Upper limb disorders

Occupational aspects of management

A national guideline

Royal College of Physicians

Setting higher medical standards

NHS Plus

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Acknowledgements

We are grateful to Professor Keith Palmer, Professor in Occupational Medicine, MRC Epidemiology Resource Centre, Southampton General Hospital, for his helpful advice during the preparation of the guideline and for comments on the draft manuscripts.

We would also like to thank Ms Barbara Smiley from the OHCEU for her administrative support.

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Citation for this document

NHS Plus, Royal College of Physicians, Faculty of Occupational Medicine. *Upper limb disorders: occupational aspects of management. A national guideline*. London: RCP, 2009.

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ISBN 978-1-86016-363-0

Review date: 2014

Royal College of Physicians of London
11 St Andrews Place, London NW1 4LE

www.rcplondon.ac.uk

Registered Charity No 210508

Cover design: WLG Design

Typeset by Dan-Set Graphics,
Telford, Shropshire

Printed by The Lavenham Press Ltd,
Sudbury, Suffolk

Contents

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Conflicts of interest: Ms Penny Barker, Principal Scientific Officer, Health and Safety Executive (HSE), declared that she was the commissioning officer for the HSE funded systematic review carried out by Crawford and Laiou.[1]

Declarations were collected at the first Guideline Development Group meeting and these were reviewed on a meeting-by-meeting basis. Where the Guideline Development Group members authored any of the reviewed papers, their papers were allocated to other members of the Group for appraisal.

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Executive summary

The purpose of this guideline is to offer evidence-based advice on the management of upper limb disorders in the workplace. The document is intended to be of use to employers, employees, occupational health and other interested parties involved in the workplace management of workers with upper limb disorders.

The overall production of the guideline was overseen by a steering group. A separate multidisciplinary Guideline Development Group (GDG) undertook the key stages of critical appraisal and synthesis of a body of published evidence that was identified by a systematic literature search, and the subsequent drafting of a series of recommendations. Four key questions were identified by the GDG at the outset, and defined according to a standard format that made explicit the target population, intervention, comparison groups and outcomes of interest. The standard methodology of the Scottish Intercollegiate Guideline Network (SIGN) was applied in the critical appraisal phase of the guideline development process.

In total, the literature search identified 1,532 papers. After two rounds of sifting, based initially on title plus abstract and subsequently full manuscript, 28 papers were included for critical appraisal. After rejecting papers that did not meet the minimum quality standard (SIGN grading of + or ++), four papers remained.

The term 'upper limb disorders' covers a large number of musculoskeletal conditions that affect the shoulder, elbow, forearm, wrist or hand. These are common conditions in adults of working age: while some are well defined with accepted diagnostic criteria, recognised risk factors and well-established medical management, other conditions such as non-specific arm pain are less well defined.

Key questions

This review addressed four questions regarding the workplace management of selected upper limb disorders:

1. In employees with carpal tunnel syndrome, what workplace interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?
2. In employees with non-specific arm pain, what workplace interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?
3. In employees with tenosynovitis, what workplace interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?
4. In employees with lateral epicondylitis, what workplace interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?

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Key findings

There is a substantial body of evidence regarding interventions for upper limb disorders but, to date, there has been insufficient focus on occupational outcomes in trials of interventions for upper limb disorders.

- Employers should consider offering computer operators with carpal tunnel syndrome the opportunity to trial different computer keyboards.
- In workers with non-specific arm pain, who have been absent from work for at least four weeks, multidisciplinary rehabilitation programmes including both physical and psychosocial approaches should be offered, or facilitated, by employers.
- There is a need for experts in this field to agree consensus definitions of conditions to facilitate further research. When investigators are researching interventions for upper limb disorders, they should address important work outcomes such as sickness absence and job retention. Further work is needed on computer workstations and alternative input devices.

Because of the paucity of high-quality published evidence to address our key questions, we also made a number of research recommendations. These aim to build an evidence base for the workplace management of upper limb disorders.

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Glossary

Bias An effect at any stage of an investigation that tends to cause results to depart systematically from the true values. Examples include observer bias due to differences among observers recording study results, and selection bias where systematic differences occur between selection of cases and controls.

Carpal tunnel syndrome A compression neuropathy due to entrapment of the median nerve within the carpal tunnel at the wrist.

Case reports In medicine, a case report is a detailed report of the symptoms, signs, diagnosis, treatment and follow-up of an individual patient. Case reports may contain a demographic profile of the patient, but usually describe an unusual or novel occurrence. This type of research cannot indicate causality but may indicate areas for further research.

Cohort study Cohort studies compare a group of people who are exposed to a risk factor (or factors) of interest with a comparison group who are not exposed. The comparison group may be the general population from which the cohort is drawn, or a group who must be similar to the study cohort except for the exposure of interest. Alternatively, subgroups within the study cohort who have different levels of exposure may be compared with each other. Study and comparison cohorts are followed through time to identify an outcome (eg a disease) of interest.

Confidence interval A confidence interval is a way of expressing the uncertainty or imprecision of a study result and it is usually interpreted as a range of values within which the true population value is likely to lie. The width of the confidence interval varies but is often set at 95%. This means that if the study were to be repeated unlimited times, for 95% of samples the 95% confidence interval would contain the fixed true population value.

Confounder A confounding factor is a variable which is associated with the risk factor under investigation and which independently determines the risk of the disease that is being studied.

Control In a case-control study, a control is a person in a comparison group that differs only in their experience of the disease in question. If matched controls are used, they are selected so that they are similar to the study group, or cases, in specific characteristics (eg age, sex, weight). In a randomised controlled trial, the control group differs from the study group only by the treatment or intervention that is being tested.

Compression neuropathy This occurs when a nerve is compressed thus interfering with its function. The most common compression neuropathy is carpal tunnel syndrome.

Critical appraisal The process of systematically examining research evidence to assess its validity, results, quality and relevance before using it to inform a decision.

Double blinding Blinding is a method used to prevent research outcomes from being influenced by bias in the observer or the subject. It is particularly important where outcomes are subjective, and might be influenced by knowledge of exposure or treatment status. In a double-blind experiment, neither the individuals nor the researchers know who belongs to the control group and the experimental group. Random assignment of the subject to the

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experimental or control group is a critical part of double-blind research design in randomised controlled trials. The key that identifies the subjects and which group they belonged to is kept by a third party and not given to the researchers until the study is over.

Dystonia A neurological movement disorder. This condition causes muscles to contract leading to abnormal movements or postures.

Ergonomics The study of workplace design and the physical and psychological impact it has on workers. Ergonomics is about the fit between people, their work activities, equipment, work systems and environment to ensure that workplaces are safe, comfortable and efficient, and that productivity is not compromised.

Epicondylitis Lateral epicondylitis, or tennis elbow, is a condition characterised by pain over the lateral epicondyle of the humerus, aggravated by loading of the hand extensor muscles at the elbow.[2] Although this condition is very common among tennis players, most sufferers do not play racquet sports.

Epidemiology This is the study of factors affecting the health and illness of populations, and serves as the foundation and logic of interventions made in the interest of public health and preventive medicine. It is considered a cornerstone methodology of public health research, and is highly regarded in evidence-based medicine for identifying risk factors for disease and determining optimal treatment approaches to clinical practice.

Evidence-based medicine The process of practising medicine based on a combination of the best available research evidence, clinical expertise and patient values.

Meta-analysis A statistical method for combining data from multiple independent studies on a given topic and synthesising those results into summaries and conclusions.

Non-specific arm pain Non-specific (fore) arm pain has been defined, for research purposes, as 'pain in the forearm in the absence of a specific diagnosis or pathology'.[3] Non-specific arm pain is the most common work-related upper limb complaint although estimates of its prevalence vary.

Phalen's test A clinical test for carpal tunnel syndrome. The individual is asked to fully flex their wrist for 60 seconds. The test is positive if the person reports tingling and numbness over the distribution of the median nerve.

Prevalence The number of all new and old cases of a disease or occurrences of an event during a particular period. Prevalence is expressed as a ratio in which the number of events is the numerator and population at risk is the denominator.

Randomised controlled trials (RCT) A type of scientific experiment most commonly used in testing the efficacy or effectiveness of healthcare services (such as medicine or nursing) or health technologies (such as pharmaceuticals, medical devices or surgery). As their name suggests, RCTs involve the random allocation of different interventions (treatments or conditions) to subjects. As long as numbers of subjects are sufficient, this ensures that both known and unknown confounding factors are evenly distributed between treatment groups.

Systematic review A summary of research (often in the biomedical or healthcare context) that uses explicit methods to perform a thorough literature search and critical appraisal of individual studies to identify the valid and applicable evidence. It often, but not always, uses

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appropriate techniques (meta-analysis) to combine these valid studies, or at least uses grading of the levels of evidence depending on the methodology used. A systematic review uses an objective and transparent approach for research synthesis, with the aim of minimising bias. While many systematic reviews are based on an explicit quantitative meta-analysis of available data, there are also qualitative reviews which nonetheless adhere to the standards for gathering, analysing and reporting evidence.

Tenosynovitis Harrington[3] defined this condition as 'inflammation of the extensor or flexor tendon sheaths at the wrist'. Tenosynovitis surveillance criteria were defined by Harrington *et al* thus: 'pain on movement, localised to the affected tendon sheaths in the wrist and reproduction of pain by resisted active movement of the affected tendons with the forearm stabilised'. Additional clinical features that might be present included tenderness, swelling over the affected tendon sheath, crepitus and redness.

Tinel's test A clinical test for carpal tunnel syndrome. The examiner percusses the flexor aspect of the wrist over the carpal tunnel. The test is positive if the individual reports tingling and numbness over the distribution of the median nerve.

Upper limb disorders The term 'upper limb disorders' covers a large number of musculoskeletal conditions that affect the shoulder, elbow, forearm, wrist or hand. These are common conditions in adults of working age: while some are well defined with accepted diagnostic criteria, recognised risk factors and well-established medical management, other conditions such as non-specific arm pain are less well defined.

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1 Methodology

Aim

The aim of this document is to develop a guideline for the workplace management of upper limb disorders excluding screening and primary prevention.

Scope

The guideline scope was developed following an initial search for systematic reviews and guidelines. This preliminary scoping search followed the National Institute for Health and Clinical Excellence (NICE) guideline protocol (www.nice.org.uk/niceMedia/pdf/GuidelinesManualAllChapters.pdf), searching for systematic literature reviews and guidelines on upper limb disorders and the workplace. The databases searched were: Medline, Cochrane Library, Health Technology Assessment website, the NICE website, and the National Guideline Clearinghouse (previously known as the US Guideline Clearinghouse).

The scoping search strategy was developed by the Guideline Leader in discussion with the Director of the Occupational Health Clinical Effectiveness Unit (OHCEU) with input from UK academic experts in the field of upper limb disorders. An information scientist undertook this scoping search. The results of this level 1 search were used by the Guideline Development Group (GDG) when drawing up their priority list for which, of the many, upper limb disorders should be subject to systematic review.

Four conditions were identified for review by the GDG: carpal tunnel syndrome, non-specific arm pain, tenosynovitis, and lateral epicondylitis. These conditions were selected for review as they were common, posed management challenges in occupational health and it was thought that there was likely to be sufficient literature to inform guideline development. The question asked was:

> 'In employees with each of the conditions selected, what interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?'

Because of the substantial literature on these topics, it was decided that the questions should focus on workplace interventions for these disorders. A workplace intervention was defined as any action carried out at a worker's place of work that was intended to improve the outcome of an existing upper limb disorder. These interventions included measures such as modified work schedules, graded return to work, alternative workstations, modified computer hardware and software, and multidisciplinary rehabilitation programmes employing the skills of physiotherapists, occupational therapists, psychologists and other health professionals.

It was discussed by the GDG that evidence on primary prevention was limited. It was agreed that the scope of this topic was very broad and merited its own review.

Examining the effectiveness of screening was considered an important issue because of the limited evidence to support it. Some members argued that it was worth using the literature search to find evidence on screening as identifying the risks in the workplace setting was important for employer-centred interventions.

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Primary prevention and pre-placement assessment were agreed by the GDG to be important issues to consider, but the GDG believed that focusing on management of disorders would be more relevant to occupational health. Consequently, the GDG decided to exclude screening and primary prevention for the purpose of the guideline scope.

The GDG agreed that managing those with upper limb disorders in the workplace would narrow down the scope of the guideline, considering also the time restrictions linked to the development of the guideline.

Audience

The guidance is intended for anyone who might give advice to workers presenting with upper limb disorders, including occupational health professionals, general practitioners and other healthcare professionals. It is also aimed at employees themselves, their representatives and managers, whether or not they have access to professional occupational health advice.

Patient and employer representation

We recognise that patients have an important contribution to make to their own medical management. The NICE and other clinical guideline development programmes aim to be patient centred (www.nice.org.uk). Similarly, NHS Plus aims for occupational health guidelines to be client centred, including the perspectives of both employees and employers. Employees bring a unique experience of their illness, and the impact that it has upon their working lives. Employers too have an important input, particularly regarding the practicability and operational implications of risk controls. Inevitably, these client perspectives may differ from each other or from the perspective of occupational health professionals. NHS Plus is committed to listening to the views of both patients (employees) and employers, considering their concerns carefully and addressing them where possible. The aim is to balance views fairly in order to produce guidelines that are ultimately useful to both parties and to the occupational and other health professionals who advise them. Both employer and employee (patient) representatives were included in the multidisciplinary Upper Limb Disorder Guideline Development Group.

