

Sounding Board

Why have we not solved the MSD problem?

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Despite worldwide attention for more than four decades, musculoskeletal disorders (MSDs) remain a substantial concern at work and result in considerable personal and societal burden. This slow progress is not for want of trying. Prevention of MSDs has been emphasized in multiple jurisdictions. For example, in 2007 the European Agency for Safety and Health at Work organized a major campaign, “Lighten the Load – How to prevent Musculoskeletal Disorders (MSDs)” and NIOSH in the USA specifically identified MSDs as a major focus in their National Occupational Research Agenda. However, the results from surveys, published sick leave, and lost time data indicate we have a way to go in preventing MSDs. Which leaves us with a question: *Why have we not solved the MSD problem?*

The initiatives mentioned above (and others) have uncovered multiple research questions including: the effects of new forms of work, the interaction of psychosocial and mechanical exposures, changing demographics, risk assessment, identification of best practice, and the implementation of interventions in companies. While all these are clearly relevant questions, we still need to know which of the answers to these – or any other question – will drive us forward in the prevention of work-related MSDs.

In order to help refine the research agenda for the Centre of Research Expertise for the Prevention of Musculoskeletal Disorders, as director, I have begun to view the prevention of MSDs around six questions. I see these six questions as a flow of logic that can be used as a heuristic. The answers to each question can help identify weak links, and prioritize where the Centre’s

researchers need to put their energies, skills and experience. The chain of linked questions could have been framed as areas of research, but when written as questions, I believe they are more thought provoking, and can help us stand back and reflect on each stage of inquiry and its key contributions to the prevention of MSDs. Asking each of these six questions helps us identify where our knowledge and practice may be wanting and the key factors that are limiting our ability to prevent MSDs at work. The intent of posing these questions is to judge whether our efforts are being derailed by not addressing key issues; workplace prevention of MSDs can only be as effective as its “weakest link”.

The six questions are:

1. How well do we understand MSDs and their burdens?
2. How good are our MSD risk factors?
3. How effective and informative are current workplace MSD assessment approaches?
4. How effective are the recommended interventions in actually reducing MSDs in the workplace?
5. How intensely and widely implemented are workplace interventions to prevent MSD?
6. How well are we improving disability outcomes for MSDs?

An example of how a weak link may be derailing our ability to reduce MSDs could be if we do have multiple efficacious interventions that we can recommend to workplaces, but those interventions are not widely implemented in workplaces. We would then not be effective in addressing the societal concern for

MSDs. A fruitful research focus – one which could markedly improve MSD prevention – would be to address this potential “weakest link” and develop and test ways of increasing the adoption of efficacious interventions. This research focus would be clearly different than, for example, if we found that workplaces were not performing adequate risk assessments and thereby not intervening on influential risk factors.

We do need to acknowledge that our knowledge of MSDs has developed greatly over the past decades. Multiple clinical examination diagnostic systems have been developed and consensus documents have been created. Laboratory studies have shown how different tissues can be damaged by acute and extended exposures. We have good information concerning the injury mechanisms for nerve functioning during impingement and pressure applications, herniation and bony damage to spinal motion units under combinations of loading, posture and frequency. We also have an understanding of how pain is produced in muscles and muscle fibres due to long-duration, low-level static contractions, and the effects of high job strain on the hormonal and endocrine systems. The interaction of these multiple factors argues for the use of a bio-psycho-social rather than a biomedical model.

In asking the first question, *how well do we understand MSDs and their burdens*, I want to reflect on what knowledge gaps could be frustrating our prevention efforts. We may choose to use tissue damage, physiological function, clinical examination, pain, functional decrements, or work disability as measures of MSD burden or to define a case. Different choices could misrepresent the burden, risk factors, the effects of treatment, or the effectiveness of workplace interventions. On the other hand, if we are grouping disorders with very different etiologies under one umbrella (for example, “non-specific low back pain”), it may lead to either focusing on misleading risk factors or inappropriate interventions. For low back pain, we could ask whether it is due to cumulative damage to a structure, a loss of spine stability [1]; or a statistically rare loading outlier in a normally innocuous task [2]? Each of these three different mechanisms of injury could lead down divergent exposure and intervention paths.

