



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

David Rempel, MD, MPH

**Department of Medicine, University of California San Francisco
School of Public Health, University of California Berkeley
Department of Bioengineering, University of California Berkeley**

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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Overhead Drilling

- shoulder fatigue
 - MS Disorders
 - Falling
 - Dust
 - Noise
 - vibration
- force: 240N



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RCT Workplace Studies: Upper Extremities

Customer service Engineers	keyboard keyswitch	(N=20)
Customer service Engineers	split keyboards	(N=80)
Customer service Engineers	armboard, trackball	(N=182)
Garment Dental hygienists	armboard, vertical mouse	(N=200)
Computer users	chair	(N=580)
Computer users	scaling tool	(N=120)
Computer users	exercise, breaks	(N=240)
Construction	overhead drill	(N=110)



RCT Workplace Studies: Upper Extremities

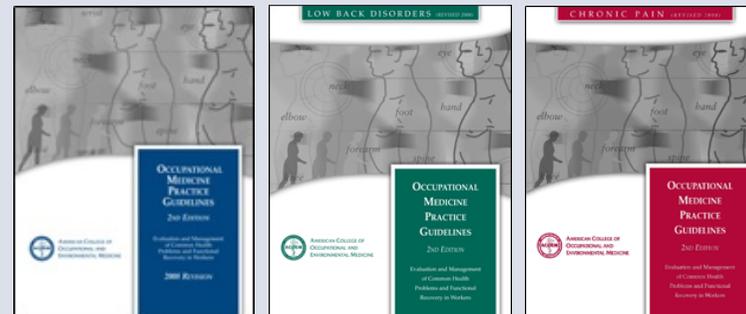
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Why

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

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Systematic Reviews

Upper Extremity MSDs

- **Workplace Interventions to Prevent Musculoskeletal and Visual Symptoms and Disorders among Computer Users: A Systematic Review.** J Occupational Rehab 2006; 16(3):317-50. Brewer S, Van Erg D, Amick BC, Irvin E, Daum K, Gerr F, Moore JS, Cullen K, Rempel D.
- **Ergonomic and physiotherapeutic interventions for treating work-related complaints of the arm, neck or shoulder in adults.** Cochrane Database of Systematic Reviews 2006, Issue 3. Art. No.: CD003471. DOI: 10.1002/14651858.CD003471.pub3. Verhagen AP, Karelis C, Bierma-Zeinstra SMA, Burdorf L, Feleus A, Dahaghin S, de Vet HCW, Koes BW.
- **Systematic review of the role of occupational health and safety interventions in the prevention of upper extremity musculoskeletal symptoms, signs, disorders, injuries, claims and lost time.** Institute for Work & Health, 2008, Amick BC, Kennedy CA, Dennerlein JT, Brewer S, Catli S, Williams R, Serra C, Gerr F, Irvin E, Mahood Q, Franzblau A, Van Eerd D, Evanoff B, Rempel D.
- **ACOEM Occupational Medicine Practice Guidelines: Hand/Wrist**, 2009.
- **AAOS clinical practice treatment guidelines for carpal tunnel syndrome**. 2008



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Systematic Review – Cochrane Library

(Slavin 1995, Verhagen 2006)

Step	Description	
1	Formulate research question	
2	Specify search terms	
3	Literature search	1752
4	Selection of studies	21
5	Assessment of risk bias	
6	Evidence synthesis	



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

Level of Evidence	Minimum quality and quantity of studies	Consistency
Strong	≥ 2 high quality RCTs	Generally consistent
Moderate	1 high quality and ≥ 2 low quality RCTs	Generally consistent
Limited	1 RCT	Generally consistent
Conflicting	Multiple RCTs	Inconsistent findings
None	No RCTs	



Cochrane & ACOEM Quality Rating of RCTs

Randomization

Treatment allocation concealed

Baseline comparability

Participant blinded

Provider blinded

Assessor blinded

Analyzed by intention-to-treat



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



No quality ratings on ...