The process of guideline development

The Royal College of Physicians, in partnership with the Faculty of Occupational Medicine, was commissioned by NHS Plus to provide the Occupational Health Clinical Effectiveness Unit (OHCEU). The OHCEU was founded in April 2007 with the primary purpose of improving the quality of occupational healthcare in the NHS. The main specific objectives were the delivery of two new clinical guidelines and two multi-centre audits by March 2009. During the inaugural meeting in March 2007, the OHCEU Steering Group prioritised two topics for guideline development:

1. the management of dermatitis in the workplace
2. the management of upper limb disorders in the workplace.

The OHCEU guidelines have been developed using a modified SIGN[5] method. The SIGN objective is to improve the quality of healthcare for patients through the development and dissemination of national clinical guidelines containing recommendations for effective practice based on current evidence.

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The process of guideline development included overall direction from a steering group and the OHCEU team. Most of the detailed work was undertaken by a multidisciplinary GDG. The roles of the various contributors to the guideline are summarised in Appendix 1.

The key steps in the process of guideline development were:

- formulating clinical questions to answer the issues identified by the scope
- systematically searching for the evidence in the published literature
- critically appraising the evidence
- distilling and synthesising the evidence and drafting recommendations
- grading a series of evidence statements and recommendations
- agreeing the recommendations
- structuring and writing the guideline
- publishing and disseminating the guideline.

Developing evidence-based questions

The approach to developing the questions for this review aimed to be inclusive, but to prioritise the most important areas for occupational health practice. Firstly, an initial literature search was carried out in order to identify any existing reviews or guidelines on the management of upper limb disorders in the workplace (scoping search). By using information from the scoping search and clinical experience, a series of questions that would affect practical aspects of the care pathway was generated. The GDG first added questions to the Guideline Leader's model to produce an expanded inclusive list of possible questions. It was agreed that, given the limitations of time and resources, a maximum of four questions could be addressed. Therefore, the GDG discussed and prioritised the inclusive list, reducing it to an agreed shortlist of four key questions. The agreed list was approved by the OHCEU Steering Group. It was acknowledged that some important questions could not be included on the final list, and that these would be a priority for future revisions or extension of the upper limb disorders guideline work.

The final questions were re-phrased using the PICO format.[4] This method defines the population (P), intervention (I), comparison (C) and outcome (O) for each question. The final PICO questions are listed in Appendix 2. The PICO questions were used to guide the literature search strategy.

Searching for the evidence – search strategy

After the identification of four key questions, the literature search strategy was developed. This iterative process involved input from the Group and the OHCEU Information Scientist. The databases searched were Medline, Embase, Cinahl, AMED (Allied and Complementary Medicine Database), the Physiotherapy Evidence Database PEDro (PICO 1 and 2 only) and the Cochrane Library.

The key terms for the literature search were derived directly from the PICO tables. The full search strategy is included in Appendix 3. The Guideline Leader sifted the output from the initial literature search on the basis of title and abstract. Papers that were obviously not relevant to each question and foreign language papers were excluded (first sift). We retrieved papers that might be relevant and hand searched the full manuscript. Papers that were not relevant or did not meet very basic quality criteria (eg having an appropriate control group) were rejected

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(second sift). The reference lists of all relevant papers were hand searched and any useful papers that had not been identified previously were also retrieved. In particular, all relevant original studies that were referenced in retrieved reviews were also retrieved and assessed. According to the SIGN methodology, we did not search for grey literature, instead confining the search to papers that had been published in peer-reviewed journals.

Appraising the evidence

All relevant papers that met the inclusion criteria were put forward for full appraisal. Appraisal was undertaken by members of the GDG according to the SIGN methodology. SIGN was chosen because the method suited the level of funding available and is a validated, widely used method for developing clinical guidelines in the UK. An adapted SIGN method is used for all guidelines produced by NHS Plus.

All GDG members undertook specific training in critical appraisal using the SIGN method. Each paper was scored independently by the Guideline Leader and one other GDG member, using standardised SIGN checklists. The scores were compared, and any discordant scores were discussed initially by the appraisers, and allocated a mutually agreed score. Any cases where discordant scores were not resolved by this process were brought to the GDG for discussion and agreement of a final score.

The results of the literature searches, both titles and abstracts, were reviewed by the Guideline Leader. Those studies (randomised controlled trials, cohort studies or systematic reviews) that appeared to address the disorder of interest, workplace interventions and occupational outcomes were selected for full text review. In addition, those articles with no abstract or where the titles did not provide sufficient information to assess their relevance were obtained for full text review. The full text of selected papers was then reviewed by the Guideline Leader and those papers that addressed the workplace management of that disorder were selected for data extraction by two reviewers, one of whom was the Guideline Leader. The reference lists of the papers chosen were reviewed to identify any additional papers. These literature searches were repeated in August 2008 to identify any additional studies published during the period of the guideline's development: the final search dates were 14 August (PICO 1), 19 August (PICO 2) and 20 August 2008 (PICO 3 and 4).

According to the SIGN methodology, papers are given a single quality rating (++, + or –) based on a combination of the risk of bias and confounding. One limitation of this method is that the allocation of the quality score is not structured explicitly, making it difficult to demonstrate consistency of scoring between appraisers. However, it was beyond the scope of our resources to develop a new detailed scoring system for appraisal. Therefore, we handled the problem by raising awareness among appraisers, asking them to consider bias and confounding separately and to comment on each specifically in their recorded assessment form. Specific guidance was given to appraisers on the assessment of bias, including whether the effect of bias was inflationary or to the null and what the size of the effect might be. Appraisers were also asked to consider not just whether confounders were addressed in the study method, but (if not) whether this omission was likely to have an important effect on the findings. The lack of consideration of a confounding factor in a study was considered to be a serious methodological flaw if the association of health outcomes with the potential confounder was strong and the factor was likely to be common in the study population. These studies were allocated a score of

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minus (–) for quality, and were rejected. The remaining studies, with quality scores of + or ++, were summarised in Appendix 7 (Evidence tables 1 to 4).

Distilling and synthesising the evidence

The completed checklists for the papers selected for data extraction were discussed by the Group and any queries regarding the study and its conclusions were clarified. The draft Considered Judgement Form* prepared by the Guideline Leader was then discussed and agreed by the Group along with their recommendations.

Grading the evidence statements

The SIGN guidelines[5] employ a grading system for evidence from peer-reviewed publications. This system ranks evidence on a four-point scale based on the study design and its potential for bias where a high-quality meta-analysis or a randomised controlled trial with a very low risk of bias is graded as 1++, case reports are graded as 3 and expert opinion is graded as 4. A detailed account of this system is given in Appendix 5.

Agreeing the recommendations

The final stage of the SIGN process comprises the discussion and agreement of recommendations based on the evidence-based statements. This process occurred within the setting of a GDG meeting. In formulating recommendations about interventions for workers with upper limb disorders, we have taken into account existing legal requirements, the evidence synthesis and the likelihood that any of the interventions might actually cause harm to workers. For this particular guideline, it was not possible to make evidence-based recommendations for occupational health practice on some of the key questions due to a lack of evidence. However, the GDG made recommendations for consensus-based good practice points and for research based on addressing the identified gaps in the evidence base.

The GDG used SIGN's Considered Judgement Form* for each question to audit and describe the decision making process for the grading of the evidence and the draft recommendations.

Guideline limitations

A specific problem arose from the historical development of the SIGN method for the assessment of clinical interventions. The resulting emphasis on randomised controlled trials (RCTs) as a gold standard is not particularly well suited to the occupational health literature, which typically has few RCTs and comprises mostly observational studies (including non-randomised intervention studies with a comparison group). Therefore it is difficult to achieve recommendations with a SIGN rating above B from research in occupational health.

* The Considered Judgement Form summarises the views of the GDG with regards to the total body of evidence covered by each evidence table.

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Other limitations

The guideline is based on systematic literature searches of the published evidence in peer-reviewed journals in English: there is the possibility of publication bias with positive results being more likely to be published, tending to give a biased view of the consistency of evidence at the synthesis stage. This is beyond the control of the GDG, and it is difficult to assess the impact of publication bias. Reviewers were not blinded to the identity of article authors or their affiliations. This review is restricted to the published evidence in peer-reviewed scientific journals for the management of selected upper limb disorders in the workplace and as such does not address the wider evidence base for the management of upper limb disorders in general practice or other clinical settings. Given this, there may be interventions which have been trialled in other settings, or interventions as yet untrialled, which might be of benefit for the management of upper limb disorders. However, these were outside the Group's remit.

Other work relevant to the guideline

A guideline on the management of upper limb disorders in the workplace was produced by the Netherlands Society of Occupational Medicine (Nederlandse Vereniging voor Arbeids-en Bedrijfsgeneeskunde (NVAB)) in 2003. This useful guideline is available online in a shortened English language version,* without the background document.[6]

The legislation governing the use of display screen equipment at work can be found in the Health and Safety (Display Screen Equipment) Regulations 1992 (amended).[7] In addition, the Health and Safety Executive (HSE) have produced guidance on the management of upper limb disorders in the workplace.[8]

There has been increasing interest in the biopsychosocial model of rehabilitation which includes the biological, psychological and social aspects of health conditions. Waddell and Burton wrote *Concepts of Rehabilitation for the Management of Common Health Problems* – a report commissioned by the UK Department for Work and Pensions (DWP) to develop the concepts for the rehabilitation of workers with common health problems.[9] They argued that rehabilitation should not be seen as a separate, second stage in the treatment of common medical conditions and the evidence indicates that rehabilitation is most effective in the period between four and 36 weeks of sickness absence. They concluded that rehabilitation, to be effective, must identify and address the barriers (health, personal/psychological, social/occupational) to recovery and return to work. The authors of a systematic review[10] of the published evidence for the management of upper limb disorders concluded that there was limited evidence that modified computer mice and keyboards are of benefit for computer users with neck or upper limb disorders. The authors of a recent wide-ranging review[11] concluded that the biopsychosocial model could usefully be applied to the management of upper limb disorders.

Writing the guideline

The first draft of the guideline was drawn up by the Guideline Leader in accordance with the decision of the GDG. The draft was presented to the GDG for comments and corrections and then to the OHCEU Steering Group for further comments. The draft was then submitted for

* Web page: nvab.artsennet.nl/English/Guidelines.htm

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one formal round of public and stakeholder consultation, through the NHS Plus website (www.nhsplus.nhs.uk) (see Appendix 6), prior to revision and publication. Editorial responsibility for the full guideline rests with the GDG.

Updating the guideline

Literature searches were repeated for all evidence-based questions at the end of the GDG development process, allowing any relevant papers published and indexed up until 14 August 2008 to be considered. Future guideline updates will consider published evidence indexed after this cut-off date. We recommend that this guideline is reviewed in five years' time.

Use of the guideline

Healthcare providers, employers and employees need to use their judgement, knowledge and expertise when deciding whether it is appropriate to apply guidelines. The recommendations cited in this guideline are a guide and may not be appropriate for use in all situations. The decision to adopt any of the recommendations cited here must be made by the healthcare professional, employer and employee in light of individual circumstances, the wishes of the patient, clinical expertise and resources.

Funding

The OHCEU is commissioned and funded by NHS Plus to produce evidence-based guidelines. NHS Plus is represented on the OHCEU Steering Group. However, it is not a member of the GDG.

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2 Development of the guideline

Introduction

Upper limb disorders epidemiology: incidence, prevalence, risk factors

The term 'upper limb disorders' covers a large number of musculoskeletal conditions that affect the shoulder, elbow, forearm, wrist or hand. Some conditions are well defined with widely accepted diagnostic criteria, recognised risk factors and well-established medical management (eg carpal tunnel syndrome) whereas other conditions, such as non-specific arm pain, are less well defined.

Upper limb disorders are common in the general population[12] although quite how common is uncertain. A recent systematic review[13] of studies of upper limb disorders found that the reported point prevalence (the number of people affected with a disorder at a specified point in time) varied substantially between studies. These authors, and others,[14] have observed that disease labels and case definitions vary considerably between studies which might, in part, explain these differences.

A review in 2003 identified 27 different classification systems for upper limb disorders[15] and a number of diagnostic schedules have been developed for use in epidemiological research into upper limb disorders.[2,3,14,16] However, there is as yet no consensus regarding the terminology of these conditions.[18] Diagnostic terms and classification criteria show considerable overlap and this diagnostic imprecision has implications for interpretation of research in this area.

Upper limb disorders are frequently attributed to work although the evidence that occupational factors are important in the development of many of these multi-factorial conditions is limited. Individuals experiencing musculoskeletal disorders tend to experience, and so report, their work as more physically demanding than their unaffected, but similarly exposed, colleagues.[19] As a consequence, those surveys that rely on self-reporting may over-estimate the occupational contribution to such conditions.[20]

The results of many studies and systematic reviews[21] have suggested that physical workplace factors eg sustained abnormal posture, abnormal force, vibration and rapid repetitive movements may be associated with upper limb disorders. Many early studies were cross-sectional in nature and while demonstrating associations between occupational exposures and upper limb disorders, they could not prove causation. A large Danish prospective study (Neck and Upper extremity Disorders Among Technical Assistants (NUDATA) study) reported that intensive use of a computer mouse was a risk factor for forearm pain and advised efforts to reduce usage to below 20–25 hours per week.[22] However, non-physical workplace factors have also been implicated. For example, a prospective cohort study in Manchester[23] found that, while repetitive movements of the arm and wrist were risk factors for forearm pain, psychosocial factors such as low peer and supervisor support were also relevant. Psychosocial factors, both within[23] and outside the workplace, increase the risk of an upper limb disorder. This study found that low satisfaction with supervisor or peer support was significantly associated with subsequent development of forearm pain.[23] Other psychosocial factors such as having a hectic, monotonous or stressful job were non-significantly associated with new forearm pain. Ryall *et al* found that a high somatising tendency increased the likelihood of an individual consulting

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a primary care practitioner with arm pain.[24] Somatising occurs where psychological distress appears to be manifested through physical symptoms.

