HAND-ARM VIBRATION SYNDROME: A SYSTEMATIC REVIEW OF RISK FACTORS AND INTERVENTIONS

Mark Boocock, Peter McNair and Peter Larmer
Health and Rehabilitation Research Centre,
Auckland University of Technology (AUT),
Private Bag 92006, Auckland 1142, New Zealand
Email: mark.boocock@aut.ac.nz

ABSTRACT

Hand-Arm Vibration Syndrome (HAVS) is an occupationally-related disease arising from prolonged and repeated exposure to vibration. A systematic review of the literature was undertaken to identify the risk factors and intervention strategies for the control and management of HAVS. Sixteen epidemiological and 11 intervention studies were considered appropriate to the review, and were critically appraised and graded according to the methodological quality of each study. Vibration exposure (duration/dose) was strongly linked to heightened levels of risk, the strength of this association being lower for neurological symptoms than for vascular symptoms. Smoking was a significant risk factor for the vascular symptoms of HAVS, while postural and environmental factors were poorly researched. Intervention strategies included: one mechanical intervention (e.g. anti-vibration tools and gloves); three mechanical and production system interventions (e.g. modified tool design and time management or protective measures); and seven modifier interventions (e.g. drug treatment). Due to the low quality of these studies, limited evidence emerged for the benefits of intervention strategies for decreasing symptoms of HAVS. The lack of support for HAVS interventions stems from the low number of studies based upon rigorous design principles, poor statistical procedures, and the inherent difficulties of introducing interventions into a dynamic and ever changing occupational setting. Concerted efforts are needed to establish a programme of research for evaluating the efficiency of HAVS interventions.

INTRODUCTION

HAVS is a generic term that embraces a number of injuries to the arms, hands and fingers, arising from prolonged and repeated exposure to vibration, which often results in considerable pain and disability, including cold intolerance, reduced sensibility, muscle weakness, loss of hand coordination, impaired dexterity, clumsiness and hand cramps (Pelmear 2000). Vibration exposure giving rise to symptoms of HAVS most often stem from occupational use of power operated hand-held tools (e.g. percussive tools used in metal and stone working, quarrying and construction). However, any vibration source of sufficient intensity (i.e. over 4 - 5000 Hz) and duration coming into contact with the hands may give rise to HAVS (Pelmear 2000) . The aims of this study were to review the literature on risk factors and interventions appropriate to the control and management of HAVS.

METHODS

A systematic literature search was undertaken of 15 electronic databases. Specific inclusion criteria (i.e. studies with clearly defined health outcome measures and well defined exposure/intervention approaches, and restricted to HAVS vascular and neurological conditions) were used to identify appropriate epidemiological studies of HAVS risk factors (e.g. force, posture, cold, smoking) and interventions (e.g. workstation design, tool design, physical training). The quality of each study was critically appraised and graded.

RESULTS

Risk factors

Sixteen epidemiological studies published after January 2000 met the inclusion criteria. Of these 16 studies, the majority (10) were rated as 'low' quality, with six rated as 'medium' quality. No study was rated as 'high' quality. The overall poor quality of studies stemmed primarily from their research design, with only 3 studies involving a prospective cohort group of participants.

Occupation: Occupational groups at increased risk of developing HAVS include: stone carvers (odds ratio (OR)=4.4); quarry drillers (OR=3.7); dockyard caulkers (OR=10.2); forestry workers (OR=2.2); African gold miners (Relative Risk (RR) = 3.08), drivers of forest machines and snowmobiles, and reindeer herders (OR range = 1.9-3.5) (Åström et al. 2006; Griffin et al. 2003; Nyantumbu et al. 2007). A Swedish study (Bylund et al. 2002) of 'hand-arm vibration cases' amongst women identified 17 occupational groups at increased risk, the highest being from the dental profession (dental technicians, RR = 680; dental hygienists, RR=330; dentists, RR=270).

Vibration exposure: All studies included in the current review found strong evidence of a relationship between vibration duration/dose and vascular symptoms. However, the strength of the association with neurological symptoms was lower than those for vascular symptoms.

Smoking: Sutinen et al. (2006) reported the highest OR (7.36) for smoking in vibration exposed workers (forestry) compared to non-smokers. Only one study (Cherniack et al. 2004) showed a significant association between smoking and neurological symptoms (OR = 1.85) of HAVS.

Postural and environmental factors: Cherniack et al. (2004) reported a significant association between working postures (raised arms above the shoulder) and vascular and neurological symptoms (OR = 2.01 and 3.01, respectively). No studies reported an association between adverse working environments and increased risk of HAVS.

Interventions

Eleven intervention studies were identified and classified according mechanical modifications (1), a combination of mechanical and production system interventions (3), and modifier interventions (7).

Mechanical interventions: Jetzer et al. (2003) investigated the effects of introducing anti-vibration tools and gloves in labourers working in roof tile manufacturing. The authors reported a modest trend towards a decrease in the overall prevalence of HAVS.

