OCCUPATONAL DISEASE PREVENTION STRATEGY

HAND-ARM VIBRATION SYNDROME

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BACKGROUND

Definition:

Hand-arm vibration syndrome (HAVS) is an occupational disease consisting of vascular, neurological and musculoskeletal pathology in the upper limbs due to exposure to hand-transmitted vibration.[1,2] Symptoms include cold intolerance of the hands, cold-induced digital blanching, numbness and tingling in the fingers, loss of sensation, decreased finger dexterity and loss of grip strength. The first scientific paper on Raynaud's phenomenon due to hand-arm vibration exposure was published by Loriga in Italy in 1911.[3] Dr. Alice Hamilton subsequently published a detailed report identifying a high prevalence of Raynaud's phenomenon due to hand-arm vibration exposure in limestone quarry workers in Bedford, Indiana in 1918.[4] By 1950, there were over 40 published reports showing an association between hand-arm vibration exposure and vasospastic disease in the hands, including papers from such prominent investigators in occupational medicine as David Edsall and Donald Hunter, and since that time there has been a large number of publications addressing the epidemiology, pathophysiology, management and prevention of HAVS.[5]

Burden of Disease:

While HAVS is a well known condition within the specialty of occupational medicine, there remains a general lack awareness of the disease by many physicians, employers and regulators. Illustrative of this lack of awareness were the results of a 1978 study of workers at the same quarry that Dr. Alice Hamilton studied in 1918. Despite 60 years of accumulated knowledge about HAVS, the follow-up study showed no appreciable change in the prevalence of HAVS in workers at the quarry (89% in 1918 vs. 80% in 1978).[6]

Hand-arm vibration exposure is common and many workers are at risk of developing HAVS. In the U.S., the Bureau of Labour Statistics currently estimates that approximately 2.5 million workers are exposed to high hand-arm vibration levels at work on a regular basis. NIOSH has estimated that about 50% of exposed workers in the U.S. have or will develop HAVS.[7] In Canada there is considerable under-recognition and under-reporting of HAVS. Using data from the United States and the United Kingdom and adjusting for population size, it has been estimated that there are between 72,000 and 144,000 prevalent cases of HAVS in Canada.[8] By contrast, there was an average of only 198 accepted claims for HAVs per year in Canada over a six year period from the beginning of 2003 to the end of 2008,[8] and this low number cannot be explained by a prior large cohort of workers already compensated.[9]

The constellation of symptoms due to vascular, sensorineural and musculoskeletal pathology associated with HAVS may have a considerable effect on disability and quality of life. For example House et al have shown that workers with HAVS have high upper extremity disability as measured by the Disabilities of the Arm Shoulder and Hand (DASH) questionnaire [10] as well as high work-related disability [11] and diminished physical and mental quality of life.[12]

HAVS has been identified as an Occupational Sentinel Health Event (OSHE), which refers to a preventable health effect whose occurrence indicates that improved control measures are needed for prevention. HAVS was included in the first list of OSHEs by Rutstein et al [13] in 1983 and in the subsequent list provided by Mullan and Murphy [14] in 1991. Hence the lack of recognition and reporting of HAVS means that opportunities for prevention in the workplace are being missed.

Pathophysiology/Causation:

HAVS is caused by hand-transmitted vibration from the use of use of hand-held vibrating tools or hand-contact with hand-guided or hand-fed vibrating machines. The main industries (tools) that pose a risk for the development of HAVS are construction (jackhammers, hammer drills, concrete breakers, grinders), mining (jackleg drills, stoper drills), forestry (chainsaws), automotive assembly (impact wrenches, riveting guns), foundries (grinders, chipping guns) and the metalworking trades (sanders, buffers).[15,16]

The use of a hand-held vibrating tool results in exposure to a spectrum of vibration frequencies and the frequencies may vary depending on the tool. Frequencies above 100 Hz are largely absorbed by the fingers/hands [17] and are associated with the development of the vascular and sensorineural components of HAVS. The resonant frequency of the fingers is in the range of about 150 to 300 Hz and these frequencies are likely the most damaging to the fingers. Tools that vibrate at frequencies lower than 100 Hz can also pose a significant health risk, although the lower frequencies tend to be transmitted beyond the hand to the arm and shoulder and may result in musculoskeletal problems.