Cultural factors may also be important in the experience of musculoskeletal symptoms: one cross-cultural study of workers found that Indian manual workers had lower rates of neck, back or arm pain than either UK manual workers of Indian origin or white UK manual workers despite having very similar physical job demands.[25]

The Industrial Injuries Advisory Council (IIAC) review of work-related upper limb disorders[26] concluded that there was insufficient evidence for the prescription of any upper limb conditions beyond those five conditions already prescribed: task specific focal dystonia, subcutaneous cellulitis of the hand, bursitis or subcutaneous cellulitis of the elbow, traumatic inflammation of the tendons of the hand or forearm and carpal tunnel syndrome.

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3 The guideline

Question 1 – Carpal tunnel syndrome

In employees with carpal tunnel syndrome, what workplace interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?

Clinical introduction

Carpal tunnel syndrome (CTS) is a compression neuropathy due to entrapment of the median nerve within the carpal tunnel at the wrist. The point prevalence of carpal tunnel syndrome is approximately 5% of the general adult population and it has an annual incidence of 1/1,000 person years. One systematic review found that some studies suggested that women are three times more likely to develop the condition than men.[27] Non-occupational risk factors associated with carpal tunnel syndrome include pregnancy, rheumatoid arthritis, diabetes mellitus, hypothyroidism and acromegaly.

A recent systematic review[17] of the relationship between work and carpal tunnel syndrome concluded that occupations with regular, prolonged exposure to hand-transmitted vibration or repetitive wrist movements were at increased risk of developing carpal tunnel syndrome. However, the author[17] concluded that 'the balance of evidence on keyboard and computer work does not indicate an important association with CTS.'

The diagnosis of carpal tunnel syndrome is based on a typical history, congruent clinical findings, such as a positive Tinel's or Phalen's test, and confirmation of slowed median nerve conduction velocity on neurophysiological testing. Some authors have relied on symptom questionnaires without clinical examination or nerve conduction studies to identify sufferers.[27] Such an approach is likely to lead to an over-estimation of disease prevalence; one study found that only a subset of symptomatic individuals met clinical criteria for carpal tunnel syndrome and even fewer fulfilled both clinical and electrophysiological criteria (nerve conduction studies).[28] There has been debate regarding the role of nerve conduction tests as some studies suggest that up to 10% of subjects with clinical features of carpal tunnel syndrome may have normal nerve conduction studies.[3] One systematic review concluded that electrodiagnostic studies were not helpful in diagnosing clinically clear-cut cases and did not predict surgical outcomes.[29] Nonetheless, electrophysiological testing is viewed by many as the gold standard for the diagnosis of carpal tunnel syndrome.[30]

Methodological introduction

Four hundred and thirty one papers were identified in the literature search, of which 81 were selected for full text review. The 350 papers rejected at the first stage included non-systematic reviews, risk factor studies, interventions for primary prevention and commentaries on carpal tunnel syndrome. Of the 81 papers selected for full text review, nine were selected for detailed review. The majority of the 72 papers rejected did not provide any data on carpal tunnel syndrome; two were studies of primary prevention; two explored risk factors for the condition;

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ten were non-systematic review articles; six did not employ a workplace intervention and seven gave insufficient data for review. The literature search was updated on 14 August 2008 when a further 29 papers were identified: after reviewing the titles and abstracts, three papers were subject to full text review but none was selected for detailed review.

Of the nine papers selected for detailed review, two low-quality studies[31,32] were rejected owing to methodological weaknesses which gave a strong potential for bias. The paper by Battevi employed unblinded assessment of study participants thus creating a strong potential for bias.[31] The Bonfiglioli study was rejected as it had a potential for bias owing to the healthy worker effect.[32] Seven papers (three papers reporting two systematic reviews,[1,33,34] three RCTs[35–37] and one cohort study[38]) were included in the synthesis of evidence and are considered in more detail below.

One systematic review of conservative treatments[1] did not identify any relevant primary research and was not considered further. The second systematic review was produced under the auspices of the Cochrane Collaboration and was reported in two papers.[33,34] That review identified and assessed two 'high-quality' RCTs: both studies are discussed below.[35,36]

There were very limited published data exploring workplace interventions for carpal tunnel syndrome. The only workplace intervention available to evaluate was the use of alternative or modified computer keyboards. Three studies[35–37] had employed alternative computer keyboards in individuals with carpal tunnel syndrome but only one cohort study[38] directly addressed an employment outcome: work functioning.

The three studies which employed alternative or modified computer keyboards are not directly comparable. Rempel[35] carried out an RCT of a computer keyboard with a non-standard key switch force profile in comparison with the same style keyboard with standard keys. The term 'key switch force profile' describes the 'feel' of the computer keys when pressed by the operator including the travel distance required to activate the key and the degree of dampening at the end of the key's travel where a looser key with greater dampening was thought to be advantageous. The authors found that the modified keyboard led to a significant reduction in pain: the mean (SD) pain rating for keyboard A at week 6 was 2.7 (1.5) and at week 12, 1.9 (1.9); for keyboard B at week 6, the mean pain rating was 2.9 (1.5) and at week 12, 4.3 (2.7), p=0.05. The authors described the pain reduction when using the modified keyboard as a low or moderate response with an effect size of 0.5 in contrast to the much greater effect size of carpal tunnel surgery at 1.4.

Ripat[37] undertook an RCT (but note that randomisation was incomplete and an intention to treat analysis was not employed) of an 'ergonomic' keyboard with altered key activation force, key travel and key vibration. The authors studied 68 symptomatic workers in a single company: 25 workers were given a commercially available ergonomic keyboard while 43 workers were given the same keyboard which had been modified both in the force needed to activate it (37 g for the modified keyboard versus 65.6 g for the standard keyboard) and the distance of key travel (0.2 mm for the modified keyboard versus 2.8 mm for the standard keyboard). Both groups showed significantly reduced symptom severity and significantly improved functional status over the 24 weeks of follow-up.

Tittiranonda and colleagues[36] trialled three keyboards with alternative keyboard geometry: Apple Adjustable Keyboard™ (termed kb1); Comfort Keyboard System™ (termed kb2); and Microsoft Natural Keyboard™ (termed kb3) and compared them with a standard keyboard.

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All three keyboards look strikingly different from a standard keyboard making blinding of keyboard users impossible. They found that there was a significant trend for improved hand function over six months follow-up for kb3 whereas the standard keyboard (placebo) group's hand function worsened.

The three RCTs of computer keyboards employed clinical measures, such as symptom reporting or self-reported change in hand function, as their primary outcomes. These are important outcomes which might be expected to influence work ability. However, caution is necessary as there is no direct evidence from these studies that such metrics are associated with better work outcomes as these were not measured. Two of these studies[35,36] were graded as + whereas the third[37] was graded as –, indicating that few of the quality criteria for an RCT had been met.

One small cohort study[38] of the return to work of individuals who had undergone carpal tunnel surgery was graded +. Being employed in a 'supportive organisation' was a significant predictor of better work role functioning at six months post-operatively (multiple logistic regression analyses adjusting for baseline work role functioning, baseline self-efficacy and self-efficacy change: OR 4.84, 95%CI 1.88–12.46). Organisations were deemed to be high-support organisations on the mean score of an 11-item scale covering: organisational culture; safety culture (leadership, training and diligence); ergonomics practices and policies; management of disability (proactive return-to-work programmes, disability case management). The summated mean scores (range 1–5) were further collapsed into two categories: high-support (score of 3 or greater) and low-support (score of <3) organisations.

Evidence statements

There is limited evidence that computer keyboards with altered force displacement characteristics[35] or altered geometry[36] are effective in reducing symptoms in workers with carpal tunnel syndrome. **Evidence level 1+**

In workers who have undergone carpal tunnel surgery, there is very limited evidence based on only one cohort study[38] with a high dropout rate, that those employers who offer supportive measures (a people-oriented culture; good safety culture; disability management including return-to-work programmes and case management; and ergonomic policies and procedures) to their employees with carpal tunnel syndrome can improve work outcomes in the medium term (six months). **Evidence level 2+**

From evidence to recommendations

The results of the two higher-quality RCTs of ergonomic keyboards[35,36] can be generalised to all workers with carpal tunnel syndrome using desktop personal computers. This limited evidence, based on two RCTs, suggests that alternative keyboards can reduce symptoms in workers with carpal tunnel syndrome. However, the interventions employed in these two studies are not directly comparable.[35,36]

The nature of computer-based work and the detailed physical characteristics of computer keyboards are continually evolving: it is unclear to what extent experimental interventions from a decade ago reflect current practices and equipment or to what extent such interventions now would be beneficial. For example, the studies reviewed[35,36] make no reference to the use of computer mice or other input devices and there are suggestions[39] that such devices are more

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problematic than keyboards for those with carpal tunnel syndrome. Keyboard characteristics have changed considerably over the time since this evidence was published. Without knowing the characteristics of any individual's existing keyboard, it is not possible to provide more specific guidance than to suggest a trial of a different keyboard. It is appropriate to review the workstation display screen equipment assessment including posture and typing techniques when trialling a different keyboard.

There is limited evidence, based on one cohort study,[38] that supportive organisations can influence work outcomes for workers with carpal tunnel syndrome requiring surgery and this is likely to be applicable to all employers. Previous research[40] has shown that organisational policies and procedures on safety and disability management can have a positive impact on employees' disability rates.

Recommendations

Recommendation	Grade*	Evidence
For those workers with carpal tunnel syndrome using display screen equipment the existing workstation assessment should be reviewed by the employer, with the involvement of the employee, and the findings acted on. This assessment should be revised whenever a substantive change to the workstation or work processes occurs, as required by the Display Screen Equipment Regulations.	**GPP**	
Employers should consider offering computer operators with carpal tunnel syndrome the opportunity to trial different types of computer keyboards.	**B**	Rempel[35] Tittiranonda[36]
Workers with carpal tunnel syndrome who are exposed to hand-transmitted vibration, should have their risk from vibration exposure reassessed and, depending on medical advice and reasonable practicability, should have their exposure reduced.	**GPP**	
Employers should consider offering those workers with carpal tunnel syndrome whose condition is aggravated by work, temporarily modified duties to allow time for the condition to improve.	**GPP**	

* See Appendix 5 for explanation of grading system.

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Question 2 – Non-specific arm pain

In employees with non-specific arm pain, what workplace interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?

Clinical introduction

Non-specific (fore) arm pain has been defined, for research purposes, as 'pain in the forearm in the absence of a specific diagnosis or pathology'.[3] Non-specific arm pain is the most common work-related upper limb disorder complaint although estimates of its prevalence vary. One large occupational surveillance scheme set in France[41] employed published criteria for assessing the work-relatedness of musculoskeletal disorders[16] and found that over half of all workers undergoing routine annual medicals reported non-specific upper limb musculoskeletal symptoms, whether work-related or not, in the previous year. A large community survey set in Southampton found that 24.7% of adults with upper limb pain had no specific diagnosis.[12]

Methodological introduction

Three hundred and forty one papers were identified in the literature search, of which 75 were selected for full text review but one paper[42] was not obtainable within the available time scale. The 266 papers rejected at the first stage included non-systematic reviews, risk factor studies, interventions for primary prevention and commentaries on non-specific arm pain. Of the remaining 74 papers, 15 were chosen for formal review regarding workplace interventions for non-specific arm pain. These 15 papers included seven RCTs, three prospective cohort studies, one retrospective cohort study, a pilot study without randomisation and three papers reporting two systematic reviews. A number of studies of non-specific musculoskeletal symptoms did not make it explicit that they had studied individuals with arm pain. The main difficulty in assessing the literature was that many authors did not make it clear whether they had studied people with a range of specific upper limb disorders or whether they had included those with non-specific arm pain. The majority of the 59 papers were rejected as they did not present data on non-specific arm pain, 10 lacked a workplace intervention, two were studies of primary prevention and two were risk factor studies.

Five studies were of low quality[37,43–46] and had a significant potential for bias. Herbert *et al* undertook a small cohort study but did not follow up the comparison group so this study provided only very limited evidence based on self-reported changes in symptom severity. A small Turkish study[44] was a non-randomised intervention in a small group of volunteers which showed reduced musculoskeletal pain scores post training. The study by Cole and others[45] was poorly designed and interpretation of results was made difficult by organisational changes occurring during the follow-up period. The study by Ripat[37] was marred by incomplete randomisation and lack of blinding. Wiholm's study[46] was hampered by a lack of blinding and dropout rates were unclear so the study had a high risk of bias. A number of studies did not distinguish between individuals with upper limb pain due to a specific upper limb condition and non-specific pain. Several studies did not distinguish between pain in the arm and pain in other regions (eg neck, back). Studies ranged from prevention (asymptomatic at baseline) through to those including patients already on sick leave for more than 90 days.

