Does keyboard design improve performance and/or comfort of workplace-based computer users with musculoskeletal disorders?

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Date: December 2002

Review Date: December 2004

Clinical Question

Does keyboard design improve performance and/or comfort of workplace-based computer users with musculoskeletal disorders (MSD)?

Clinical Scenario

Alternative keyboards may be recommended for clients with MSD in order to reduce symptoms. This recommendation is at a considerable cost to employers and may generate requests from other employees without symptoms seeking alternative keyboards. It is unclear whether clients with MSD benefit from this intervention and whether the cost to the employer is justified.

Summary of Key Findings

- One study located met the inclusion/exclusion criteria.
- The study design was RCT and was appraised for this article.
- The RCT reviewed found that there was a reduction in hand pain and improvement in function in participants who used the "kb3" keyboard (Microsoft Natural keyboard) over several months.

Clinical Bottom Line

The use of the Microsoft Natural Keyboard instead of the conventional linear keyboard ("101 Keyboard") did provide benefits to workers with MSD over a period of several months. There was a trend toward improvement in overall pain, symptom severity and functional status of users. It was difficult to identify whether these benefits were substantial due to the large number and range of variables studied. The authors did not provide guidance or comment regarding relative value of the benefits obtained.

The reviewers would recommend the use of the Microsoft Natural Keyboard to computer users with MSD on a trial basis as a result of this study.

Limitation of CAT

This summary of evidence has been prepared by members of OT Network who are developing skills in critical appraisals.

Methodology

Search Strategy

The search strategy aimed to identify a range of study designs (representing higher levels of evidence as follows):

- Level I Systematic Reviews
- Level II Randomised Controlled Trials.

(Clinical Practice Guidelines based on these levels of evidence were also searched).

Search Terms

Patient/Client: musculoskeletal disorders, computer us*, occupational overuse syndrome, repetitive strain injury, cumulative trauma disorders

Intervention: keyboard design, keyboard, computer us*, alternative keyboards

Comparison: Nil

Outcome: Prevention, comfort, performance, productivity

Sites/Resources Searched

- ACP Journal Club
- Journals@OVID Full text
- Cinahl
- CMA Infobase – Clinical Practice Guidelines
- Cochrane Library
- Database of Abstracts of Reviews of Effectiveness (DARE)
- Effective Health Care Bulletins
- Embase
- Joanna Briggs Institute
- MEDLINE
- National Electronic Library for Health – Clinical Guidelines Database
- National Guidelines Clearinghouse
- National Institute for Occupational Health and Safety
- National Occupational Health and Safety Commission
- PEDro – The Physiotherapy Evidence Database
- PsycINFO
- Scottish Intercollegiate Guidelines Network (SIGN)
- WorkCover NSW
- WorkCover Victoria
- WorkCover SA
- Worksafe WA

Inclusion/Exclusion Criteria

Inclusion Criteria

- Existing musculoskeletal disorder/s (eg. tendonitis, carpal tunnel syndrome, repetitive strain injury, occupational overuse syndrome)
- Use of computer for work
- Long-term (ie. experiment > 3 months)
- Adult subjects (ie. 19+ years of age)
- Studies published in English with publication date 1997-2002.

Exclusion Criteria

- Studies investigating keyboard design other than tray geometry (eg. keyforce, keyswitch, auditory feedback)
- Studies investigating other or multiple workstation factors (eg. computer monitor angle, workstation layout, wrist rests)
- Studies measuring other human factors (eg. muscular effort, finger motion, tendon travel, wrist motion, wrist posture)
- Subjects without musculoskeletal disorder/s (ie. if no reference was made to MSD/s, it was assumed that the subjects did not have any history or symptoms)
- Subjects with significant medical diagnoses / disabilities (eg. spastic hemiparesis)

Results

Results of Search

One RCT met our inclusion criteria. The authors of the RCT reviewed mentioned that there was one another randomized intervention trial of musculoskeletal disorders among computer users; however, the members of the OT Network were unable to identify this research from the reference list nor was it revealed in our search process.