With high exposure, HAVS can develop over a surprisingly short time frame. The literature reports latencies between the onset of tool use and the development of HAVS to range between six weeks and 14 years.[7] The latency depends on the intensity of hand-arm vibration exposure and tools with high hand-arm vibration exposure may have latencies less than two years. The pathophysiology of the HAVS vascular, neurological and musculoskeletal components involves several factors.

The vascular component of HAVS is a form of secondary Raynaud's syndrome due to both local and systemic mechanisms. These mechanisms include, but are not limited to, local selective loss of nerve fibres in the digits that produce the potent vasodilator calcitonin-gene-related peptide (CGRP), hypertrophy of smooth muscle due to repetitive episodes of vasoconstriction, microangiopathy as a result of direct trauma from hand-transmitted vibration exposure, arterial thrombosis due to traumatic shear stresses to the vascular endothelium triggering a coagulation cascade, vasospasm from centrally mediated increased sympathetic tone, and increased circulating vasoactive mediators from damaged endothelial cells.[18,19] The development of vascular HAVS in the hands may also lead to secondary cold-induced vasoconstriction in the feet.[20] House et al [21] have shown that the risk of developing severe cold-induced plethysmography responses in the toes is increased 4 to 5 fold in workers with HAVS who have such severe changes in their hands. The mechanism for these effects in the feet secondary to vascular HAVS in the hands is thought to be generalized activation of the sympathetic nervous system or systemic release of vasoactive mediators such as endothelin-1 or norepinephrine.

The neurological component of HAVS is a form of digital sensory neuropathy that primarily involves damage to the nerve fibers associated with direct local trauma from vibration exposure.[22,23] Epidemiological studies have also indicated an increased prevalence of concurrent nerve entrapment syndromes such as carpal tunnel syndrome,[24] which are considered co-morbid findings rather than being part of the sensorineural component of HAVS.

The musculoskeletal (MSK) component of HAVS is less well characterized, as it is difficult to differentiate vibration induced pathology from that due to ergonomic stressors in manual work.[25] Current evidence suggests that HAV exposure can result in decreased grip strength [26,27] and possibly Dupuytren's contractures.[28,29] Also associated with HAVS, but with less evidence, are bone cysts, osteoporosis in the hands and wrists, elbows and shoulders, epicondylitis, and non-specific muscle and joint pain/stiffness.[25]

Avocational risk factors may contribute to the development or aggravate symptoms of HAVS, in particular the vascular component of HAVS. Identification of these risk factors is important to rule out competing etiologies for the symptoms as well as to optimize management. The primary modifiable risk factor is smoking, which results in acute peripheral vasoconstriction, thereby possibly worsening symptoms of Raynaud's phenomenon. Vasoconstricting medications may also worsen symptoms, with the best known being beta blockers and some anti-migraine medicines. Smoking as well as other factors including hypercholesterolemia, hypertension, and diabetes mellitus increase the risk of peripheral atherosclerotic disease which may affect vasospastic symptoms. Specifically, post occlusive reactive hyperemia associated with recovery of circulation after vasospasm has been documented to be reduced in individuals with increased cardiovascular risk factor burden.[30]

Regulations:

The International Organization for Standardization (ISO) has guidelines for measuring hand-arm vibration.[31,32] These include a weighting scheme for hand-arm vibration measurement that gives greater weight to lower frequencies (< 32.5 Hz). This weighting network is used not only by the ISO but also the European Union (EU) vibration directive, the American National Standards Institute (ANSI) voluntary standard for hand-arm vibration and the American Conference of Governmental Industrial Hygiensts (ACGIH) TLV for hand-arm vibration. However there is some controversy about this weighting scheme and various alternatives have been proposed that would give more weight to the higher frequencies. Despite this, it is unlikely that there will be any change in the ISO weighting scheme in the near future.

Occupational exposure to hand-arm vibration is regulated by legislation in the European Union[33] and the member EU countries have adopted the EU Directive for vibration. In the U.S., the American National Standards Institute (ANSI) issued ANSI S2.70-2006,[34] which is a voluntary standard based on the EU Directive. Hence there is significant harmony between the EU HAV Directive and ANSI S2.70. Also exposure limits for hand-transmitted vibration have been formulated by the American Conference of Governmental Industrial Hygienists (ACGIH).[35] However the Occupational Safety and Health Administration (OSHA) in the U.S. has not developed an OSHA standard for hand-arm vibration. NIOSH has developed recommendations about HAV exposure [36] and continues to carry out research on the health effects of hand-arm vibration exposure, the biodynamic response of the hand-arm system to hand-arm vibration and methods to prevent HAVS.