Mechanical and production systems/organisational culture: Two studies (Koskimies et al. 1992; Saito 1987) investigated the effects of introducing improved designs of chainsaws in combination with altered work exposure amongst groups of forestry workers. In both studies there was found to be a reduction in the prevalence rate of HAVS. Aiba et al. (1999) found that the introduction of anti-vibration impact wrenches and strategies for reducing coldness in a group of factory workers reduced the prevalence of vibration white finger (VWF) from 5% to zero over eight years.
Modifier interventions: Mixed findings have been reported for the effects of drug treatment on symptoms of HAVS. Drugs included in these studied were Clonidine (centrally acting drug affecting the discharge of peripheral sympathetic nerves), Diltiazem and Nifedipine (calcium antagonists producing vasodilation of peripheral blood vessels), and batroxobin (a defibrinogating drug). Following a treatment regime involving whole body exposure to cold combined with local warming of the affected hands, Carlsson et al. (2003) found changes in symptoms or sensitivity to touch/pressure.
Ceasing exposure: Some evidence suggests that circulatory problems in the fingers do not progress and improvements are more often in those who have ceased exposure to vibration with lower levels of HAVS. Individuals with higher levels of HAVS often continue to have symptoms and abnormal physiological responses. It is apparent that confounding factors such as smoking can influence on going symptoms and clinical findings.

DISCUSSION

There was found to be a substantial amount of epidemiological literature linking the occurrence of vascular and neurological components of HAVS with repeated exposure to vibration. The evidence appears compelling with respect to heightened levels of risk, and the strength of association appears stronger for vascular as opposed to neurological symptoms. Whilst smoking represents a high risk factor for the vascular component of HAVS in groups of workers exposed to vibration, evidence linking postural and environmental factors (e.g. ambient temperature) appears poorly documented. The current review found limited evidence from good quality studies supporting the use of mechanical interventions, a combination of mechanical and production systems, or modifier interventions for decreasing HAVS. The poorly structured introduction of anti-vibration programmes, and a lack of intervention studies based upon rigorous design principles and sound statistical procedures have limited our ability to develop robust intervention strategies. Limitations in research design and methodology often reflect the inherent difficulties of introducing interventions into occupational settings that are continually changing. Future work should be directed towards establishing a programme of research targeted at evaluating the efficacy of HAVS interventions.

References

Aiba, Y., Ohshiba, S., Ishizuka, H., Sakamoto, K., Morioka, I., Miyashita, K. and Iwata, H. (1999). A study on the effects of countermeasures for vibrating tool workers using an impact wrench. *Industrial Health* 37(4): 426-31.

Åström, C., Rehn, B., Lundström, R., Nilsson, T., Burström, L. and Sundelin, G. (2006). Hand-arm vibration syndrome (HAVS) and musculoskeletal symptoms in the neck and the upper limbs in professional drivers of terrain vehicles--a cross sectional study. *Applied Ergonomics* 37(6): 793-9.

Bylund, S. H., Burström, L. and Knutsson, A. (2002). A descriptive study of women injured by hand-arm vibration. *The Annals of Occupational Hygiene* 46(3): 299-307.

Carlsson, I., Cederlund, R., Holmberg, J. and Lundborg, G. (2003). Behavioural treatment of post-traumatic and vibration-induced digital cold sensitivity. *Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery* 37(6): 371-8.

Cherniack, M., Morse, T. F., Brammer, A. J., Lundström, R., Meyer, J. D., Nilsson, T., Peterson, D., Toppila, E., Warren, N., Fu, R., Bruneau, H. and Croteau, M. (2004). Vibration exposure and disease in a shipyard: a 13-year revisit. *American Journal of Industrial Medicine* 45(6): 500-512.

Griffin, M. J., Bovenzi, M. and Nelson, C. M. (2003). Dose-response patterns for vibration-induced white finger. *Occupational and Environmental Medicine* 60(1): 16-26.

Jetzer, T., Haydon, P. and Reynolds, D. (2003). Effective intervention with ergonomics, antivibration gloves, and medical surveillance to minimize hand-arm vibration hazards in the workplace. *Journal of Occupational and Environmental Medicine* 45(12): 1312-7.

Koskimies, K., Pyykkö, I., Starck, J. and Inaba, R. (1992). Vibration syndrome among Finnish forest workers between 1972 and 1990. *International Archives Of Occupational And Environmental Health* 64(4): 251-256.

Nyantumbu, B., Barber, C. M., Ross, M., Curran, A. D., Fishwick, D., Dias, B., Kgalamono, S. and Phillips, J. I. (2007). Hand-arm vibration syndrome in South African gold miners. *Occupational Medicine (Oxford, England)* 57(1): 25-29.

Pelmear, P. L. (2000). Vibration (hand-arm and whole body). Hunter's diseases of occupation. P. J. Baxter, P. H. Adams, A. Tar-Ching, A. Cockcroft and J. M. Harrington. London, Arnold.

Saito, K. (1987). Prevention of the hand-arm vibration syndrome. *Scandinavian Journal of Work, Environment and Health* 13(4): 301-304.

Sutinen, P., Toppila, E., Starck, J., Brammer, A., Zou, J. and Pyykkö, I. (2006). Hand-arm vibration syndrome with use of anti-vibration chain saws: 19-year follow-up study of forestry workers. *International Archives of Occupational and Environmental Health* 79(8): 665-671.