Sample size
Study duration
Outcomes



Effect of four computer keyboards in computer users with upper extremity musculoskeletal disorders

Tittranonda et al. Am J Ind Med 1999

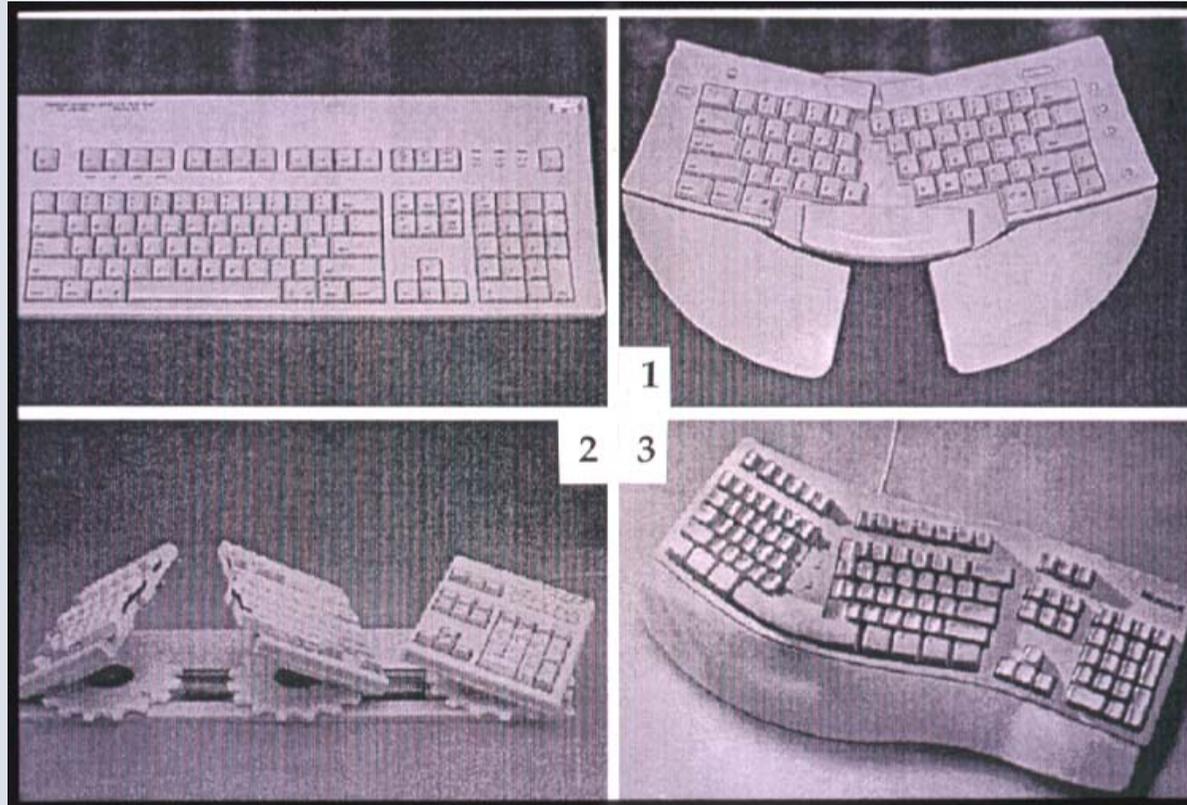
- Design: Six month RCT in the workplace
- Subjects: 80 LLNL employees
tendonitis or carpal tunnel syndrome
> 20 hours per week of computer use
- Intervention: placebo and 3 alternative keyboards
- Outcomes: - pain severity scores every 6 weeks for 6 months
- change function (modified DASH)
- physical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