The ACGIH exposure limit differs from the EU Directive and ANSI S2.70 in that the ACGIH bases its exposure limit on a single dominant axis (x, y or z), whereas the EU Directive and ANSI S2.70 consider the vector sum of the x, y and z axes (square root of the sum of the three squared ISO frequency-weighted rms acceleration values). Specifically, the ACGIH exposure limit states that for 4–8 hr./day, an ISO frequency-weighted acceleration of 4 m/s^2

should not be exceeded; for 2–4 hr./day, 6 m/s^2 should not be exceeded; for 1–2 hr./day, 8 m/s^2 should not be exceeded, and for exposures less than 1 hr./day, 12 m/s^2 should not be exceeded. In contrast, the ANSI voluntary standard and the EU directive set a daily action limit value and daily exposure limit value integrated over an eight-hour day (A(8)). The daily action limit value is 2.5 m/s^2 and the daily exposure limit value is 5 m/s^2. If the calculated A(8) value is greater than 2.5 m/s^2, the action value has been exceeded and the employer is required to develop a control program for workers exposed to hand-arm vibration, which includes medical surveillance. If the calculated A(8)value exceeds 5.0 m/s^2, the permissible exposure limit has been exceeded and the employer must reduce employee exposure to hand-arm vibration below an A(8) of 5.0 m/s^2.

In Canada, only two of the 13 provinces and territories (British Columbia and New Brunswick) have specified occupational exposure limits for HAV, and both reference the ACGIH TLVs for hand-arm vibration.[8] However it is unclear to what extent these regulations are actually enforced in these provinces, especially in light of the low numbers of HAVS cases reported to their compensation boards. In Ontario there are no regulations for hand-arm vibration exposure. However the general duty clause under the Occupational Health and Safety Act could be used to control worker exposure to hand-arm vibration in specific workplaces.

Prevention:

Taylor and Pelmear[37] reported that in workers less than 50 years of age with early vascular HAVS (Stockholm Vascular stage 0 or 1), only 30% will show recovery with avoidance of further vibration exposure. However workers with Stockholm vascular stage 3 or 4 do not tend to recover even with removal from exposure.[37] The neurological component of HAVS also tends to be irreversible, as do some of the musculoskeletal outcomes associated with hand-arm vibration exposure. Therefore given the fact that HAVS tends to be persistent and its demonstrated effects on upper extremity disability and quality of life, a focus on prevention is important.

Primary prevention of HAVS can be approached systematically using the hierarchy of controls model beginning with personal protective equipment (anti-vibration gloves) and progressing through higher levels of control including administrative controls, engineering controls, substitution and elimination. Most of the prevention literature has focused on the use of anti-vibration gloves, administrative controls and engineering controls but there has not been a systematic review on HAVS prevention published to date. Secondary prevention and tertiary prevention are also important in workers with subclinical HAVS (secondary prevention) or clinically significant HAVS (tertiary prevention). However the focus should be on primary prevention.

A general approach to prevention can be summarized as follows; (1) Identification of the hand-arm vibration hazard by vibration measurement, (2) Limiting exposure to within recognized exposure limits (through tool purchasing policies and limiting exposure time), (3) Use of anti-vibration gloves, (4) Regular and effective tool maintenance, (5) Education and training of workers about the hazard of vibration and its control, (6) Medical surveillance of workers with high exposure), and (7) Advising workers to avoid smoking and wear warm clothes to maintain a high body temperature.[34] Development of an overall disease prevention strategy to implement these prevention recommendations is a difficult task and requires awareness of the hazard and incentives to implement controls by involved stakeholders. The purpose of this document is to address the manner in which this can be accomplished.

PREVENTION STRATEGY

HAVS can be prevented using the hierarchy of controls model.[37,38,39] These controls are addressed in detail in *Objective 1* of this document. Improved understanding of hazard awareness and the determination of when these controls are needed can be facilitated by establishing appropriate reporting and surveillance mechanisms (*Objective 2*). All levels of prevention, primary, secondary and tertiary, should make use of the best evidence available (*Objective 3*). To date, primary preventive efforts have been insufficient in most workplaces, particularly in the construction sector. Some of the larger mining companies have had an improved focus on reducing vibration exposure in the past few years.