Similarly, we now have a substantial and consistent body of knowledge that demonstrates the strong association of MSDs with many exposures found in workplaces and have high attributable fractions for many of these. Exposure measures have improved over the years from initially just considering job titles, to self-reports of physical and psychosocial risk factors, to structured

observations, and more recently to technical measures of muscle activity or modeled joint loads. Identified risk factors now include mechanical factors (force, posture, repetition, duration), work organizational factors (worker perceptions of demand, control, and co-worker and supervisor support; the so-called psychosocial factors) as well as individual factors. These relationships have been demonstrated in multiple types of work, with a wide variety of exposure assessment approaches, and a wide variety of study designs, including high-quality prospective cohort studies; the NIOSH MSD Consortium Studies are an example of a concerted attack on this question.

While it is possible to identify risk factors without having knowledge of the underlying patho-physiology by using epidemiological approaches, coherence of the statistical and physiological information would give us more confidence that the relationships are causal, and will increase the likelihood that intervening on the risk factors will have an effect on MSD development and burden. It has been said that we now need to move on from etiologic studies and concentrate on intervention studies, and so we pose our second question: *how good are our MSD risk factors?*

The thought provoking studies of Gerr and colleagues, illustrate possible disconnects in our knowledge [3]. Despite intervening on risk factors derived from a preceding etiologic study, the effects on MSDs were disappointing. This leads us to wonder whether the mainly postural risk factors were misleading due to the strong non-postural components of exposures reported during computer work [4], whether the identified postural risk factors were too far removed from the target tissue pathophysiology [5]? Alternatively, the intervention itself was the weak link. To this point, we do not have an answer. I will return to the question of intervention later. Another continuing challenge is defining and operationalizing the exposure domains. Issues include: the different meanings assigned to psychosocial factors – individual traits or perceptions of the work; the intermingling of domains – work organization factors, for example, will drive both mechanical and psychosocial exposures; and the interaction with co-workers and supervisors may affect biomechanical factors [6]. Thinking more broadly about workplace health leads us to recognize the overlap of MSD concerns with those of workplace stress. Synergies with the stress research methodologies and literature are potentially highly valuable [7].

Of course, there is a cascading effect from our knowledge of risk factors which in turn is partially depen-

dent on our knowledge of the disorders themselves; we do know that poorly characterized risk factors will lead to inadequate assessments. We know that hazard identification and risk assessment is an important first step for workplaces. This leads to our third question: *How effective and informative are current workplace risk assessment approaches*, especially for small and medium sized enterprises that employ the majority of workers? There is a wide variety of hazard identification and risk assessment approaches that include interviews, questionnaires, observational approaches and pencil and paper tools with scoring systems to estimate risk or intervention priorities. But little has been done to document their measurement characteristics such as their reliability between people or over time or their responsiveness to workplace change. More technically demanding methods are available and are used in research and some epidemiological studies, however we have found that these are infrequently used, except by some experts.

Two other important issues relate to the effectiveness of risk assessment approaches. The first problem results from the typical dominance of physical risk factor assessments and the resulting blindness to psychosocial factors and their connected workplace organizational factors. Interventions on potentially critical work organizational factors may not be vigorously pursued or may be seen as outside the realm of MSD prevention. The other is that high levels of risk factors are relatively easy to document, even with moderate training and simple tools, but, because the risk factors for MSDs are ubiquitous, some judgment of the level of risk is needed for prioritization. The utility of developing thresholds and limit values enters the discussion at this point. As the worst exposures are eliminated – the low hanging fruit – identifying further risks becomes increasingly difficult without more training and better tools. Yet little attention has been paid to the training required to use even simple tools effectively.

Moving to our fourth question, a substantial number of interventions, many that are industry specific, have been developed and used widely. Reducing awkward postures by workstation redesign or adjustment is a well-established practice and recommendations are available for postural and force exposures as well as manual material handling tasks. There is evidence that introduction of specific pieces of equipment are beneficial in the medium term but that equipment, training and policies must be combined. The body of case studies supports the effectiveness of ergonomics programs and the business consensus is that multi-component programs are preferable [8].