Tittranonda et al. Am J Ind Med 1999; 35:647

placebo

Apple Split



Comfort

Microsoft Natural

Introduction

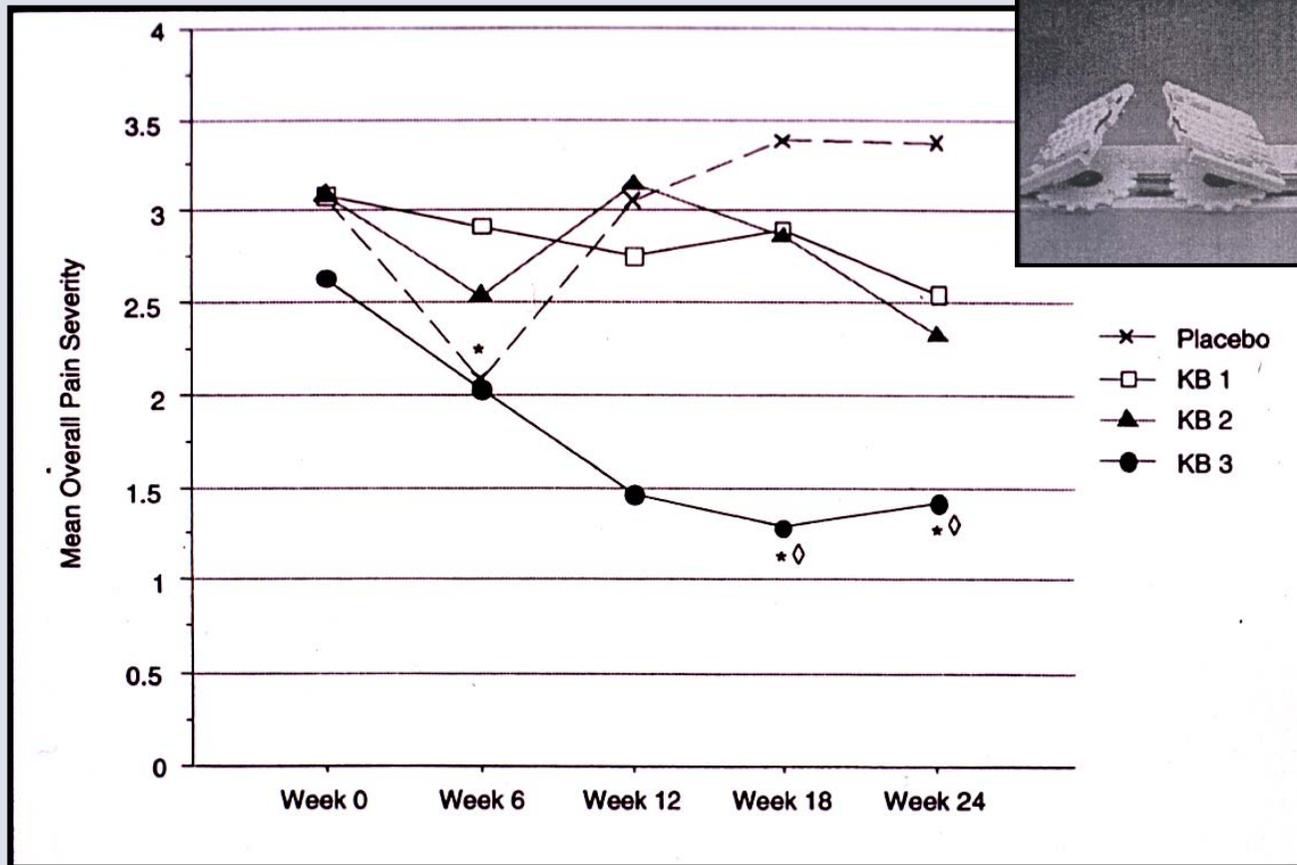
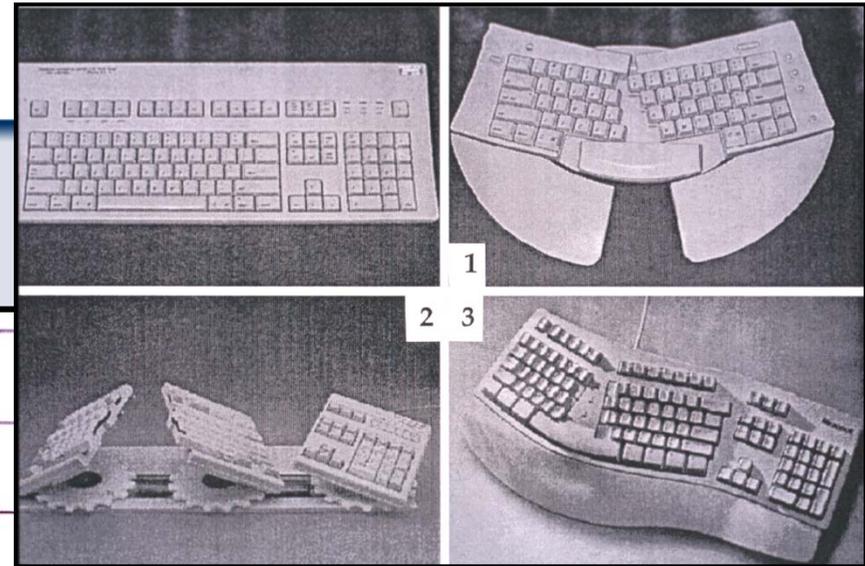
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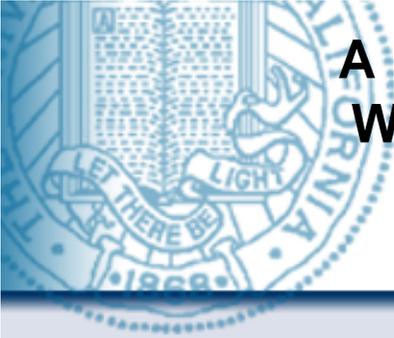
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Limitations