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One high-quality but small (n=38) Dutch RCT of multidisciplinary rehabilitation[47] focused on workers with non-specific upper limb disorders. To be eligible, participants had to have had sick leave for at least 50% of their contracted hours over a period of between 4 and 20 weeks. That study showed a positive effect of rehabilitation on physical functioning ($p=0.016$), physical disability ($p=0.039$) and fear/avoidance of pain ($p<0.001$). However, return to work was not significantly different from usual care (predominantly input from their occupational physician (100%), general physician (67%), physical therapy (93%) supplemented by manual therapy (33%)) at 12 months with 86% of the intervention group returning to work as compared to 73% in the usual care group. An outpatient intervention was delivered at 13 different centres using a standardised protocol. Groups of workers (n~8) were seen by a team of four comprising a doctor, a psychologist, a physiotherapist and an occupational therapist. The intervention included attendance at 13 whole-day sessions (9am–5pm), five return-to-work sessions and a feedback session over a two-month period. Each day was made up of four 90-minute sessions: two physical sessions aimed at improving endurance and strength using graded activity training starting at 30% of the patients' MVC and aerobic activity; and two covered psychological issues. Education on unhelpful pain behaviour was included along with social sporting activities such as bowling. One psychological session was aimed at preparing workers to return to work and discussing work experiences while the other focused on cognitive behavioural techniques and education focusing on goal setting and attainment, coping mechanisms and stress reduction. Each week there was a half-hour session on relaxation exercises. A workplace visit was arranged in week three of the programme.

A high-quality Swedish RCT of multidisciplinary rehabilitation,[48] for workers with non-specific musculoskeletal pain who had been absent from work for 90 days, examined return to work and subsequent sickness absence over a five-year period. The authors found better work stability over the long term in the rehabilitation group (58% at work in the rehabilitation group at five years versus 52% in the control group). Over three years of follow-up, the mean number of sick days was lower in the rehabilitation group than the control group although their absence rates were above the Swedish national average. The better outcome was, however, restricted to Swedish workers and was not seen in those migrant workers who also received the rehabilitation programme. This multidisciplinary programme was delivered on an outpatient basis by a rehabilitation doctor, a nurse, a physiotherapist, an occupational therapist, a psychologist, a social worker and a vocational counsellor. Patients were evaluated by the doctor and after that initial assessment, other team members were involved as required following a multidisciplinary case conference to identify obstacles in returning to work. The team held weekly reviews of progress until the patient returned to work or another outcome (eg disability pension) was agreed. The physiotherapist undertook a mixture of individual and group sessions for pain management, relaxation, exercises for strength and fitness and education on ergonomics. The psychologist employed cognitive behavioural techniques in both individual and group sessions on pain, fear and avoidance behaviour, beliefs and expectations, coping strategies and stress management. The occupational therapist and vocational counsellor supported workers both in contacts with employers and in vocational training at workplaces. The social worker's role was to provide social support, family counselling and to assist in dealings with authorities.

Studies of workplace ergonomic interventions were generally of lower quality than the two RCTs of multidisciplinary rehabilitation. A number of studies have examined ergonomic training or ergonomic interventions in the workplace[49–52] and have shown some beneficial effects. In one study,[49] these effects were not sustained throughout the 10 months of follow-up, although at two months, both the intensive ergonomic group and the education-only group showed significant

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improvements. In a study of active ergonomics training, Greene *et al* did not find any significant difference between the intervention and control groups in the intensity, frequency or duration of upper extremity symptoms as measured using a modified National Institute for Occupational Safety and Health (NIOSH) questionnaire although back pain did show improvements on all three measures.[51] However, the study sample excluded those receiving treatment from a healthcare professional for upper extremity disorders and included workers with no, or only mild pain, at baseline. As a result, the population might not be representative and/or the effects may be diluted. Pillastrini *et al* found evidence of a non-significant improvement in pain severity in the hands/wrists of a group of computer operators given ergonomic training with a mean (SD) pre-intervention score of 17 (17) versus 11 (11) in the group given information only.[52] After the intervention, the mean scores were 12 (12.1) versus 12 (12.4) respectively, p=0.292. One prospective cohort study (Nelson 1998) explored the impact of deployment to a new office building with improved workstations in comparison with colleagues not relocated. Overall satisfaction with the physical workstation was significantly associated with improvement in hand/arm symptoms but it was unclear whether this improvement related to non-specific arm pain and so this study was not considered further.[53]

One well-conducted RCT explored stress management training and ergonomic interventions[50] and found that stress management training and an ergonomic intervention were associated with improved upper extremity function and reduced pain at follow-up. The ergonomic intervention included a workstation assessment by the researchers and, where necessary, adjustments to the workstation to reduce ergonomic risks. Participants were given instruction on stretching exercises to do at their workstations and access to ergonomic information on their employer's website. The stress management intervention involved: two 70-minute stress management sessions; completion of a two-week stress diary; use of a relaxation training CD developed for the study; and access to two books on stress management. The group receiving both interventions (the 'ergo-stress' group) also received emails (n=24), at fortnightly intervals, with advice on addressing biomechanical and work stressors. There were no significant differences between the two groups for any outcomes including total functional impairment (derived from four Disabilities of the Arm, Shoulder and Hand (DASH) subscales: physical function impairment; interference with work and daily activities; sleep impairment; and interference with social activities) and work stress (measured using the life stressors and social resources inventory) at three or 12 months. However, there were significant improvements in all subjects over time for pain (baseline mean pain score 5.1 reduced to 3.4 at 12 months); DASH symptom severity score at baseline 32.7 reduced to 24.1 at 12 months and upper extremity function score reduced from a mean of 80.1 at baseline to 54.5 at 12 months.

One low-quality study,[46] which was not blinded, explored three stress management interventions: progressive relaxation, applied relaxation and Tai Chi. Occupational outcomes such as sickness absence were not measured in this study. The authors concluded that all of these interventions had a favourable impact, in the short term, on musculoskeletal symptoms in the lower arm: the intervention group mean symptom score change between assessments one and two was not significant at 0.09±0.2 points but the reference group scores increased by 0.6 points p<0.0001.

Two systematic reviews[33,54] examined management of a range of work-related upper limb disorders including non-specific musculoskeletal disorders. A Cochrane systematic review[33] concluded that there was limited evidence that breaks from computer work improved work-

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related complaints of the arm, neck or shoulder[55] when compared with no breaks (RR 1.83, 95%CI 1.27–2.64). The evidence for massage as add-on to physical therapy was based on only one low-quality study[56] where the improvement was non-significant, RR 1.38 (95%CI 0.88–2.16). In general, there was a lack of consistent evidence for workplace interventions which the authors, in part, attributed to the heterogeneity of the studies identified. Although the study by Verhagen[33] was highly rated, the evidence identified in that systematic review was generally weak and included complaints of the neck and shoulder as well as the arm. Given this, it was not employed in drafting the recommendations.

The PICO 2 literature searches were re-run, on 19 August 2008, using the same search terms and databases as the original literature search. Forty three papers were identified and after screening the titles and abstracts, five papers were selected for full text review along with an RCT[55] identified from hand searching the reference list of a systematic review.[33] After full text review, three papers (two RCTs and a cohort study) were selected for detailed review and are discussed below.

Conlon[57] found that, for engineers using a computer for >20 hours/week, a forearm support decreased right upper extremity discomfort (0.35 reduction in symptoms on a discomfort scale with a range of 0–10). This RCT was graded as + but there were concerns that the observed effects, although statistically significant (p=0.035), were so small as to be of little clinical relevance. As a consequence, this study was not employed in drafting the recommendations.

Another RCT studied the effects of a software programme that prompted computer users to take regular breaks.[55] The authors found that neither the frequency nor the severity of musculoskeletal complaints changed over the 12-week study. Similarly, sickness absence was not affected by the intervention. However, such computer breaks were associated with a perceived reduction in symptoms. These results were interpreted in a previous systematic review[33] as providing limited evidence that breaks from computer work improved work-related upper limb complaints. It is debatable how much weight should be placed on an intervention that modifies perceptions of symptoms but does not have a significant impact either on the frequency or the severity of such complaints. This study was not considered further as neither the frequency nor the severity of musculoskeletal complaints was addressed by this intervention.

A Dutch cohort study[58] examined the impact of modified work on the recurrence of sick leave due to musculoskeletal complaints. The authors found that undertaking modified work duties before returning to full duties reduced subsequent sick leave due to musculoskeletal complaints (OR 0.37, 95%CI 0.18–0.75). However, there were concerns that the difference in outcomes might be due to some other, unmeasured aspect of employment rather than the intervention. Although 30% of workers had upper limb disorders, it was unclear how many had non-specific arm pain thus limiting its relevance. This low-quality study with a high dropout rate was not considered further.

Evidence statements

There is high-quality evidence, based on two well-designed RCTs from Sweden and the Netherlands,[47,48] that multidisciplinary rehabilitation for non-specific musculoskeletal disorders, including non-specific arm pain, is beneficial for those workers who have been absent from work for at least four weeks. **Evidence level 1++**

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There is inconsistent evidence, based on three RCTs and one cohort study,[49–52] in different populations, using different interventions and outcome measures, for benefit from ergonomic training with or without an accompanying workplace ergonomic intervention. **Evidence level 1+**

From evidence to recommendations

The limited evidence of benefit from multidisciplinary rehabilitation, drawn from well-designed RCTs in Dutch and Swedish workers, is potentially applicable to occupational health practice in the UK. These two RCTs of multidisciplinary rehabilitation drew participants from a range of employers and industries and so their results could, perhaps, be generalised to all workers who have been absent from work for at least four weeks with non-specific upper limb pain. Although only two trials were identified, these were of good quality and consistent in showing beneficial results (but note that migrant workers did not benefit from multidisciplinary rehabilitation in the Swedish study). One study examined rehabilitation for non-specific upper limb disorders while the other explored rehabilitation for non-specific musculoskeletal pain. Common aspects of the multidisciplinary rehabilitation process were physical sessions to include strength and fitness exercises and education, cognitive behavioural approach to include stress management, coping strategies and occupational therapy liaison with the workplace. Thus, there is limited evidence, based on these two studies, favouring multidisciplinary rehabilitation over usual care for non-specific arm pain among those workers absent from work for at least four weeks as outcomes are better in terms of increased return to work, reduced sickness absence and improved work stability. Such programmes typically include both physical and behavioural components. The resource implications of such an approach in the UK are unclear. One study showed that the cost effectiveness of such an intervention was similar when compared with usual care. Good communication between team members is important and the multidisciplinary team should meet regularly to discuss cases.

There is inconsistent evidence for benefit from stress management training, ergonomic training or ergonomic interventions in the management of non-specific arm pain.

Recommendations

Recommendation	Grade	Evidence
For those workers with non-specific arm pain using display screen equipment, the existing workstation assessment should be reviewed by the employer, with the involvement of the employee, and the findings acted on. This should be revised whenever a substantive change to the workstation or work processes occurs, as required by the Display Screen Equipment Regulations.	**GPP**	
In workers with non-specific arm pain, who have been absent from work for at least four weeks, multidisciplinary rehabilitation programmes including both physical and psychosocial approaches should be offered, or facilitated, by employers.	**B**	Meijer[47] Lindh[48]

continued

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Recommendation	Grade	Evidence
The physical sessions, which should be led by a health professional (eg physiotherapist, occupational therapist), are aimed at improving strength and endurance using graded activity. Relaxation sessions and energy conservation sessions should be included and should aim to equip the employee with effective coping strategies. Education on ergonomics may be included.	**B**	Meijer[47] Lindh[48]
The psychosocial component, which should be led by a health professional (eg psychologist, occupational therapist), is aimed at improving coping strategies using cognitive behavioural techniques, and preparation for return to work including liaison with the employer. Education on effective coping mechanisms for pain should be included.	**B**	Meijer[47] Lindh[48]
For employees absent from work with non-specific arm pain for more than four weeks, an individualised return-to-work plan should be agreed, in advance of the individual's return to work, following liaison between the rehabilitation team, the employer and the worker.	**GPP**	
Employers should consider offering those workers with non-specific arm pain whose condition is aggravated by work, temporarily modified duties to allow time for the condition to improve.	**GPP**	

Question 3 – Tenosynovitis

In employees with tenosynovitis, what workplace interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?

Clinical introduction

Harrington[3] defined this condition as 'inflammation of the extensor or flexor tendon sheaths at the wrist'. They distinguished this from de Quervain's disease, a stenosing tenovaginitis which affects the supporting tissues that surround the tendons of extensor pollicis brevis and abductor pollicis longus within the first extensor compartment. Tenosynovitis surveillance criteria were defined by Harrington *et al* as 'pain on movement, localised to the affected tendon sheaths in the wrist and reproduction of pain by resisted active movement of the affected tendons with the forearm stabilised'. Additional clinical features that might be present included: tenderness, swelling over the affected tendon sheath, crepitus and redness. Tenosynovitis (excluding de Quervain's disease) affected 1.1% of men and 2.2% of women (point prevalence) in a large community survey in Southampton.[12]

Methodological introduction

Two hundred and fifty six papers were identified in the literature search, of which 19 were selected for full text review. The 237 papers rejected at the first stage included non-systematic

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reviews, risk factor studies, interventions for primary prevention and commentaries. Of the 19 papers selected for full text review, one was selected for detailed review and a further paper was identified from a hand search of references. The remaining 18 papers were rejected as they either lacked data on tenosynovitis (n=15) or did not describe a workplace intervention (n=3). The literature search was updated on 20 August 2008 when 41 papers were identified: after reviewing the titles and abstracts, two papers were selected for full text review but neither was selected for detailed review.

One systematic review of conservative treatments[1] did not identify any primary research and was not considered further.

There was limited evidence for workplace interventions employing modified keyboards in individuals with tendonitis.[36] The authors trialled three keyboards with alternative keyboard geometry: Apple Adjustable Keyboard™ (termed kb1); Comfort Keyboard System™ (termed kb2); and Microsoft Natural Keyboard™ (termed kb3) and compared them with a standard keyboard. All three keyboards look strikingly different from a standard keyboard making blinding of keyboard users impossible. They found a significant trend for improved hand function over six months follow-up for kb3 whereas the standard keyboard group's hand function worsened. However, the diagnostic criteria employed were unlikely to distinguish between tendonitis (historically thought to be due to inflammation of the tendon) and tenosynovitis (inflammation of the synovial sheath). It should be noted that histology rarely provides evidence of inflammatory changes in affected tendons although the clinical picture is suggestive of such changes with redness, swelling and pain over the tendon. A more accurate term for tendonitis is therefore tendinosis.[59]

The RCT of modified computer keyboards[36] employed clinical measures such as symptom reporting or change in hand function as its primary outcomes. These are important outcomes which might be expected to influence work ability. However, caution is necessary as there is no direct evidence from this study[36] that such metrics are associated with better work outcomes. This study was graded as + indicating that some of the quality criteria for an RCT had been met and that those criteria that had not been met were unlikely to alter the study's conclusions.