Yet a key question remains: *Can the interventions that we are recommending actually reduce MSDs in the workplace?* A number of concerns are worth highlighting in this challenging area. It can be argued that most of the intervention research studies that have been published represent, in effect, efficacy studies. They are performed in a laboratory or workplace settings under well-controlled, even ideal, conditions – ideal in the sense that the interveners are highly competent, the organizations are carefully selected, and a large amount of resources are typically dedicated to the intervention. If positive effects are not seen in these research intervention studies, one is left with the question of whether the intervention was not efficacious, whether the implementation was not intense enough or sustained for long enough, or whether the study and its design were unable to detect any changes. In these complex settings it is important to understand why the intervention was or was not efficacious so as to better plan broad implementation strategies.

Despite well-established practices, many commonly recommended workplace interventions have not been examined for their ability to improve health (MSD) outcomes or their ability to change exposures. Recent systematic reviews have not supported the success of widespread interventions [9]. This leads to our fifth question. To improve health (MSD) outcomes generally, three conditions need to be met: 1) The choice of intervention must be well chosen to address the risk factors identified; 2) the type of intervention is known to be efficacious for the setting of interest; and 3) it is implemented widely and intensely. To focus on the latter, recent studies are throwing light on the intensity of interventions by documenting exposure changes, coverage and adherence, and the connections between the reported exposure changes and health changes reported [10]. In order to achieve intensity, an intervention must substantially reduce exposure in high risk tasks, must address the highest risks, either peaks or long term exposures, be available to all those with high exposures, and must be used by those same people. If any of these factors are small, the resulting intensity of the intervention will be low and the probability of improved musculoskeletal health outcomes will also be low [11]. Moreover, to have a societally useful impact, efficacious interventions must be implemented in a large proportion of workplaces with risk factors. Based upon a survey from Washington State, it appears that many workplaces contained substantial MSD hazards, i.e., exposure for over 4 hrs per day. In 2001 for example, 18.5% of all firms reported risk factors of inten-

sive keying, 11.8% for repetitive activity of the whole arm and 11.6% for lifting or lowering above shoulders or below the knee while twisting [12]. Expressed differently, only one tenth of the firms surveyed reported that no employees were exposed to any risk factor. A very large number of workplaces would therefore have to perform prevention activities to have an impact on MSD burden.

This observation leads to our next question: *How intensely and widely implemented are workplace interventions against MSD?* We have relatively little information about the extent to which interventions to prevent MSDs have been implemented. Taking the data from Washington State again, in smaller companies, for those that had a case of MSDs in the last year, only about one-half had made even one MSD prevention action in their whole workplace [12].

A recent model proposed for sports injury prevention argues that implementing efficacious interventions requires a deep understanding of the intervention context or the intervention will be ineffective [13]. Using the knowledge and practice from cognate fields of organizational development may improve intervention intensity appreciably; a “diffusion of innovation” framework [14] or a “stages of change” framework [15] may offer critical reformulations of our intervention approaches. However it is worth noting that organizational change of any kind – including ergonomics programs to prevent MSDs – is challenging and, based upon the business literature, many, even most, such initiatives may fail [16].

Finally, we address our sixth question. It is known that those people who have had an MSD are much more likely to suffer a subsequent incident. It also seems that some MSDs persist for long periods. Because most people suffer from MSDs at some point in their lives, it has been suggested that to impact MSD burden, prevention activities should take place at the primary, secondary and tertiary levels simultaneously [17]. We also know that it is important for psychological health and commitment to the workplace that workers return to work even if they are not totally pain free. The social support provided by supervisors, co-workers, workplace policy and procedures, as well as clinical management is key [18]. However, *how well are we improving disability outcomes for MSDs?*

In conclusion, with each of the six questions, I have attempted to summarize where we are firmer in our knowledge, but I have also attempted to highlight where the weak links might be and some of the pitfalls that may flow from this lack of knowledge. Despite the

provisional and incomplete nature of our knowledge, organizations and individuals continue to make decisions concerning the prevention of MSDs on a daily basis. Yet in order to truly make a difference we need to fashion and test MSD prevention strategies that are feasible, socially acceptable, affordable, scalable and sustainable – and which have good coverage for substantial parts of the working population. Ideally they should also result in measurable MSD improvements within a reasonable time-frame. Yet with limited resources we need to prioritize the issues that are restraining our effectiveness. We need to focus our energies on specific research that will potentially maximize our intervention impact at the societal level while we continue to build the knowledge base around MSDs and improve prevention strategies. The targeted approach of the Health and Safety Executive in the UK is an example of this strategy [19].