- 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



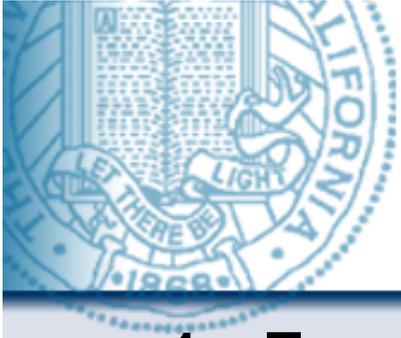
Call Center

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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



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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 \geq 2 days

Physical exam - structured

Physician blinded to intervention

Outcome Measures

Δ pain score

Incident musculoskeletal disorder



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

	Beta - Coefficient	95% CI	P Value
Neck-Shoulder Region	- 0.48	[- 0.85 to -0.10]	0.01
Right Distal Upper Extremity	- 0.66	[- 1.06 to -0.25]	0.002
Left Distal Upper Extremity	- 0.30	[- 0.63 to 0.03]	0.08

[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

	Hazard Ratio	95% CI	P Value
Neck-Shoulders Disorders	0.49	[0.24 to 0.97]	0.04
R Distal Upper Extremity Disorders	0.64	[0.28 to 1.45]	0.29
L Distal Upper Extremity Disorders	0.29	[0.08 to 1.05]	0.06

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

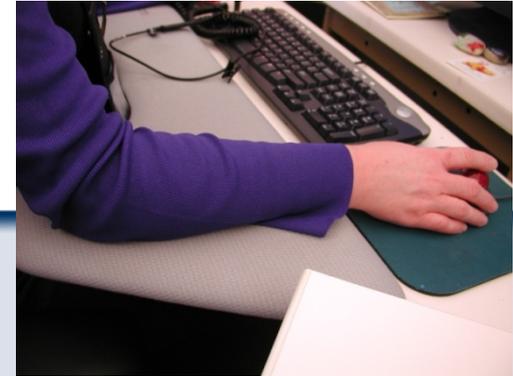
Return-On-Investment (ROI)

- 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



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3rd Generation Device

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



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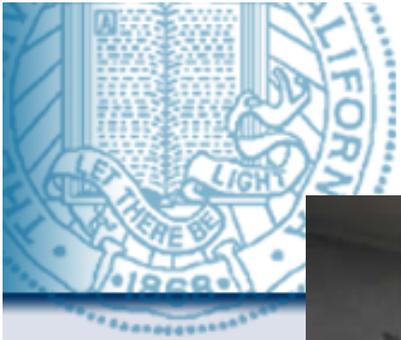
Rempel et al. Ergonomics (in press); Rempel et al. Prof Safety 2007

N=23

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

No difference
productivity







Summary Workplace RCTs

Access

Workplaces are dynamic
production & staffing changes

Exposures are complex
biomechanical
psychosocial





Conclusions

- Research Action

- Need for workplace RCTs, especially ‘Limited Evidence’ interventions
- Allow non-RCTs in systematic reviews
- Measure intermediate risk factors in RCTs
- For RCTs attention to details (CONSORT; Altman 2001)
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- Public Policy Action



Thank you

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