The main barriers to primary prevention for HAVS seem to be: (1) lack of awareness and (2) lack of incentives (financial, regulatory) to implement control measures. Lack of awareness can be addressed through education of relevant stakeholders. This is discussed in *Objective 4* of this document. The reduction of HAV exposure consistent with international guidelines and regulations should be emphasized with targeting of high exposure occupations and industries (*Objective 5*). Recommendations for promotion of ongoing engagement and strategic partnerships to achieve HAVS prevention are discussed in *Objective 6.*

Objective 1: Focus On Reducing Harmful Exposures

For purposes of prevention, it is useful to categorize risk factors for HAVS into exposure, ergonomic factors and individual factors, which can be addressed through a hierarchy of controls approach (elimination, substitution, engineering controls, administrative controls, and personal protective equipment). Exposure factors include the acceleration and frequency spectrum of the vibrating tools; duration of exposure and work-rest cycling; tool maintenance; and protective equipment, in particular anti-vibration gloves. Ergonomic/biodynamic factors (grip forces, position of the hand and arm relative to the body) and predisposing individual risk modifiers such as smoking and medications) lend themselves to control through educational efforts and modification of user characteristics.

Elimination and substitution may sometimes be feasible in particular industries and work operations. Examples include the design of metal castings to eliminate or reduce the degree of hand finishing required; descaling steel structures using abrasive blasting instead of pneumatic tools; use of robotics or remote control to eliminate the need for workers to use hand-held vibrating tools. However in many industries and work activities elimination and substitution are not currently feasible for hand-arm vibration exposure.

Engineering controls are very important in terms of reduction of exposure and primary prevention. There are some measures that can be taken by employers such as mounting tools to reduce vibration exposure, but most engineering controls occur during tool design and manufacture and therefore are largely driven by tool manufacturers. Legislation in the European Union has encouraged manufacturers to incorporate vibration reduction engineering controls into the development of new tools. Canadian employers need to have increased awareness of the importance of purchasing lower vibration tools and incorporating this into purchasing policies. Regulatory measures would provide an additional incentive for employers to do this. Other measures employers can take are to have written policies for tool maintenance schedules (the vibration is reduced though proper tool maintenance) and protocols for replacing tools that no longer function properly and cannot be adequately fixed.

The primary administrative control to reduce the risk of HAVS is to limit exposure duration, so that the exposure to HAV over a working day is not excessive. In the EU countries, this means that the integrated exposure over an eight hour day (A(8)) must not exceed 5 m/s^2. Hence if tools have a high vibration intensity (acceleration), the duration of exposure must be low enough to ensure that the A(8) is not exceeded. The Health and Safety Executive in the U.K. has an excellent website that allows employers to determine if the A(8) has been exceeded for a particular magnitude of vibration exposure and to reduce the exposure duration accordingly. As well the duration of exposure can be guided by the existing ACGIH exposure duration limits for particular magnitudes of HAV exposure. The ACGIH also recommends that workers have a 10 minute rest period after each one hour period of exposure to HAV. Increased education directed at employers and workers would be useful to draw greater attention to the use of administrative controls to lower vibration exposure.

Personal protective equipment is the last line and least effective form of prevention of HAVS. There is some epidemiological evidence to suggest that anti-vibration gloves may reduce HAVS symptoms in exposed workers [40] and anti-vibration gloves are often considered to be a component of an overall HAVS prevention program.[40,41] However a recent comprehensive review by Hewitt et al [42] indicated that the anti-vibration gloves have little protection at lower frequencies. The protection varies with the direction of vibration, being best in the z axis (the direction in the long axis of the fingers/hand) and least in the y axis. Little protection is provided by anti-vibration gloves when using tools of low frequency vibration, although better protection is provided for tools whose dominant frequency is in the high frequency spectrum.[42] Therefore, depending on the frequency characteristics of the tool, anti-vibration gloves may provide some protection from the incident vibration exposure. International Standard ISO 10819 [43] specifies the vibration reduction criteria for AV gloves and gloves have to demonstrate this reduction to be labelled as ISO approved. To be compliant with ISO 10819, anti-vibration gloves must be of the full-finger type.