Evidence statement

In workers with tenosynovitis there is limited evidence, based on only one study, that computer keyboards with altered force displacement characteristics or altered geometry can be effective in reducing symptoms. **Evidence level 1+**

From evidence to recommendations

The evidence, from a single study of US workers, is directly applicable to occupational health practice in the UK.[36] The evidence that modified keyboards are helpful in reducing symptoms can be generalised to all workers with tenosynovitis using desktop personal computers. Many workers use computer keyboards but only a small proportion will develop tenosynovitis. The likely impact of the intervention, on a population basis, is limited although individual sufferers might benefit.

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Recommendations

Recommendation	Grade	Evidence
For those workers with tenosynovitis using display screen equipment, the existing workstation assessment should be reviewed by the employer, with the involvement of the employee, and the findings acted on. This should be revised whenever a substantive change to the workstation or work processes occurs, as required by the Display Screen Equipment Regulations.	**GPP**	
Employers should consider offering those workers with tenosynovitis whose condition is aggravated by work, temporarily modified duties to allow time for the condition to improve.	**GPP**	

Question 4 – Lateral epicondylitis

In employees with lateral epicondylitis, what workplace interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?

Clinical introduction

Lateral epicondylitis, or tennis elbow, is a condition characterised by pain over the lateral epicondyle of the humerus, aggravated by loading of the hand extensor muscles at the elbow.[2] Although this condition is very common among tennis players, most sufferers do not play racquet sports. In surveys, it is reported more frequently in the dominant arm and is more common in mid-life. Most patients recover over a 12-month period[60,61] although relapses are common. Conservative management includes rest, acupuncture, splinting and non-steroidal anti-inflammatory drugs but those with persistent difficulties may require surgery.[62] A series of Cochrane Collaboration reviews published in 2002 concluded that the evidence for the efficacy of these interventions is limited.[63–66] A recent systematic review[67] concluded that there was insufficient evidence for lateral epicondylitis to be prescribed for the purposes of Industrial Injuries Benefit in the UK. Nonetheless, there was limited evidence of an occupational association in specific occupations such as meat cutting and sausage making.

A prospective survey in one English general practice found an annual incidence of lateral epicondylitis of approximately 4 per 1,000 patients[68] while a Swedish survey reported a one-year period prevalence of 0.5–1%.[69] A high-quality community-based survey in Southampton[12] employed a structured examination schedule and found a lateral epicondylitis point prevalence of 1.3% among men and 1.1% among women. A French occupational surveillance scheme[41] found a point prevalence of 2.2% in men and 2.7% among women. A Finnish study[70] found a point prevalence of 1.3% in both genders while a Swedish study, set in Stockholm in the mid-1960s, found a one-year period prevalence of 2.5%.[71]

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Methodological introduction

Three hundred and eighty three papers were identified in the literature search, of which 37 were selected for full text review. The 346 papers rejected at the first stage included non-systematic reviews, risk factor studies, interventions for primary prevention and commentaries. Of the 37 papers selected for full text review, three papers were selected for detailed review. The majority of the 34 papers rejected did not provide any data on lateral epicondylitis, two explored risk factors for epicondylitis, six did not employ a workplace intervention and one was a study protocol. The literature search was updated on 20 August 2008 when a further six papers were identified but none were selected for full text review.

The literature search identified one prospective cohort study of low quality[72] which explored a multifaceted intervention to reduce musculoskeletal disorders. There was a significant potential for selection bias in this study and so it was not considered further.

One retrospective cohort study of the effects of splinting[73] on lateral epicondylitis was graded as of low quality owing to the retrospective collection of data of doubtful validity from multiple centres (eg it was unclear what, if any guidance had been given to clinicians when grading the severity of the condition). However, unless this imprecision in grading was systematic, it would simply attenuate the observed associations rather than bias them. The authors had employed statistical methods to adjust for key confounders but there were substantial concerns among the reviewers that other unmeasured factors might have affected the study's conclusions and so it was not considered further.

There was a single RCT of a minimal educational intervention, in addition to usual care, in the management of lateral epicondylitis.[61] There was a significant potential for bias in this study owing to a low recruitment rate. In addition, there was poor compliance in the control group and so it was not considered further.

Evidence statement

There is a lack of high-quality evidence to inform the workplace management of lateral epicondylitis.

From evidence to recommendations

The evidence base for the workplace management of lateral epicondylitis is limited and no workplace intervention is of proven benefit.

Recommendation

Recommendation	Grade	Evidence
Employers should consider offering those workers with lateral epicondylitis whose condition is aggravated by work, temporarily modified duties to allow time for the condition to improve.	**GPP**	

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4 Future research and audit criteria

Recommended areas of research

There has been insufficient focus on occupational outcomes in treatment trials for upper limb disorders.[74] There is a need for experts in this field to agree consensus definitions of conditions to facilitate further research. Efforts to validate outcomes, including subjective outcomes such as self-rated pain, should be pursued. Researchers should address important work outcomes, such as sickness absence, and standardise their measurement. Further work is needed on computer workstations and alternative input devices.

Recommended questions for future research

The following questions are a priority for future guideline development:

- When studying workers with upper limb disorders, greater clarity and consistency is needed in the definition of upper limb disorders studied, interventions undertaken and the metrics employed to assess clinical outcomes and especially occupational outcomes eg sickness absence, productivity or employment retention than at present.
- For working people using computers, studies of new or modified computer equipment should reflect current work practices when seeking to demonstrate improved outcomes in those already suffering from an upper limb disorder.
- When studying working people with upper limb disorders, studies comparing interventions such as multidisciplinary rehabilitation with usual care or no care should include occupationally relevant outcomes (job retention, sickness absence etc) with long-term follow-up to demonstrate sustainability.
- In the management of workers with upper limb disorders, more research is needed to determine what elements of organisational policy and procedure, when compared with other employers in the same sector, influence occupational outcomes such as sickness absence and job retention.
- For workers with upper limb disorders, modern keyboard designs need to be further researched and compared with current standard computer keyboards to establish whether they influence occupational outcomes such as sickness absence and productivity.
- For workers with upper limb disorders, other workstation components and work/task design should be compared with standard computer workstations and work practices to establish whether they influence occupational outcomes such as sickness absence.

Audit criteria

In the absence of established audit criteria, employers should be able to demonstrate continued improvement in the following measures.

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Recommendation	Audit criteria
Employers should offer all computer users with carpal tunnel syndrome the opportunity to trial different computer keyboards.	% of computer users with carpal tunnel syndrome who have been offered a trial of different computer keyboards.
For employees with carpal tunnel syndrome, the employer should review the risk assessment for their computer workstation and act on any significant findings.	% of employees with carpal tunnel syndrome with a written record of a display screen equipment (DSE) reassessment.
Workers with carpal tunnel syndrome who are exposed to hand-transmitted vibration should have their risk from vibration exposure reassessed and, depending on medical advice and reasonable practicability, should have their exposure reduced.	% of employees with carpal tunnel syndrome who are exposed to hand-transmitted vibration with a written record of a vibration exposure reassessment.
For employees with non-specific arm pain, multidisciplinary rehabilitation programmes including both physical and behavioural approaches should be offered.	% of employees with non-specific arm pain who have been offered multidisciplinary rehabilitation including both physical and behavioural approaches.
For employees absent from work with upper limb disorders for more than four weeks, the occupational health practitioner should liaise (with the worker's consent) with the general practitioner, consultant or physiotherapist.	% of employees absent from work with upper limb disorders for >4 weeks where the occupational health practitioner and treating general practitioner have liaised.
For employees absent from work with upper limb disorders for more than four weeks, an individualised return-to-work plan should be agreed in advance of the individual's return to work.	% of employees absent from work with upper limb disorders for >4 weeks with a written return-to-work plan agreed in advance of the individual's return to work.

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Appendix 1 Role and remit of the guideline developers

The Guideline Development Group (GDG) was established for the duration of the project, to comprise representation of key stakeholder groups and to undertake development of the guideline.

The team delivering the project consisted of:

- Guideline Development Group Leader
- Guideline Development Group
- Project Manager
- Information Scientist
- Clinical Director of OHCEU.

Membership of the project team is listed on page v of the guideline. Declarations of interest were required from all individuals involved in development of the guideline.

The governance framework within which OHCEU operates ensures that development and delivery of our projects are overseen by the Steering Group and Executive Committee of the OHCEU. Respectively these are an external and internal stakeholder group responsible for the strategic direction of OHCEU, advising on the relevance of the work programme to those delivering occupational health services in the UK, and responsible for the delivery to NHS Plus of high-quality deliverables.

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Appendix 2 Key questions on the occupational health management of upper limb disorders

Question 1: In employees with carpal tunnel syndrome, what workplace interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?

Population	Intervention	Comparison	Outcome
Adults with carpal tunnel syndrome	Physical therapies Medication/drugs Surgery Ergonomics/workplace interventions	No intervention Other intervention Placebo	Symptom relief Functional improvement Sickness absence Job retention

Question 2: In employees with non-specific arm pain, what workplace interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?

Population	Intervention	Comparison	Outcome
Adults with non-specific arm pain	Physical therapies Medication/drugs Surgery Ergonomics/workplace interventions	No intervention Other intervention Placebo	Symptom relief Functional improvement Sickness absence Job retention

Question 3: In employees with tenosynovitis, what workplace interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?

Population	Intervention	Comparison	Outcome
Adults with tenosynovitis	Physical therapies Medication/drugs Surgery Ergonomics/workplace interventions	No intervention Other intervention Placebo	Symptom relief Functional improvement Sickness absence Job retention

Question 4: In employees with lateral epicondylitis, what workplace interventions are effective at preventing/reducing sickness absence/retaining normal job/preventing ill health retirement?

Population	Intervention	Comparison	Outcome
Adults with lateral epicondylitis	Physical therapies Medication/drugs Surgery Ergonomics/workplace interventions	No intervention Other intervention Placebo	Symptom relief Functional improvement Sickness absence Job retention

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Appendix 3 Electronic searches

The following search strategy was used as the population for each PICO and searched in the following electronic databases:

- MEDLINE 1950 to 2008
- EMBASE 1980 to 2008
- Cinahl 1981 to 2008
- AMED (Allied and Complementary Medicine Database) 1985 to present
- The Cochrane Library.

The electronic databases were last searched on 14 August 2008.

Search Strategy:

Population

1. *Arm Disease/
2. *Arm Injury/
3. *Limb Pain/
4. *Arm/
5. *Upper Extremity/
6. (upper adj extremity adj disorder$).ti,ab.
7. *Hand Injury/
8. *Hand Injuries/
9. *Hand Movement/
10. (hand adj movement).ti,ab.
11. (hand adj (injur$ or movement)).ti,ab.
12. *neck pain/
13. (neck adj (pain or disorder)).ti,ab.
14. *Musculoskeletal Disease/
15. *Musculoskeletal System Inflammation/
16. (Upper adj limb adj disorder$).ti,ab.
17. (Work adj2 musculoskeletal adj disorder).ti,ab.
18. wrmsd.ti,ab.
19. wruld.ti,ab.
20. wmsd.ti,ab.
21. *Cumulative Trauma Disorder/
22. *Tendinitis/
23. tendin$.ti,ab.
24. *Repetitive Strain Injury/
25. (occupation$ adj overuse adj syndrome).ti,ab.
26. (Repetition adj Strain adj Injury).ti,ab.
27. (Repetitive adj Motion adj Disorder$).ti,ab.
28. (Strain adj Injury).ti,ab.
29. RSI.ti,ab.

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30. or/1-29
31. *Occupational Health/
32. *Occupational Exposure/
33. (environment adj (work$ or occupation$)).ti,ab.
34. ((profession$ or work$ or occupation$) adj3 climate).ti,ab.
35. ((profession$ or work$ or occupation$) adj3 health).ti,ab.
36. ((profession$ or work$ or occupation$) adj3 expsoure).ti,ab.
37. *Occupational Disease/
38. *Food Industry/
39. (food adj industr$).ti,ab.
40. *industry/
41. *Named Groups By Occupation/
42. *Occupational Groups/
43. or/31-42
44. *ergonomics/
45. ergonom$.ti,ab.
46. *occupational health/
47. *Work Environment/
48. *vocational rehabilitation/
49. *Human Engineering/
50. (human adj engineering).ti,ab.
51. Biomechanics/
52. *Workplace/
53. *workload/
54. (workplace adj design).ti,ab.
55. redeployment.ti,ab.
56. retraining.ti,ab.
57. (tool adj design$).ti,ab.
58. *Self Help/
59. *Self-Help Devices/
60. (self adj3 device$).ti,ab.
61. *device/
62. *assistive technology device/
63. *Patient Information/
64. (patient adj information).ti,ab.
65. or/44-64

(A systematic review and exclusion filter were added to the final search strategy.)

The following search strategies were used as the intervention for each question:

PICO1

1. *Carpal Tunnel Syndrome/
2. "carpal tunnel syndrome".ti,ab.
3. CTS.ti,ab.