Eight other laboratory studies where reviewed. These studies were based on short term use of alternative geometry keyboards, however, these studies excluded participants with musculoskeletal disorders and thus did not meet our inclusion criteria on experimental design and subjects.

Figure 1. Study designs of articles retrieved by search

Methodology of Studies Retrieved	Number Located	Source of Evidence
Clinical Practice Guidelines (Evidence-based)	0	N/A
Systematic Reviews	0	N/A
Randomised Controlled Trial	**1**	**PubMed**
Controlled trials, cohort or case-control analytic studies	0	N/A
Case series: Post – test only, Pre - test/Post - test	8	PubMed x 7 Ovid x 1
Expert opinion including literature/narrative reviews, consensus statements, descriptive studies and individual case studies	0	N/A

Specific Results

The randomised controlled trial was the only study that met the inclusion and exclusion criteria and as RCT's represent a high level of evidence, it was appraised for this article (refer to Figure 2).

Figure 2. Description and Appraisal of RCT by Tittiranonda et al (1999)

Objective of Study

To determine whether computer users with MSD can gain health benefit from long-term use of alternative geometry keyboards.

Intervention Investigated

The effects of four computer keyboards were evaluated with eighty (80) computer users with MSD. Variables investigated were clinical findings, pain severity, functional hand status, and comfort.

Four groups, each of twenty subjects, were assigned one keyboard for use at work over a six month period. Three groups utilised an alternative geometry keyboard and the fourth group, serving as the control, was assigned a placebo (their usual keyboard which had been cleaned & stickers attached stating that it had been modified). The control group was told that their keyboard had been modified for the purpose of the research study. Measures for all groups were taken simultaneously at baseline and at 6, 12, 18 and 24 weeks.

Primary Outcome Measures

1. Data on medical history and on psychological work stress factors were collected at baseline.
2. Standardised physical examination of the upper extremities was conducted for each participant at baseline and at the end of the 6 month trial.
3. Subjective rating of overall pain severity, regional symptom severity and hand function in relation to activities of daily living were taken at baseline, at 6 weekly intervals during the study and at the end of the study.
4. At 3 months, subject weight and height were measured on a calibrated balance scale and anthropometric measurements were collected using electronic and body callipers.
5. Continuous keying data collection was obtained (via specialist software) during the first 6 weeks of the study.
6. Keyboard user preferences were obtained by subjects providing comparison information on their pre-trial keyboard and the assigned keyboard at the conclusion of the 6 month trial.

Results

Arm and Hand Symptoms

- There was a significant trend of reduced overall pain severity in the alternative keyboard groups with significant reductions in overall pain severity in kb3 (Microsoft Natural keyboard) at 6 months compared to the placebo group. ($p<0.05$)
- Corresponding decrease in pain severity at 6 months for kb3 was significant for subjects with tendonitis ($p<0.05$) but not for those with CTS ($p>0.05$) compared to the placebo group
- There was significant improvement in right upper limb volar forearm stiffness of the tendonitis subjects using kb3 ($p<0.05$) and significant decreases in finger numbness in the dorsal aspect of the right hand in kb1 and kb3 users ($p<0.05$) when compared to the placebo.
- Evaluation of the CTS subgroup showed a significant improvement in right volar forearm numbness and right dorsal forearm pain at 6 months for kb1 and kb3 when compared with the placebo ($p<0.05$)
- Kb1 group showed significant improvements at 6 months in left volar hand and wrist pain, dorsal pain in the fingers and forearm stiffness, numbness and pain ($p<0.05$) compared to the placebo group
- Kb3 group had significant decreases in dorsal pain in the left digits and stiffness in the forearms ($p<0.05$) compared to the placebo group
- Kb1 CTS subgroup had significant decreases in left dorsal hand and wrist pain and forearm stiffness ($p<0.05$) compared to the placebo group.