The main barriers to implementation of primary prevention measures are lack of awareness and lack of incentives (financial, regulatory). Educational efforts targeted at employers and workers will provide the most benefit in the short term. Increased awareness of the hazard posed by HAV could lead to reduction in exposure, initially mainly by administrative controls and better tool maintenance as well as the use of ISO approved AV gloves. The reduction of exposure by purchasing lower vibration tools would have a major impact on reducing the hazard and could be phased in over a period of time as new tools are needed.

The development of legislation for HAV is a difficult undertaking but it would provide a strong incentive to reduce the exposure and prevent HAVS. This is likely a more medium to long term objective in the overall disease prevention strategy. The EU directive, which has been adopted by the EU countries, including the U.K. would be a good model for any future legislation in Ontario. It includes an exposure limit value (ELV) of an A(8) of 5 m/sec^2, which must not be exceeded and a daily exposure action value (EAV) of an A(8) of 2.5 m/sec^2, above which the employer is required to institute a control program including medical surveillance and training of workers.

From an educational standpoint, the Health and Safety Executive (HSE) in the United Kingdom has an extensive body of literature directed at employers about implementation of primary prevention, including user friendly guides to the vibration levels of common tools and user times to keep the A(8) exposures below the permissible exposure limit. This information is easily accessible at the HSE website. A HAV/HAVS educational tool designed for both employers and workers has also recently been developed by the Occupational Health Clinic at St. Michael's Hospital and has been shown to increase awareness of HAVS prevention in the construction sector in Ontario.[44]

Objective 1: Key Actions

Short term

1. Discuss and prioritize strategies to facilitate prevention of hand-arm vibration hazards in the workplace. This should involve various workplace parties including employers, HSAs, the MOL, occupational health professionals, unions and worker representatives.
2. Build awareness of the hazard of HAV exposure, especially in the construction, mining and forestry sectors. The key messages are common to many occupational diseases and need to be reinforced on a frequent basis. These include the fact that HAVS is a common condition, significantly affects disability and quality of life, needs to be detected early and is preventable if the hazard is identified and properly controlled.
3. Collect and review educational materials on HAVS and its prevention with the aim of developing educational products (e.g. posters, other print and electronic materials) aimed at Ontario employers, workers, unions, HSAs and occupational health and safety professionals. Examples of existing tools that can be reviewed and form the basis for the development of educational interventions include those of the Health and Safety Executive (HSE) in the United Kingdom and tools developed and used at the Occupational Health Clinic at St. Michael's hospital (see Appendices).
4. Identify needs and gaps in educational programs on HAVS for OHS professionals including the HSAs and the MOL.
5. Develop and make accessible evidence-based educational products and tools to prevent HAVS. These should be easily accessible with flexibility to customize by sector or business setting.
6. Perform a jurisdictional review of HAV legislation and regulations both nationally and internationally.

Medium term

1. Review and develop on an ongoing basis educational materials to provide guidance on HAVS prevention aimed at employers. The educational materials would be informed by ongoing research to enhance educational impact.
2. Provide enhanced educational outreach to employers on HAVS and its prevention.
3. Educate MOL inspectors on HAVS to enable them to provide advice to workplaces with identified HAV hazards. In lieu of performing vibration measurements, MOL inspectors could use a quick reference guide with average vibration levels of various tools to assist in hazard identification.
4. Identified HAV hazards could be addressed using the General Duty Clause of the Occupational Health and Safety Act, s.25(2)(h) and/or s.54(1)(k). These clauses could be used in the absence of a specific HAV regulation, until such a regulation is developed.

Long Term

1. Consider developing a regulation for HAV exposure under the Occupational Health and Safety Act in Ontario. This could include the exposure limit values and daily exposure action values used in the European Union Directive. An alternative would be the TLV for HAV developed by the ACGIH. This HAV regulation would lead to

enhanced hazard recognition and control and would obviate the need to use a general duty clause for any necessary enforcement in the workplace.

2. Ongoing research to evaluate the awareness and prevention of the hazard posed by HAV in Ontario workplaces and the development of enhanced educational materials to address any identified gaps.

Objective 2: Establish Appropriate Reporting and Surveillance Mechanisms

There is currently no published information on the number of workers exposed to hand-arm vibration in Ontario or Canada. Establishment of an exposure registry might initially focus on identification of key sectors, in particular mining, construction and forestry. This might allow broad estimation of the number of workers exposed to high levels of hand-arm vibration on a regular basis. The ministry of labour inspectors could collect information on exposure and help to gradually develop such an exposure registry in Ontario. This would also help to target educational interventions.