My intent is to be speculative and I invite the readership of *WORK* to respond to my assessment of the state of our present research knowledge, and more importantly, to identify knowledge and practice gaps which may be acting as major barriers to our success.

References

- [1] J. Cholewicki and S.M. McGill, Mechanical stability of the *in vivo* lumbar spine: implications for injury and chronic low back pain, *Clin Biomech (Bristol, Avon)* **11**(1) (1996), 1–15.
- [2] J. van Dieën, Dekkers, J. Joris, Groen, H. Toussaint and O. Meijer, Within-subject variability in low back load in a repetitively performed, mildly constrained lifting task, *Spine* **26** (2001), 1799–1804.
- [3] F. Gerr, M. Marcus, C. Moteilh, L. Hannan, D. Ortiz and D. Kleinbaum, A randomized controlled trial of postural interventions for prevention of musculoskeletal symptoms among computer users, *Occupational and Environmental Medicine* **64**, 478–487.
- [4] M. Wærsted, Human muscle activity related to non-biomechanical factors in the workplace, *Journal European Journal of Applied Physiology* **83** (2000), 151–158.
- [5] R. Wells, D. Van Eerd and G. Hagg, Mechanical exposure concepts using force as the agent, *Scandinavian Journal of Work, Environment & Health* **30**(3) (2004), 179–190.
- [6] W. Marras, R. Cutlip and S. Burt, Waters, T National occupational research agenda (NORA) future directions in occupational musculoskeletal disorder health research, *Applied Ergonomics* **40** (2009), 15–22.
- [7] M. Kompier and A. van der BEEK, Psychosocial factors at work and musculoskeletal disorders, *Scand J Work Environ Health* **34** (2008), 323–325.
- [8] National Research Council and Institute of Medicine, *Musculoskeletal Disorders and the Workplace: Low Back and Upper Extremities*, National Academy Press, Washington DC, 2001.
- [9] S. Brewer, D. Van Eerd, B. Amick III, E. Irvin, K. Daum, F. Gerr and S. Moore, Workplace interventions to prevent

- musculoskeletal and visual symptoms and disorders among computer users: A systematic review, *J Occup Rehabil* **16** (2006), 325–358.
- [10] F. Lötters and A. Burdorf, Are changes in mechanical exposure and musculoskeletal health good performance indicators for primary interventions? *Int Arch Occup Environ Health* **75** (2002), 549–561.
- [11] R. Wells, A. Laing and D. Cole, Characterizing the intensity of ergonomics interventions for the prevention of musculoskeletal disorders: mechanical exposures, in press, *WORK*, Oct 2009.
- [12] B. Silverstein, M. Foley, N. Pollisar et al., Impact of implementing the Washington State ergonomics rule: Final Report 73-1-2004 SHARP Technical Report, Department of Labor and Industries, Washington State, USA, 2004.
- [13] C. Finch, A new framework for research leading to sports injury prevention, *Journal of Science and Medicine in Sport* **9** (2006), 3–9.
- [14] E. Rogers, *Diffusion of Innovation*, (Fifth ed.), Free Press, New York, 2003.
- [15] H. van der Molen, J. Sluiter and M. Frings-Dresen, Behavioural change phases of different stakeholders involved in the implementation process of ergonomics measures in bricklaying, *Applied Ergonomics* **36** (2005), 449–459.
- [16] C. Kennedy and D. Harvey, *Managing and Sustaining Radical Change: A Study of Best Practices and Methods for Managing the Human Dimension of Major Business Projects*, Business Intelligence Ltd, London, UK, 1987.
- [17] J. Frank, A-S. Brooker, S. DeMaio, M. Kerr, A. Maetzel, H. Shannon, T. Sullivan, R. Norman and R. Wells, Disability due to occupational low back pain: What do we know about primary prevention? *Spine* **21**(24) (1996), 2908–2917.
- [18] R.L. Franche, K. Cullen, J. Clarke, E. Irvin, S. Sinclair and J. Frank, Workplace-based return-to-work interventions: a systematic review of the quantitative literature, *J Occup Rehabil* **15**(4) (2005), 607–631.
- [19] HSE, Research agenda for the priority programme on musculoskeletal disorders, Health and Safety Executive, UK (2005/06 ed).