Temporal Patterns of Pain Severity

- For kb3 the reduction in overall pain severity from baseline was statistically significant at 18 and 24 weeks ($p<0.05$) when compared with the placebo group

Functional Status

- In general, consistent improvements in functional activities were demonstrated in kb3 while a decline in hand function was observed in the placebo. The improvement in overall functional status score for kb3 at 6 months was statistically significant ($p<0.05$)

Clinical Outcomes

- Clinical status based on Phalen's Test, Tinel's sign and Finkelstein's test remained unchanged for a majority of participants after 6 months of keyboard use

Keyboard Preference

- A trend toward greater improvement in pain severity (ie. pain reduction) was observed with greater satisfaction with the keyboards ($p<0.05$)
- In general improvement in pain severity was associated with the group who rated the alternative keyboard as being better than their usual keyboard (ie. standard keyboard), while worsening of symptom was observed among those who rated their assigned keyboards as being worse than the standard.
- 100% of the placebo group rated their assigned keyboards as being better or same as the standards, although the group mean pain severity had worsened at 6 months.

Authors' Conclusions

There was a trend toward greater improvement in overall pain, symptom severity and functional status in kb3 and kb1 compared to placebo. Overall pain severity decreased initially (week 6) in all keyboard groups, including the placebo, but disappeared in week 12 and later. This suggests a possible placebo effect. It is likely that exposure periods of 12 weeks or more are needed to detect persistent health effects associated with alternative keyboards.

Reviewers' Appraisal Comments

Validity (Methodology, rigour, selection, biases)

- Participants assigned to the three experimental groups or the control group randomly.
- Random allocation process described as a "random permuted block method" (Pocock 1991).
- Participants were stratified on the basis of disorder type (carpal tunnel syndrome and tendonitis or tendonitis only).
- Participant eligibility criteria established and groups matched to ensure comparability of results.
- No information provided re: blinding of researchers during allocation process.
- Blinding of nurse practitioners (undertaking physical examination of subjects) to previous medical history and keyboard assignments.
- Subjects were treated the same way with the only difference being the assignment of keyboard type.
- Physical examinations were focused on both nerve and tendon related findings. These measures are less sensitive outcome measures than symptom or hand function ratings.
- High dropout rate (45%) with kb2 may result in underestimation of the true intervention effect due to "survivor bias" (early loss of subjects due to symptom worsening).
- Authors acknowledge that statistical power may be limited for detection of effects in clinical outcomes due to small sample size (n=20 per group)
- The nature of the computer tasks was not documented and this could have an impact on the comfort and/or performance associated with keyboard use (eg. numeric vs text entry, use of mouse vs keyboard commands)

Results (Favourable or unfavourable, specific outcomes of interest, size of treatment effect, stat. and clinical significance)

- Definition of MSD based on definition used by previous research. Authors acknowledge there is no accepted diagnostic "gold standard" for MSD
- Statistical analysis provided for between group differences
- Confidence intervals for the size of treatment effect were not provided.
- Standard deviation data were provided for some but not all results
- Confidence intervals could be calculated on those results where standard deviation data were provided, however, due to limited information about instruments used, size of treatment effect could not be calculated for some of those results.

References

- CASP form: www.phru.org.uk/casp/resources/index.htm
- McMaster University forms: www.fhs.mcmaster.ca/rehab/ebp
- McCluskey, A., & Lovarini, M., Workshop notes, (2002) Increasing the use of evidence by occupational therapists in NSW.

Articles critically appraised for this summary of evidence

Level II Evidence

1. Tittiranonda, P., Rempel, D., Armstrong, A., & Burastero, S. (1999). Effect of Four Computer Keyboards in Computer Users with Upper Extremity Musculoskeletal Disorders. *American Journal of Industrial Medicine, 35, 647-661.*

Related articles not included in the appraisal

Level III Evidence

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4. Ro, J., & Jacobs, K. (1997) Wrist postures in video display terminal operators (VDT) using different keyboards, *Work: a journal of prevention, assessment & rehabilitation, 9(3): 255-66*
5. Smith, M., Karsh, B., Conway, F., & Cohen, W., James, C., Morgan J., Sanders, K. & Zehel, D.(1998) Effects of a spilt keyboard design and wrist rest on performance , posture and comfort. *Human Factors, 40, 2, 324-325*
6. Swanson, N., Galinsky, T., Cole, L., Pan., & Suater, S. (1997). The impact of keyboard design on comfort and productivity in a text-entry task. *Applied Ergonomics, 28, 1, 9-16*
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