In the U.S, the Bureau of Labour Statistics has estimated that approximately 2.5 million workers are currently exposed to hazardous levels of HAV on a regular basis. It is also estimated that about 50% of these workers have or will develop HAVS.[7] In the U.K., a large cross-sectional survey by Palmer et al.[16] in 2000 estimated that 4.2 million men and 667,000 women were occupationally exposed to hand-transmitted vibration, with at least 1.2 million men and 44,000 women being exposed at levels in excess of the action limit for 8 hours. Based on the U.S. and U.K. estimates and adjusting for population size there are likely to about one to two million workers exposed to hand-arm vibration on a regular basis in Canada, with about one-third of these working in Ontario.

Medical surveillance programs for workers exposed to hand-arm vibration are currently not required in Ontario or other jurisdictions in Canada. It is possible that surveillance programs have been established in some larger companies, in particular in the mining sector, but there is no published information about this. There is information available from the WSIB in Ontario and the other workers' compensation boards in Canada about the number of claims for HAVS. However the available published information indicates considerable under-recognition and under-reporting of HAVS, not only in Ontario, but throughout Canada.[8] Improved awareness of the hazard of HAV by employers and employees would likely result in improved recognition and reporting of HAVS cases to the WSIB in Ontario.

Medical surveillance at the level of individual workplaces could be feasible. For example the EU Directive requires medical surveillance of workers exposed above the daily exposure action value (EAV) of 2.5 m/s^2. A workplace-based medical surveillance program could mirror the one used in the United Kingdom. The program identifies vibration-related disease at an early, and therefore, still reversible stage and provides a mechanism to monitor effectiveness of primary prevention efforts (control measures). The HSE requires that new HAVS cases detected in medical surveillance must be reported under the reporting regulation terms of the Reporting of Injuries, Diseases and Dangerous Occurrences Regulation, 1995 (RIDDOR). There are no publicly available reports on the success of including HAVS as a reportable disease using RIDDOR or how the HSE has used the data to facilitate prevention. However the development of regulations for HAV in Ontario similar to those in the EU, should improve the reporting of cases of HAVS in Ontario and in turn provide opportunities for enhanced prevention.

Objective 2: Key Actions:

Short Term

1. Perform an international jurisdictional scan of vibration surveillance programs, both exposure identification programs and medical surveillance programs.
2. Develop exposure assessment tools for employers to use in their workplaces. This could include information to access various HAV electronic exposure databases to obtain exposure estimates for specific tools, as well as teaching employers to use a vibration calculator to determine exposure times for specific tools whose vibration accelerations are known.
3. Provide outreach to employers through HSAs and directly accessible educational information about hazard surveillance tools (similar to those used by the HSE in United Kingdom – see Appendices) to encourage workplace specific hazard surveillance programs.
4. Develop a model medical surveillance program for workers exposed to high levels of hand-arm vibration and make this program available to employers in the educational materials developed for HAV/HAVS.

Medium Term

1. Carry out a feasibility study of the development of a HAV hazard surveillance database. The benefits of such a database in terms of education, hazard identification and control and research would need to be emphasized. This would involve collaboration with the MOL, WSIB, HSAs, unions, employers and other interested parties. The construction of the database would be facilitated by the development of educational tools that would build awareness of the hazard of HAV and increase knowledge about prevention opportunities.
2. Carry out a feasibility study of the development of a HAVS medical surveillance database.

Long Term

1. Establish a HAV hazard surveillance database and/or a HAVS medical surveillance database if the feasibility studies indicate that these databases would be of benefit and can be efficiently developed and operationalized.
2. Develop a much more in-depth understanding of the exposure to HAV in Ontario in terms of the number of workers exposed, the number with HAVS, the sectors and industries in which exposure occurs, the types of tools, duration of exposure and control measures. This will provide a useful tool for prevention and will inform ongoing educational and research efforts.