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4. *Peripheral Neuropathy/
5. ((Peripheral adj nerve adj entrapment) or syndrome).ti,ab.
6. *Nerve Compression/
7. (nerve adj entrapment adj syndrome).ti,ab.
8. *Median Nerve/
9. (Carpal adj Tunnel adj Compression).ti,ab.
10. (median adj nerve adj neuropathy).ti,ab.
11. (median adj nerve adj entrapment).ti,ab.

PICO2

1. (Musculoskeletal adj2 Pain).ti,ab.
2. *Musculoskeletal Disease/
3. *Arm Injury/
4. (arm adj1 pain).ti,ab.
5. (non adj specific adj arm adj pain).ti,ab.
6. (Work adj2 musculoskeletal adj disorder).ti,ab.
7. wrmsd.ti,ab.
8. wruld.ti,ab.
9. wmsd.ti,ab.
10. *Cumulative Trauma Disorder/
11. *Repetitive Strain Injury/
12. (occupation$ adj overuse adj syndrome).ti,ab.
13. (Repetiti$ adj Strain adj Injury).ti,ab.
14. (Repetiti$ adj Motion adj Disorder$).ti,ab.
15. (Strain adj Injury).ti,ab.
16. RSI.ti,ab.

PICO3

1. *Tenosynovitis/
2. tenosynovitis.ti,ab.
3. tendinous synovitis.ti,ab.
4. *Tendon Entrapment/
5. *Tendons/
6. (tendon$ adj entrapment).ti,ab.
7. *Wrist Injuries/
8. (work adj2 musculoskeletal adj disorder).ti,ab.
9. wrmsd.ti,ab.
10. RSI.ti,ab.
11. *Repetitive Strain Injury/
12. (occupation$ adj overuse adj syndrome).ti,ab.
13. (Repetiti$ adj Strain adj Injury).ti,ab.
14. (Repetiti$ adj Motion adj Disorder$).ti,ab.
15. (Strain adj Injury).ti,ab.

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PICO4

1. *Epicondylitis/
2. *Tennis Elbow/
3. (medial adj epicondylitis).ti,ab.
4. epicondylitis.ti,ab.
5. (tennis adj elbow).ti,ab.
6. (golfer$ adj elbow).ti,ab.
7. *Elbow Injury/
8. (elbow$ adj disorder).ti,ab.
9. *Elbow Disease/
10. (elbow adj tenderness).ti,ab.
11. wrmsd.ti,ab.
12. *Repetitive Strain Injury/
13. (occupation$ adj overuse adj syndrome).ti,ab.

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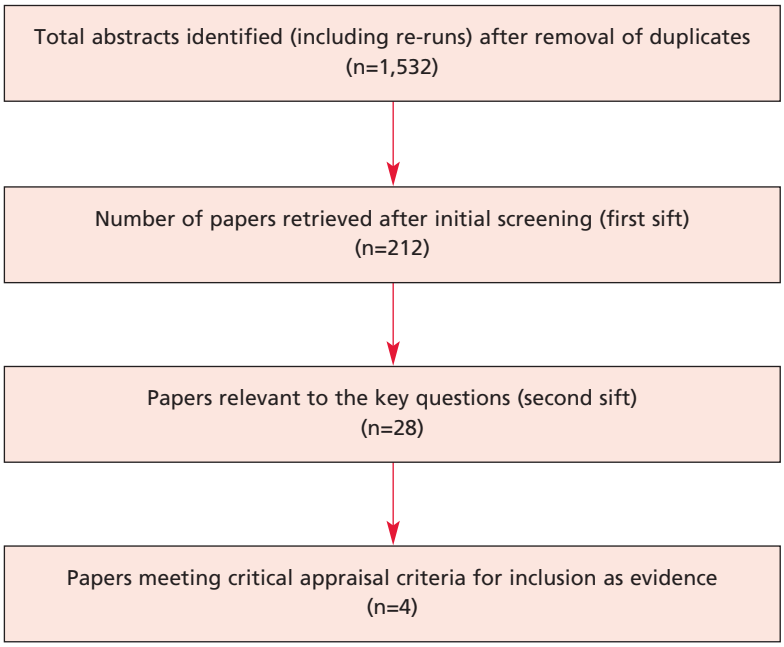
Appendix 4 Summary of literature search (all questions)

Flow chart showing selection of papers



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Appendix 5 SIGN grading system for evidence statements

The SIGN guidelines[5] employ a grading system for evidence from peer-reviewed publications. This system ranks evidence on a four-point scale, based on the study design and its potential for bias. A high-quality meta-analysis or a randomised controlled trial (RCT) with a very low risk of bias is graded as 1++, case reports are graded as 3 and expert opinion is graded as 4.

Levels of evidence	
1++	High-quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias
1+	Well-conducted meta-analyses, systematic reviews, or RCTs with a low risk of bias
1–	Meta-analyses, systematic reviews, or RCTs with a high risk of bias
2++	High-quality systematic reviews of case control or cohort studies. High-quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal
2+	Well-conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal
2–	Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal
3	Case reports, case series
4	Expert opinion

Thus, the level of evidence indicates both the type of study from which the evidence is derived and the quality of the study as graded by the reviewers. The evidence statements are then used to generate recommendations, with grades indicating the quality and weight of evidence behind each recommendation. The grades employed are as follows:

A	At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population; or A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating consistency of results
B	A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results; or Extrapolated evidence from studies rated as 1++ or 1+
C	A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results; or Extrapolated evidence from studies rated as 2++
D	Evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+

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Good Practice Points

Good Practice Points (GPPs) are practical points that the GDG wishes to emphasise but for which there is not, nor is there likely to be, any research evidence – for example, some aspect of management or treatment that is regarded as such sound clinical advice that nobody is likely to question it. These are not alternatives to evidence-based recommendations, and are only used where there is no other way of highlighting the issue.

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Appendix 6 Consultation

The scope of the guideline was made publicly available on NHS Plus website (www.nhsplus.nhs.uk) from the start of the project. Following sign-off of the draft guideline by the GDG and OHCEU Steering Group, consultation was extended to members of the organisations/groups represented on the GDG and OHCEU Steering Group, as key stakeholders.

A one-month consultation period took place via the NHS Plus website. Stakeholders were advised to sign up to the NHS Plus email alert to receive notification of the consultation period, in addition to which notice of the consultation period was posted on the NHS Plus website.

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Appendix 7 Evidence tables

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Table 1: Carpal tunnel syndrome (CTS)

Bibliographic citation	Study design	Level of evidence	Number of subjects	Patient characteristics	Intervention	Comparison	Length of follow-up	Outcome measures	Effect size	Source of funding
Amick[38]	Cohort study	2+	197 subjects at baseline, 128 subjects at 2 months, falling to 122 subjects at 6 months	Workers with CTS confirmed by nerve conduction studies	Predictors of work role functioning at 2 months and 6 months after carpal tunnel surgery	Three levels of outcome: not working/working but limited/ working at >90% of capacity by a range of baseline predictors including work-related social support, job control and organisational policies	12 months	Return to work, work functioning	At 6 months being employed in a 'supportive organisation' was associated with successful work functioning OR 4.84 (95%CI 1.88–12.46) after adjusting for work role functioning at baseline.	CDC/NIOSH, NIAMS, Robert Wood Johnson Foundation
General comments: Being employed by a supportive organisation is predictive of successful return to work after carpal tunnel surgery. However, whether this finding extends to conservatively managed workers is not addressed.										
Battevi[31]	Cohort study	2–	66 subjects with CTS of a total of 92 subjects with work-related musculo-skeletal disorders of the upper limbs. Subsequent data are presented by affected wrists making it difficult to determine numbers of affected subjects employed in the assembly bay and electrical engine workshops.	16 male, 50 female CTS sufferers	Task redesign in workplace. 25 patients given orthoses	Allocation to low-demand job vs unmodified job	Follow-up duration is unclear but is at least 12 months in some subjects.	Condition improved/ unchanged/worsened	Percentage of CTS-affected wrists which improved was analysed by job (redesigned vs unmodified).	Not stated
General comments: Strong potential for bias owing to unblinded assessment therefore reject study.										
Bonfiglioli[32]	Cohort study	2–	51 assembly line workers and 55 non-assembly workers were assessed at baseline. In year 2, 40 assembly line workers were examined of whom 32 had taken part in the baseline survey.	The characteristics of the 32 assembly line workers at year 2 are not reported: the initial study group of assembly line workers at baseline were 51 workers of whom 32 were men, 19 women; mean age 36.3±11.4 years; mean body mass index (BMI) 23.6±3.1.	Reduced hours of work	Hours of work	2 years	Hand symptoms, motor and sensory conduction velocities	CTS symptoms at year 2 when compared with CTS symptoms at baseline were significantly decreased p<0.001.	Not declared
General comments: This was an uncontrolled natural experiment. Repetitive work was associated with a higher level of CTS and abnormal nerve conduction studies (NCS). These findings appear to be reversible following a period of less repetitive work. Note potential for bias by healthy worker effect. The 2-year follow-up of 32 assembly line workers gives no information on demographic details: reject study.										
Crawford[1]	Systematic review	1+	n/a	n/a	n/a	n/a				HSE
General comments: Little evidence to support workplace intervention strategies for carpal tunnel syndrome.										

continued

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Table 1: Carpal tunnel syndrome (CTS) – *continued*

Bibliographic citation	Study design	Level of evidence	Number of subjects	Patient characteristics	Intervention	Comparison	Length of follow-up	Outcome measures	Effect size	Source of funding
Rempel[35]	RCT	1+	12 subjects were allocated a modified keyboard and 12 matched subjects were allocated a control keyboard at study inception. Only 20 subjects finished the study.	The baseline study group were well matched with no significant differences between groups.	Alternative computer keyboard with reduced keyboard force-displacement characteristics	Comparison between 2 keyboards, keyboard A having reduced keyboard force-displacement characteristics and keyboard B being a standard keyboard	12 weeks but it is unclear whether the 25th subject (the back-up subject initially not paired with a matched subject) was assigned a keyboard at baseline or within the first 2 weeks when 4 subjects dropped out.	1. self-administered symptom questionnaire 2. self-administered hand function questionnaire 3. standardised examination by a blinded assessor including timed Phalen's test 4. median nerve conduction latencies 5. rating of keyboards.	Significant decrease in pain (0: no pain, 10: worst pain) when using keyboard A vs keyboard B between weeks 6 and 12 of study. There was a significant difference between keyboards (favouring keyboard A) for right hand in Phalen's test time* using repeated measures analysis of variance (ANOVA) (measured at baseline, week 6 and week 12) right hand p=0.006.	Northwest Trade Adjustment Assistance Centre, Seattle and Keytronic Corporation, Spokane, Washington
General comments: There is limited evidence to support an alternative force-displacement keyboard as a workplace intervention in the management of workers with carpal tunnel syndrome. Note the small sample size, rematching of subjects early in study and short follow-up time.										
Ripat[37]	RCT	1–	43 symptomatic workers using modified keyboard and 25 symptomatic workers using 'standard' MN keyboard	Adapted keyboard, mean age 41.7 (range 22–61 years), 'standard keyboard' mean age 43.0 (range 30–57 years). 58% were female in LT group and 76% female in unadapted (MN) group. No significant differences in years at job, hand dominance	Alternative style ergonomic keyboard versus 'standard' ergonomic keyboard	Comparison between ergonomic keyboard (MN)† and ergonomic keyboard with altered activation force, vibration and key travel	6 months follow-up	Symptom Severity Scale (SSS); Functional Status Scale (FSS); Quebec User Evaluation of Satisfaction with assistive Technology (QUEST); Phalen's test; Abductor pollicis brevis strength test; touch threshold measured using Semmes-Weinstein monofilament	SSS p<0.0001 baseline to 24 weeks FSS p<0.001 baseline to 24 weeks QUEST p<0.0001 baseline to 24 weeks Phalen's test p<0.025	Manitoba Hydro
General comments: Limited evidence to support the use of ergonomic keyboards for individuals with CTS. 'Although the benefits gained from the two keyboards in the study were similar, non-significant trends towards improved function were found for the Light Touch (LT) keyboard.'										

*Subjects asked to actively flex their wrists to maximum, maintain this position for 60 seconds and report when, if at all, symptoms of numbness and tingling occur in the fingers.
†Microsoft Natural MultiMedia Keyboard™

continued

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Table 1: Carpal tunnel syndrome (CTS) – *continued*

Bibliographic citation	Study design	Level of evidence	Number of subjects	Patient characteristics	Intervention	Comparison	Length of follow-up	Outcome measures	Effect size	Source of funding
Tittiranonda[36]	RCT	1+	Overall 80 (44 with CTS). 11 CTS subjects were randomised to 1 of 4 keyboards.	Employees of the Lawrence Livermore National Laboratory. To be eligible they had to be full-time employees, employed on their job for more than 3 months and used a computer for 4 hours/day or 20 hours/week or more. None had previously used an alternative geometry keyboard. Exclusion criteria were previous carpal tunnel surgery, or carpal tunnel syndrome, wrist or forearm tendonitis diagnosed more than 2 years prior to review. Subjects were well matched and baseline demographics across the four groups showed only one significant difference across 28 measures.	Alternative geometry keyboards versus placebo keyboard	Between alternative geometry keyboards and placebo keyboard	6 months	Mean (SD) of pain severity as measured using self-administered question-naire rating severity of pain and discomfort in previous week (0: none, 10: worst imaginable) Hand functional status based on self-rating of 11 activities of daily living and an overall score (0: no difficulty at all, 10: most difficult) Standardised, blinded, clinical examination; mean (SD) of timed Phalen's test (duration of time , up to 60 seconds, until symptoms of numbness and tingling occur in the area inner-vated by the median nerve after wrist flexion), Tinel's sign, Finkelstein's test Keyboard preference rated using an 11-point visual analogue score (VAS) with verbal anchors	Pain severity was reduced for alternative geometry keyboards, expressed as change in severity between baseline and 6 months, an effect which was significant for kb3 when compared to placebo (1.21±3.1 vs –0.29±1.5, p<0.05). This was significant for the tendonitis group (n=36) but not the carpal tunnel syndrome group (n=44); tendonitis, 2.00±2.3 vs –0.28±1.9, p<0.05 (kb3 vs placebo); CTS, 0.50±3.7 vs –0.28±1.9, p>0.05. Increase in overall hand functional status of 1.38±2.1 for kb3 vs –0.5±1.3 for placebo Clinical status was unchanged for the majority of cases after 6 months.	US Department of Energy
General comments: Limited evidence supporting the use of alternative geometry keyboards for workers with carpal tunnel syndrome. When compared to placebo, alternative geometry keyboard kb3 and to a lesser extent kb1 demonstrated an improving trend in pain severity (not sig.) and hand function (sig.) after 6 months' use.										
Verhagen[33]	Systematic review	1++	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
General comments: This systematic review found limited evidence for the efficacy of specific keyboards with an alternative force displacement or geometry only for carpal tunnel syndrome.										
Verhagen[34]	Systematic review	1++	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
General comments: Limited evidence for some computer keyboard designs in people with CTS when compared to other keyboards or placebo.										

