reviews

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Conclusions
Overhead Drilling

- shoulder fatigue
- MS Disorders
- Falling
- Dust
- Noise
- vibration

-force: 240N
### RCT Workplace Studies: Upper Extremities

<table>
<thead>
<tr>
<th>Group</th>
<th>Equipment</th>
<th>N</th>
</tr>
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<tbody>
<tr>
<td>Customer service</td>
<td>keyboard keyswitch</td>
<td>20</td>
</tr>
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<td>Engineers</td>
<td>split keyboards</td>
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</tr>
<tr>
<td>Customer service</td>
<td>armboard, trackball</td>
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</tr>
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<td>armboard, vertical mouse</td>
<td>200</td>
</tr>
<tr>
<td>Garment</td>
<td>chair</td>
<td>580</td>
</tr>
<tr>
<td>Dental hygienists</td>
<td>scaling tool</td>
<td>120</td>
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<tr>
<td>Computer users</td>
<td>exercise, breaks</td>
<td>240</td>
</tr>
<tr>
<td>Construction</td>
<td>overhead drill</td>
<td>110</td>
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## RCT Workplace Studies: Upper Extremities

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<thead>
<tr>
<th>Role</th>
<th>Equipment Description</th>
<th>Sample Size</th>
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Introduction  
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Conclusions
RCTs: Gold Standard for EBM and Systematic Reviews

Policy influenced by EBM and Comparative Effectiveness
Medical Treatment Guidelines
Insurance Company Policies
Regulations (e.g., California)

American College of Occupational and Environmental Medicine
Medical Practice Guidelines
Systematic Reviews
Upper Extremity MSDs


- AAOS clinical practice treatment guidelines for carpal tunnel syndrome. 2008
Systematic Reviews
Upper Extremity MSDs


- **AAOS clinical practice treatment guidelines for carpal tunnel syndrome.** 2008
## Systematic Review – Cochrane Library
### (Slavin 1995, Verhagen 2006)

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Formulate research question</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Specify search terms</td>
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</tr>
<tr>
<td>3</td>
<td>Literature search</td>
<td>1752</td>
</tr>
<tr>
<td>4</td>
<td>Selection of studies</td>
<td>21</td>
</tr>
<tr>
<td>5</td>
<td>Assessment of risk bias</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Evidence synthesis</td>
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</table>

### Introduction

Systematic Reviews

### Systematic Reviews

Three RCTs

### Conclusions
Conclusions Differ
(Verhagen 2006)

- **Limited** evidence for positive effect for
  - Alternative geometry keyboards
  - Alternative key switch displacement keyboards
  - Breaks during computer work
  -Massage added to manual therapy
  - Manual therapy added to exercise
  - Exercise compared to massage

- **Conflicting** evidence for
  - Exercises
  - Ergonomic programs
# Data Synthesis - Cochrane

<table>
<thead>
<tr>
<th>Level of Evidence</th>
<th>Minimum quality and quantity of studies</th>
<th>Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong</td>
<td>≥ 2 high quality RCTs</td>
<td>Generally consistent</td>
</tr>
<tr>
<td>Moderate</td>
<td>1 high quality and ≥ 2 low quality RCTs</td>
<td>Generally consistent</td>
</tr>
<tr>
<td>Limited</td>
<td>1 RCT</td>
<td>Generally consistent</td>
</tr>
<tr>
<td>Conflicting</td>
<td>Multiple RCTs</td>
<td>Inconsistent findings</td>
</tr>
<tr>
<td>None</td>
<td>No RCTs</td>
<td></td>
</tr>
</tbody>
</table>

- **Introduction**
- **Systematic Reviews**
- **Three RCTs**
- **Conclusions**
<table>
<thead>
<tr>
<th>Randomization</th>
<th>Treatment allocation concealed</th>
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<tr>
<td>Baseline comparability</td>
<td>Participant blinded</td>
</tr>
<tr>
<td>Provider blinded</td>
<td>Assessor blinded</td>
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<tr>
<td>Analyzed by intention-to-treat</td>
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Cochrane & ACOEM Quality Rating of RCTs

Quality: high ≥ 5 of 9 (7 of 22 studies)

Randomization
Treatment allocation concealed
Baseline comparability
Participant blinded
Provider blinded
Assessor blinded
Analyzed by intention-to-treat
Eligibility criteria specified
Point estimates and measures of variability for outcomes
Cochrane & ACOEM Quality Rating of RCTs

Quality: high ≥ 5 of 9  (7 of 22 studies)
Quality: high ≥ 8 of 11

Randomization
Treatment allocation concealed
Baseline comparability
Participant blinded
Provider blinded
Assessor blinded
Analyzed by intention-to-treat
Eligibility criteria specified
Point estimates and measures of variability for outcomes
Co-interventions avoided
Compliance acceptable
Dropout rate acceptable
Timing of assessments

Introduction  Systematic Reviews  Three RCTs  Conclusions
No quality ratings on ...