Objective 3: Ensure Maximum Use of Best Evidence

High priority sectors for targeted intervention to prevent HAVS are generally known (mining, construction, forestry) and the groundwork regarding evidence for and implementation of control strategies has already been done by the Health and Safety Executive (HSE) in the United Kingdom, the American Conference of Governmental Industrial Hygienists (ACGIH), the International Organization for Standardization (ISO), the American National Standards Institute (ANSI) and the National Institute for Occupational Safety and Health (NIOSH). Use of data and guidance information from these organizations should be sufficient to ensure that the best evidence is being utilized. However a synthesis of research information and a concise summary in a format and location accessible to employers and other stakeholders is needed.

Operationalizing primary and secondary prevention strategies requires stakeholders to be knowledgeable about HAV and HAVS. This process requires capturing the evidence and delivering it to employers and workers though effective knowledge transfer and exchange. This can be accomplished though the HSAs by their provision of guidance documents and other educational tools, as well as through training programs for workers and health and safety representatives who can be involved in risk assessments in their workplaces. Occupational health professionals and inspectors must also be trained to carry out and interpret field measurements. Education of healthcare providers about HAVS is important to improve identification of HAVS cases and filing of compensation claims, as well as referral to specialized centres for more detailed assessment. HAVS is an occupational sentinel health event[13,14] and improved recognition by clinicians, including primary care physicians is needed.

With respect to research, to date most HAVS research in Canada has focused on diagnostic methods to assist in clinical evaluation and compensation as well as determination of the effect of HAVS on disability and quality of life. Internationally there has been considerable research on pathophysiology, dose/response and the HAV frequency specificity of the various components of HAVS. In the future more emphasis is needed on research synthesis of available information and the development and evaluation of educational interventions to build awareness and to increase knowledge about prevention opportunities.

Objective 3 - Key Actions:

Short Term

1. Carry out a synthesis of research information on HAV/HAVS that is relevant to prevention in the workplace. This should be written in brief, clear language, with a focus on how the findings can be translated into practical applications in the workplace with a focus on prevention.
2. Facilitate linkages between HAVS researchers and the OHS system partners to form working groups with the aim of developing effective and evidenced-based guidance documents and educational tools for employers and workplaces.

Medium Term

1. Develop evidenced-based guidance documents and educational tools based on the research synthesis for employers, workers, HSAs, and other workplace parties. Educational tools already developed by the Health and Safety Executive in the United Kingdom could help in tool development, as they are based on best evidence.
2. Continue to work with the provincial medical schools to ensure that undergraduate medical training includes an appropriate level of education about HAVS and other common occupational diseases in the curriculum (Occupational Health Champions Program, which focuses on occupational health content in the medical schools' curricula in Ontario).
3. Support inclusion of best evidence information regarding HAVS in Occupational Medicine residency training for specialists and training for family physicians.

Long Term

1. Ongoing evaluation of research to ensure that current research findings relevant to prevention of HAVS are incorporated into educational materials.
2. Ongoing development of evidence-based prevention tools (eg. posters, bulletins, websites) that are easily accessible and may be customized to specific sectors/workplaces.

Objective 4: Improve Education and Awareness

Effective prevention of HAVS, as with occupational disease in general, requires improved education and awareness of occupational health stakeholders including employers, workers, organized labour, occupational health and safety professionals, healthcare providers, the Ministry of Labour, the WSIB, HSAs and the occupational health research community.

Building awareness of HAV/HAVS and increasing knowledge about prevention opportunities are important priorities. This involves, among other things, developing various new educational products and tools about HAV/HAVS. The educational materials for employers and employees should be brief, written in clear language, evidence-based, easily accessible and customizable to specific sectors/workplaces. The Skin Health at Work Toolbox to prevent occupational dermatitis that was developed by CREOD, in collaboration with various occupational health stakeholders, could serve as a model in this regard. For example CREOD and Workplace Safety & Prevention Services, MOL are partnering to produce research-based skin health prevention posters for use in workplaces that may be used in their initial form or customized using a simple online tool. A similar approach for HAV/HAVS could provide a set of useful educational materials with the potential to greatly improve awareness of this hazard and the opportunities for prevention.

Of the three main sectors at risk for HAVS (construction, mining and forestry), the mining sector seems to be the most progressive to date with respect to recognition and prevention of HAVS. The construction sector in Ontario has been the subject of recent research by CREOD, with this research suggesting a general lack of awareness of the condition among employers and workers.[44] This is likely the result of the transient and itinerant nature of the work, and an abundance of small to medium-sized employers for whom educational materials and outreach is difficult. The forestry sector in Ontario has not been a primary HAVS research focus to date in Ontario and additional work is needed in this sector.