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Table 2: Non-specific arm pain

Bibliographic citation	Study design	Level of evidence	Number of subjects	Patient characteristics	Intervention	Comparison	Length of follow-up	Outcome measures	Effect size	Source of funding
Meijer[47]	RCT	2 ++	23 employees in intervention group (16 women) and 15 employees in usual care group (10 women)	Dutch bank and university employees, working at least half time, suffering from non-specific upper extremity musculoskeletal disorders, aged between 18 and 65 years and on sick leave for more than 50% of full-time hours during a period between 4 and 20 weeks 14 females and 6 males in intervention arm with mean age 38.3 years (SD 7.8), 9 females and 5 males in usual care group with mean age 37.9 years (SD 9.0)	Multidisciplinary rehabilitation programme including graded activity training; psychological sessions addressing return-to-work preparation and education regarding inappropriate pain behaviour; relaxation exercises. It is unclear how many subjects received the workplace intervention: a workplace visit.	Comparisons made between intervention and usual care at three time points (2 months, 6 months and 12 months)	1 year	Dutch version of DASH (Disability Arm Shoulder Hand questionnaire); SF-36 Health Survey (Dutch); handgrip measured using Jamar dynamometer; Tampa scale for kinesiophobia; visual analogue scales (VAS) of i) pain and ii) other complaints. Economic outcomes: direct and indirect costs. Cost effectiveness assessed for return to work; decrease on pain VAS; decrease on VAS 'other complaints'	Absolute effect sizes measured using Cohen's d: large effect size in short term (2 months) for physical disability (0.92), pain (0.97), other complaints (1.20) and kinesiophobia (2.07). In long term (12 months), large effect size only seen for kinesiophobia (1.71)	Funded by the Netherlands Organization for Health Research and Development (ZONMw) and a supplementary grant from the UWV
General comments: Multidisciplinary treatment has a positive effect on physical functioning, physical disability and fear/avoidance of pain. However, return to work is not significantly different from usual care at 12 months follow-up.										
Wiholm[46]	RCT	1–	66 (10 females) in intervention group and 50 (15 females) in reference group.	Staff drawn from two departments of a multinational telecommunication company. The two departments were comparable with regards to key background factors, such as education and work duties. Most participants were aged between 30 and 39 years.	Choice of one of three interventions: progressive relaxation; applied relaxation; Tai Chi	Comparisons were made between intervention group (as a whole) and reference group as there were no significant differences between the three training methods.	8 months	Self-reported symptoms expressed as musculoskeletal indices for neck/back and for lower-arm. Psychosocial indices	Significant difference in lower arm index between groups at second assessment (month 3): intervention group scores did not change between first and second assessments but the reference group mean score worsened by 0.6 points (index ranges from 5–20 points).	Not stated
General comments: Low-quality study. Authors concluded that 'stress management intervention has a favourable impact on musculoskeletal symptoms from the lower arm,' but whether this included non-specific arm pain is unclear.										
Dalkilinc[44]	RCT	2–	40 subjects	25 males, 15 females with a mean age of 27.3 years, SD 4.7. All participants were employed in a Turkish software company.	Ergonomics and physiotherapy training for 6 hours	Pre- and post-intervention results on Rapid Upper Limb Assessment tool (RULA), NIOSH checklist and pain VAS	Unclear	RULA score, NIOSH checklist score and pain VAS	Among symptomatic workers with musculoskeletal pain (n=26, 4 with wrist-hand pain, 3 with shoulder pain) the pain VAS declined from 4.17±1.26 pre-intervention to 2.10±1.12 post intervention, $p<0.05$.	Not disclosed
General comments: This non-randomised intervention study in a small group of volunteers showed reduced musculoskeletal pain scores post training. The findings require confirmation in an RCT.										

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Table 2: Non-specific arm pain – *continued*

Bibliographic citation	Study design	Level of evidence	Number of subjects	Patient characteristics	Intervention	Comparison	Length of follow-up	Outcome measures	Effect size	Source of funding
Feuerstein[50]	RCT	1+	'Ergo-only' group n=47 'Ergo-stress' group n=46	Groups differed significantly on age (ergo-stress group mean 48.8 years, SD 7.8; ergo-only group 45.1 years, SD 7.8, p<0.05). No differences between groups for years at task, hours/week, education, marital status or gender (ergo-only: 32 females, 4 males; ergo-stress: 25 females, 9 males)	An ergonomic intervention ± job stress management training	Comparison between two groups: one receiving an ergonomic intervention, the other an ergonomic intervention and job stress management training	12 months	Stress (Life Stressors and Social Resources Inventory), pain (VAS), symptoms (symptom severity subscale of DASH), functional limitation (upper extremity function scale of DASH) and general physical and mental health (SF-12)	No significant differences between groups for pain, symptom severity, upper extremity function, SF-12 or work stress	Part funded by Office Ergonomics Research Committee
General comments: Ergonomic intervention and job stress management led to improved upper extremity function and pain at 3 and 12 months compared with baseline, but in the absence of a non-intervention group it cannot be concluded that the improvement was due to the intervention. There were no differences in outcome between the two groups: stress management did not add anything to the ergonomics intervention.										
Nelson[53]	Prospective cohort study	2+	998/1452 (68.7%) subjects in relocated group at baseline and 179/287 (62.4%) in the two reference buildings. 557 subjects (38.3%) in the relocated group and 55 subjects (19.1%) in the two reference buildings provided matchable responses on both occasions.	Limited data provided on age and gender. No statistical tests undertaken but authors state that 'when age and gender distributions were compared for the matched respondents and the target population, matched respondents were slightly more likely to be female… (and) tended to be slightly older than the target population.'	Deployment to a new office building with improved workstations	Comparisons are made between employees relocated to a new office building with improved work-stations and staff who remained in their existing buildings.	For 7 months after the intervention (ie 1 year between the pre- and post-intervention questionnaires)	Physical work environ-ment, psychosocial aspects of work environment and symptom self-reports	Overall satisfaction with the physical workstation was significantly associated with improve-ment in hand/arm symptoms between 1992 and 1993 in multiple logistic analyses: OR 2.0.	Part funded by US Environmental Protection Agency (EPA). Technical and administrative support from staff of Washington State Department of Labor and Industries and EPA staff
General comments: Musculoskeletal symptoms in the arms were reduced following staff relocation to an office with modern workstations. To what extent this reflects an improvement in non-specific arm pain is unclear as no examination of participants was undertaken and the questionnaire data do not address this issue.										
Lindh[48]	RCT	1++	238 workers in rehabilitation group and 226 in control group	There were no significant differences between the rehabilitation group and the control group with regards to age (mean age 39 years vs 40 years), gender (63% women vs 61% women), marital status (68% married vs 76%), nationality (62.5% Swedes vs 60% Swedes) or sick leave in the preceding 2 years (80 days ± 54 vs 77 days ± 49.5). There was a significant difference between the groups with respect to location of pain with low back pain being more common in the rehabilitation group (27% vs 22%).	Multidisciplinary rehabilitation programme. Pain treatment, relaxation, fitness, ergonomic education. Inter-ventions on pain, fear and avoidance behaviour, stress management. Occupa-tional therapy offered support in contact with employers (workplace intervention) and support of vocational training in the workplace. Social worker provided family counselling, social support.	Comparison is made between rehabilitation programme and usual care by return-to-work time and subsequent sickness absence.	5 years from the first day of sick leave	Return to work and subsequent sickness absence over 5 years follow-up	Among Swedes (but not immigrants) the number of sick listed days in the next 3 years after return to work was reduced when compared with usual care. Exact numbers are not given but Figure 4 in the paper suggests in period 6 (3 years after intervention) a near 25% reduction (~58 days vs ~82 days) in the number of sick listed days when com-pared with usual care. For return to work, 50% of the rehabilitation group returned to work at 9 months whereas the control group had achieved this figure at 6 months. For at work during follow-up, at 12 months there were no differences between the groups.	The Swedish Work Environment Fund, the AMF-trygghetsforsakring and the Greta and Einar Asker Foundation
General comments: A multidisciplinary rehabilitation programme as opposed to usual care for non-specific musculoskeletal pain results in greater work stability (but not earlier return to work) in Swedes. This benefit was not seen in migrant workers.										

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Table 2: Non-specific arm pain – *continued*

Bibliographic citation	Study design	Level of evidence	Number of subjects	Patient characteristics	Intervention	Comparison	Length of follow-up	Outcome measures	Effect size	Source of funding
Ketola[49]	RCT	1+	Intensive group had 39 subjects, education group 35 subjects and reference group 35 subjects at baseline.	The three groups were well matched on age, gender, handedness, height, body weight, work experience, visual display unit work and computer mouse use.	Workstation visit by ergonomist and self-assessment of work-station vs 1 hour ergonomic education vs educational leaflet	Comparison made between the three groups on self-reported muscular strain, discomfort and pain	10 months	Self-recorded musculo-skeletal discomfort, pain and strain	Mean musculoskeletal discomfort as rated at 2 months and 10 months in each group based on a five-point rating scale (1: feel good to 5: feel very uncomfortable). Differences were not significant between the groups although both intensive and education groups' ratings were better than the reference group's ratings for the shoulders, neck and upper back.	The Finnish Work Environment Fund
General comments: Both an intensive ergonomics intervention and ergonomics education showed modest but non-significant effects in reducing musculoskeletal discomfort among workers using visual display units when compared to a reference group who received an educational leaflet.										
Herbert[43]	Cohort	2–	54 women – of whom 36 received the inter-vention (a highly adjustable chair). Only these 36 were followed up and the remaining 18 were either not using a manual spooler, were lost to follow-up or did not receive the intervention.	54 women. 36 in intervention group (72% Hispanic, 25% Indian); the remaining 18 (83% Hispanic, 16.7% Indian) did not receive intervention. The mean age of the intervention group was 48.1 years, mean age of the other group was 43.9 years. There were no statistically significant differences in baseline demographics between the intervention and comparison groups.	Provision of a highly adjustable chair	Proportion of workers in inter-vention group with pain in at least one anatomic region before and after intervention and change in severity of pain among those reporting pain at baseline	8 months for intervention group	Prevalence of pain and severity of pain in intervention group	Symptom prevalence (%) and self-reported pain severity on a five-point scale (zero: no pain to 4: worst pain in life)	UNITE and Council for American fashion: a Labor-Management Industry Development Fund
General comment: This small cohort study did not follow up the comparison group so this study provides only very limited evidence for this intervention based on self-reported changes in symptom severity. It provides limited evidence that provision of a highly adjustable chair reduces musculoskeletal symptoms. However, it is unclear whether these symptoms relate to specific upper limb disorders or to non-specific arm pain.										
Cole[45]	Cohort study	2–	433 subjects	Mean age 41.1 years (SD 8.1), 42% male, 15.7 years of tenure (SD 8), 82% full-time staff, 16% part-time/permanent staff and 1% temporary staff	Ergonomics programme	Levels of symptoms, pain intensity and work disability (DASH) were assessed.	5 years	Work Disability of the Arm, Shoulder and Hand (DASH) score in 2001	1996 DASH score was the strongest predictor of 2001 DASH score. Pain intensity in 1996, age, repetitive strain injury (RSI) training and supervisor awareness were significant predictors for 2001 pain intensity. Age increased pain intensity by 0.2 points on a 0–100 point scale for every 10 years increase in age.	Workplace RSI committee and the US National Institute for Occupational Safety and Health/National Institutes of Health
General comments: Does not distinguish between non-specific arm pain and other causes of arm pain. The authors state that this ergonomics programme was associated with reduced frequency and severity of pain.										
Verhagen[34]	Systematic review of RCT and CCT	2++								n/a
General comments: Limited evidence for the effectiveness of adding breaks to computer work (van den Heuvel 2003), limited evidence, based on one low-quality study, massage as an add-on treatment to manual therapy (Leboeuf 1987).										