Sample size
Study duration
Outcomes
Effect of four computer keyboards in computer users with upper extremity musculoskeletal disorders


<table>
<thead>
<tr>
<th>Design:</th>
<th>Six month RCT in the workplace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects:</td>
<td>80 LLNL employees</td>
</tr>
<tr>
<td></td>
<td>tendonitis or carpal tunnel syndrome</td>
</tr>
<tr>
<td></td>
<td>&gt; 20 hours per week of computer use</td>
</tr>
<tr>
<td>Intervention:</td>
<td>placebo and 3 alternative keyboards</td>
</tr>
<tr>
<td>Outcomes:</td>
<td>- pain severity scores every 6 weeks for 6 months</td>
</tr>
<tr>
<td></td>
<td>- change function (modified DASH)</td>
</tr>
<tr>
<td></td>
<td>- physical examination changes</td>
</tr>
<tr>
<td>Funding:</td>
<td>DOE (W-7045-ENG-48)</td>
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</table>

Introduction Systematic Reviews Three RCTs Conclusions
Limitations

- No participant blinding
- Treatment allocation not concealed
- No measurement of intermediate factors
  - keyboard adjustment
  - wrist postures
A Randomized Controlled Trial Evaluating the Effects of Two Workstation Interventions on Upper Body Pain and Incident Musculoskeletal Disorders among Computer Operators.
Rempel et al. OEM 2006, 63(5):300-306

Call Center

Introduction Systematic Reviews Three RCTs Conclusions
4 Treatment Arms

1. Ergonomics training (n=46)
2. Training and trackball (n=45)
3. Training and armboard (n=46)
4. Training and trackball and armboard (n=45)

Marble Mouse, Logitech

Morency forearm support
Participants (N=182)

Baseline Questionnaire

**Weekly pain Q (0 – 10 pt scale)**
- Neck/shoulder
- Hand/wrist/arm (R & L)
- Pain medication

If pain > 5, or pain meds ≥ 2 days
- Physical exam - structured
- Physician blinded to intervention

**Outcome Measures**
- Δ pain score
- Incident musculoskeletal disorder

Introduction  Systematic Reviews  **Three RCTs**  Conclusions
Results

269 attended recruitment meetings

182 agreed to participate and eligible - randomized

113 weekly pain score > 5 or used pain meds ≥ 2 days
   (11 did not qualify for PE (acute, not WR, preex))
   (7 refused PE or on leave)

95 received physical exam

77 received a diagnosis (18 w/o findings)

63 with incident diagnosis
   39 neck-shoulder
   29 R distal upper extremity
   17 L distal upper extremity

57 dropouts (21 job change, 10 discomfort)
Analysis (Intention to Treat)

Δ pain score: Linear regression
Incident case: Cox proportional hazards model

covariates in models
  forced  pre-intervention pain
  age
  gender
  composite psychological strain
  iso-strain

other covariates included if > 0.05 effect on model

• No trackball X armboard INTERACTION
## Results

- Effect of forearm support on pain score change
- Final models adjusted for covariates

<table>
<thead>
<tr>
<th>Region</th>
<th>Beta Coefficient</th>
<th>95% CI</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck-Shoulder Region</td>
<td>-0.48</td>
<td>[-0.85 to -0.10]</td>
<td>0.01</td>
</tr>
<tr>
<td>Right Distal Upper Extremity</td>
<td>-0.66</td>
<td>[-1.06 to -0.25]</td>
<td>0.002</td>
</tr>
<tr>
<td>Left Distal Upper Extremity</td>
<td>-0.30</td>
<td>[-0.63 to 0.03]</td>
<td>0.08</td>
</tr>
</tbody>
</table>

[covariates: forced plus current smoker, educational level, body mass index]

- Effect size NS = 0.31 (score change/SD of change score)
Results

- Effect of forearm support on incident cases
- Final models adjusted for covariates
- Hazard ratio < 1.0 is protective

<table>
<thead>
<tr>
<th>Hazard Ratio</th>
<th>95% CI</th>
<th>P Value</th>
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<tr>
<td>Neck-Shoulders Disorders</td>
<td>0.49</td>
<td>[0.24 to 0.97]</td>
</tr>
<tr>
<td>R Distal Upper Extremity Disorders</td>
<td>0.64</td>
<td>[0.28 to 1.45]</td>
</tr>
<tr>
<td>L Distal Upper Extremity Disorders</td>
<td>0.29</td>
<td>[0.08 to 1.05]</td>
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Covariates: forced plus ethnicity, pain medication, current smoker, hand intensive activity outside of work, seniority, total break minutes per day, educational level, job title, typing speed, body mass index, low back pain score, previous surgery in upper body
Results

Return-On-Investment (ROI)

- Cost of intervention and installation $75
- Actual annual incidence of WC claims for neck shoulder=0.014
- Assume annual incidence reduced by 49%
- Typical non-traumatic neck shoulder claim: $11,450
- ROI: 10.6 months

- No change in productivity
Lessons

- Allocation concealed
- Physician blinding
- Drop out rate 25%
  - Included in intention-to-treat analysis
- Compliance: visit one month after intervention
- No subject blinding but confusion
- Contamination
- No intermediate variables: posture, shoulder muscle load
Overhead Drilling

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3rd Generation Device

Rempel et al. Ergonomics (in press); Rempel et al. Prof Safety 2007

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3rd Generation Device
Rempel et al. Ergonomics (in press); Rempel et al. Prof Safety 2007

N=23

Significantly Improved
regional body pain
usability
shoulder posture
head posture
hand force

No difference
productivity

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Summary
Workplace RCTs

Access

Workplaces are dynamic production & staffing changes

Exposures are complex biomechanical psychosocial
Conclusions

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- Allow non-RCTs in systematic reviews
- Measure intermediate risk factors in RCTs
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Public Policy Action
Thank you

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