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Table 2: Non-specific arm pain – *continued*

Bibliographic citation	Study design	Level of evidence	Number of subjects	Patient characteristics	Intervention	Comparison	Length of follow-up	Outcome measures	Effect size	Source of funding
Ripat[37]	RCT	1–	43 symptomatic workers using modified keyboard and 25 symptomatic workers using 'standard' MN keyboard	Adapted keyboard, mean age 41.7 (range 22–61 years), 'standard keyboard' mean age 43.0 (range 30–57 years). 58% were female in LT group and 76% female in unadapted (MN) group. No significant differences in years at job, hand dominance	Alternative style ergonomic keyboard versus 'standard' ergonomic keyboard	Comparison between ergonomic keyboard (MN) and ergonomic keyboard with altered activation force, vibration and key travel	6 months follow-up	Symptom Severity Scale (SSS); Functional Status Scale (FSS); Quebec User Evaluation of Satisfaction with assistive Technology (QUEST); Phalen's test; Abductor pollicis brevis strength test; touch threshold measured using Semmes-Weinstein monofilament	SSS p<0.0001 baseline to 24 weeks FSS p<0.001 baseline to 24 weeks QUEST p<0.0001 baseline to 24 weeks Phalen's test p<0.025	Manitoba Hydro
General comments: There is limited evidence to support the use of ergonomic keyboards for individuals with work-related upper limb disorders. This might be applicable to those with non-specific arm pain.										
Pillastrini[52]	Prospective cohort study	2+	99 subjects in ergonomic training group and 97 subjects in the comparison group	No significant differences between groups for age, gender, height, weight, BMI, work experience, no. of breaks/day, single break duration and VDT use hours/day	Ergonomic group received leaflet and ergonomic adjustment of workstations whereas information-only group received the leaflet.	Analyses are based on group member-ship (ergonomic intervention group versus information group). The ergonomic group received both a leaflet and ergonomic adjustment of their workstations whereas the information-only group received the leaflet alone.	5 months	Levels of self-reported pain as shown on a pain drawing	OR 5.6, 95%CI 0.7–45.9 for wrist/hand pain adjusting for age, sex and BMI for ergonomic intervention group compared with information group.	Not stated
General comments: Evidence of a non-significant improvement in pain severity in the hands/wrist in a group of computer operators given ergonomic training. However, it is unclear whether the study included workers with non-specific arm pain.										
Verhagen[33]	Systematic review of RCTs and CCTs	1++	21 trials of which 17 included people with non-specific neck, shoulder or upper limb disorders							The Dutch Health Insurance Executive Board (CvZ) and Erasmus MC, Department of General Practice, Netherlands
General comments: This systematic review found limited evidence for computer breaks vs no breaks in non-specific neck, shoulder or arm pain based on one RCT (Van der Heuvel 2003), RR 1.83 (95%CI 1.27–2.64), no evidence for exercise as an add-on treatment RR 1.03, 95%CI 0.76–1.38 based on the same RCT and limited evidence for massage as an add-on treatment based on one very small study (Leboeuf 1987) RR 1.38, 95%CI 0.88–2.16. Much of the evidence identified related to non-specific neck and shoulder pain rather than non-specific arm pain.										
Greene[51]	RCT	1+	University employees: 43 subjects in the intervention group and 44 subjects in the control group	No statistically significant differences between groups for age, education, tenure of current job, computer use as hours/week, hours/day and lifetime use but there were significantly more males in the control group	Active ergonomics training (AET) of 6 hours duration (2 x 3 hour sessions) including self assess-ment of own work-station, didactic teaching, discussion and problem-based activities	Comparisons made between AET and delayed AET (control group)	1 year	Exposure assessed by RULA, musculoskeletal symptoms assessed with modified NIOSH symptom survey, ergonomics knowledge assessed using 15-item multiple-choice test, self efficacy assessed by 3 questions and outcome expectations based on 3 questions	Upper extremity symptom intensity pre-intervention 0.57 (SD 0.53) for intervention group and 0.67 (SD 0.74) after; 0.70 (SD 0.74) pre-test for control group and 0.59 (SD 0.63) post test, p=0.62	Not stated
General comments: No evidence from a small RCT that AET is effective in reducing the intensity, frequency or duration of upper limb musculoskeletal symptoms in workers.										

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Table 2: Non-specific arm pain – *continued*

Bibliographic citation	Study design	Level of evidence	Number of subjects	Patient characteristics	Intervention	Comparison	Length of follow-up	Outcome measures	Effect size	Source of funding
Konijnenberg[54]	Systematic review of published evidence, in English, for conservative treatment of repetitive strain injury	1+	12 RCTs and 3 controlled trials were identified which examined conservative treatment for repetitive strain injuries.						Only English language articles reviewed: this may have led to publication bias as some evidence that studies with positive results are more likely to be published in English	
General comments: 'Little is known about the effectiveness of conservative treatment options for repetitive strain injury,' Konijnenberg *et al* 2001.										
Van Dujin[58]	Prospective study	2–	Study reports 54 subjects with modified work and 83 without modified work absent with musculoskeletal disorders for 6 weeks and followed them up for 12 months but this is from an initial group of 262 workers. Note that the population denominator is unknown.	Age 43 years (SD 7) in modified work group vs 44 years (SD 7) in unmodified work group. Gender (female) n=25 (46%) vs 24 (29%). Modified work group members were significantly more likely to be single, have a job requiring prolonged standing, but less likely to do frequent lifting, kneeling or to have arms above shoulders. Importantly, the modified work group members were also less likely to report chronic musculoskeletal complaints in the past 12 months.	Modified work and its influence on subsequent sickness absence	Sickness absence over the 12 months following return to work either on modified work or without modified work	12 months	Sickness absence over the 12 months following return to work due to i) any musculoskeletal disorder (MSD), ii) the same MSD, iii) another MSD	Modified work was associated with a significantly reduced risk of further sick leave in the next 12 months in a multivariate regression analysis (OR 0.37, 95%CI 0.18–0.75) adjusting for age, marital status, prolonged standing, frequent lifting (>25 kg), chronic complaints in the past 12 months, musculoskeletal sick leave in previous 12 months, functional limitations upon returning to work, and general physical health.	Funded by the Netherlands Organisation for Health Research and Development (ZONMW)
General comments: Only a proportion of subjects (30%) had upper extremity disorders of undefined type. Note also the very significant dropout rate. Although this does not inform the review, this study does suggest an area for further research.										
Van den Heuvel[55]	RCT	1+	280 sent questionnaires, 268 consented to participate in cluster randomised study. Control group n=90 across six locations; breaks-only n=97 across eight locations; both breaks and exercises n=81 across eight locations	Control group: 43% male, mean age 37 Breaks-only group: 46% male, mean age 39 Breaks and exercise group: 66% men, mean age 42 years. Significant difference in age and gender between control and intervention groups	Computer prompted breaks ± exercise	Comparisons made between control group, breaks-only group and breaks and exercise group	8 weeks	Perceived recovery from musculoskeletal complaints, self-reported sick leave and productivity	Self-reported change in complaints (range 1–7 where a lower score indicates fewer complaints) Control group 3.7 (95%CI 3.5–4.0) Breaks group 3.3 (95%CI 3.0–3.5) Breaks + exercises group 3.3 (95%CI 3.0–3.6) P<0.05 between intervention and controls	
General comments: Limited relevance: computer software that forces operators to take breaks increases perceived recovery from mild musculoskeletal complaints but does not influence the frequency or severity of complaints. Whether this perceived benefit is sustained beyond 12 weeks or would operate in more severe cases is uncertain.										

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Table 2: Non-specific arm pain – *continued*

Bibliographic citation	Study design	Level of evidence	Number of subjects	Patient characteristics	Intervention	Comparison	Length of follow-up	Outcome measures	Effect size	Source of funding
Conlon[57]	RCT	1+	206 participants: 1. Conventional mouse n=52 2. Alternative mouse n=52 3. Board plus conventional mouse n=51 4. Board plus alternative mouse n=51.	**Group / Age / Gender / Baseline discomfort** 1 / 41.2 (8.43) / 33% female / 1.60 (2.03) 2 / 43.3 (10.8) / 25% female / 1.75 (1.86) 3 / 42.6 (10.3) / 24% female / 1.83 (2.32) 4 / 44.4 (9.66) / 29% female / 2.22 (2.18)	Forearm support board and/or an alternative mouse with a neutral forearm posture: four intervention groups. 1. Conventional mouse 2. Alternative mouse with neutral forearm posture 3. Conventional mouse with forearm posture board 4. Alternative mouse with forearm support board. Note that all workstations also had minor ergonomic adjustments made to them.	Comparison between those who received the alternative mouse and those who did not. Separate analysis for those who received the forearm support versus those who did not	52 weeks or until study withdrawal if before 52 weeks	Change in discomfort by region (neck/shoulder; right upper extremity; left upper extremity)	Beta coefficient adjusted for age, gender, effort/reward imbalance, hours of aerobic activity, mean pre-intervention score and oopherectomy. Significant effect for forearm support on right upper extremity beta coefficient: –0.35 (–0.67 to –0.03) p=0.035. This means a 0.35 reduction in symptoms on a discomfort scale with a range of 0–10 ie a modest change. Non-significant effect for alternative mouse on neck/shoulder discomfort in unadjusted model only	Not declared

General comments: In engineers using a computer for >20 hours/week, a forearm support may modestly decrease right upper extremity discomfort (0.35 reduction in symptoms on a discomfort scale with a range of 0–10).

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Table 3: Tenosynovitis

Bibliographic citation	Study design	Level of evidence	Number of subjects	Patient characteristics	Intervention	Comparison	Length of follow-up	Outcome measures	Effect size	Source of funding
Tittiranonda[36]	RCT	1+	Overall 80 subjects were randomised to one of four keyboards: 9 tendonitis cases to each group; placebo, kb1, kb2, kb3 and 11 carpal tunnel syndrome cases to each group	Subjects were well matched and baseline demographics across the four groups showed only one significant difference across 28 measures.	Alternative geometry keyboards versus placebo keyboard	Between alternative geometry keyboards and placebo keyboard	6 months	Mean (SD) of pain severity Hand functional status Standardised, blinded, clinical examination Keyboard preference	Pain severity was reduced for alternative geometry keyboards, expressed as change in severity between baseline and 6 months, an effect which was significant for kb3 when compared to placebo (1.21±3.1 vs –0.29±1.5, p<0.05).	US Department of Energy

General comments: Yes: limited evidence supporting the use of alternative geometry keyboards for workers with tensosynovitis. When compared to placebo, alternative geometry keyboard kb3 and to a lesser extent kb1 demonstrated a significant reduction in pain severity and improved hand function after 6 months' use.

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Table 4: Lateral epicondylitis

Bibliographic citation	Study design	Level of evidence	Number of subjects	Patient characteristics	Intervention	Comparison	Length of follow-up	Outcome measures	Effect size	Source of funding
Derebery[73]	Cohort study	2+	3236 subjects received a splint. 1378 subjects did not receive a splint.	Splint group mean age 41.4 years (SD 9.29), non-splint group 41.3 years (SD 9.5) Significant differences between groups for severity rating by initial treatment provider, gender, (women were more likely to be splinted), treatment lag (higher rates of splinting if seen within 1 week) and type of epicondylitis (more likely to be splinted if lateral epicondylitis)	Use of splint with or without physiotherapy	Comparisons are made between those receiving or not receiving a splint and further analysed by the subgroup that received physio-therapy vs those that did not.	Not stated. Mean treat-ment durations by subclass reported instead	Rates of limited duty (by healthcare provider not employee or employer), lost time, treatment duration, specialist referrals and both medical and physio-therapy visits/charges	No benefit from splinting compared with no splinting in this retrospective study	Not stated
General comments: Provides limited evidence that splinting may not be of benefit for epicondylitis.										
Chatterjee[72]	Cohort study	2–	274 men and 421 women employed in three sections in a UK Ford Motor Company plant	274 men and 421 women, mean age 49.1 years (SD 7.3 years)	Multifaceted work-place intervention including education, engineering modifications, task redesign	Comparisons are made between subjects with and without an upper limb disorder and over time in the annual incidence of upper limb disorders.	8 years	Annual incidence of upper limb disorders	Between 1987 and 1990, the reported annual incidence rate of upper limb disorders fell from 2.1 to 0.1. The denominator is not specified but given a cohort of 695 workers with 88 primary lesions followed up over 10 years, this would suggest the annual incidence rate is per 1,000 workers.	Not stated
General comments: This low-quality study provides limited evidence to support a multifaceted workplace intervention to reduce upper limb disorders incidence. It is unclear whether the annual incidence of epicondylitis changed (as distinct from the annual incidence of all upper limb disorders) following these interventions.										
Haahr[61]	RCT	1–	141 in intervention group and 125 in comparison group	There were no statistically significant differences between the intervention and control groups for age, gender, work type and clinical features (baseline distress, pain location, pain scores, dominant side affected). There was a significant difference in the proportion of participants with less than 11 years education (11% in intervention group vs 22% in control group, p<0.01).	Minimal occupational medicine intervention including advice to exercise and stay active versus usual care	Self-reported condition and overall 50% reduction in pain at follow-up	12 months	Self-reported overall development of the condition in follow-up questionnaires at 3, 6 and 12 months and a 50% reduction in a combined pain and function score (range 0–36) where a higher score indicates greater problems	For perceived unchanged or overall worse tennis elbow: High strain (based on job title) OR 3.0 (95%CI 1.0–8.7) High physical strain OR 8.5 (95%CI 1.0–74.7) High baseline pain score OR 2.3 (95%CI 1.0–5.3) Treatment group (inter-vention) OR 1.0 (95%CI 0.4–2.3)	The Research Council of the National Working Environment Authority, the Danish Insurance Association and the Medical Research Unit of Ringkjoebing County
General comments: The study provides limited evidence, based on one RCT with a high potential for bias, that minimal occupational medicine intervention including advice to exercise and stay active has no benefit over usual care in general practice. The treatment selected appears to be less important than addressing physical demands in the workplace.										

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