To improve education of workers and employers, improved incorporation of vibration hazards into Workplace Hazardous Materials Information System (WHMIS) training should be done. WHMIS, a combination of federal and provincial legislation, requires both general and hazard-specific training for workers. It should be noted that in the hazard specific training, WHMIS already has a section on hazardous physical agents such as noise, vibration and radiation. However more detailed information about HAV/HAVS and control strategies should be provided during WHMIS training. Hand-operated vibrating tools should have associated information sheets akin to MSDSs addressing vibration magnitudes and recommended durations of exposure. More detailed information about control strategies for hand-arm vibration using the hierarchy of controls model should be provided. Emphasis should be placed on purchasing lower vibration tools, proper scheduling of tool maintenance, administrative controls to reduce vibration exposure duration and proper procedures for using and gripping vibrating tools. The use of AV gloves should be mentioned but emphasis should be placed on other strategies to reduce hand-arm vibration exposure.

Objective 4: Key Actions

Short Term

1. Develop a strategy in collaboration with occupational health and safety partners to create educational materials for HAV/HAVS. The focus should be on HAV hazard awareness and prevention of HAVS for employers, employees, organized labour and frontline occupational health and safety professionals.

2. Identify and assemble information on available educational materials for HAVS prevention. The HSE website in the U.K. is an excellent starting point for this.
3. The CREOD Skin Health at Work Toolbox should serve as a model for the development of these hand-arm vibration educational products.
4. Begin to develop educational materials that are evidence based and are written in brief, clear language with a focus on how the findings could translate into practical preventive applications in the workplace.
5. The goals of easily accessibility of educational materials and the ability to customize the materials for specific workplaces should be attended to during the development and eventual rollout of these programs.

Medium Term

1. Rollout of educational material for HAVS initially focusing on the construction, mining and forestry sectors. Partnering with the relevant HSAs, MOL and organized labour is needed to facilitate this process.
2. HSAs should develop and deliver training programs within their relevant sectors on the hazards of HAV exposure and prevention of HAVS based on the new educational materials.
3. The MOL inspectors could increase their focus on HAV exposure in the workplace and direct employers to the new educational materials to enhance compliance with recommended exposures.

Long Term

1. Once the educational materials have been developed, there should be continual improvement based on user feedback and new research evidence to ensure that the products remain relevant and effective.
2. An evaluation of the awareness of the hazard of HAV and the utilization of prevention opportunities should be carried out on a periodic basis to ensure that the new educational materials and methods of delivery are having an impact on prevention in the workplace. Any problems identified should lead to improvement and updating of the existing programs.

Objective 5: Target High Priority Diseases, Exposures, Occupations, and Industries

HAVS is a common occupational disease although it is under-recognized by physicians, in particular primary care physicians, and under-reported to compensation boards in Canada, including the Workplace Safety and Insurance Board in Ontario.[8] Many workers are exposed to high levels of hand-arm vibration and a high proportion of these workers (about 50%) are likely to develop HAVS if the exposure levels continue.[7] As well the latency time between first exposure and the development of HAVS may be quite short (i.e. < 2 years) if the exposure intensity is high. Also HAVS is a recognized sentinel health event of occupation.[13,14] Therefore HAVS should be considered a high priority occupational disease.

In terms of the occupations and industries most at risk, the principal sectors affected in Ontario are construction, mining and forestry although high exposure to HAV also occurs in other sectors such as manufacturing. Most of the patients assessed for HAVS at the Occupational Health Clinic at St. Michael's Hospital in the Occupational Disease Specialty Program come from the construction and mining sectors. The number of workers exposed to HAV in Ontario has not been well characterized to date.

The most effective approach for prevention would be to initially target educational interventions in those sectors in which the exposure to HAV is known to be high. This would involve partnering with the relevant HSAs, specifically the Infrastructure Health & Safety Association (construction, electrical and utilities, aggregates, natural gas, ready-mix concrete and transportation) and Workplace Safety North (forestry, mining, smelters, refineries, pulp and paper, and printing industries) and other OHS system partners.

As well the MOL could initially target the construction, mining and forestry sectors for assessment of the hazard of HAV and the utilization of appropriate control strategies in specific workplaces. Over time additional sectors/workplaces should also be included.

Objective 5: Key Actions

Short Term

1. Develop educational materials for HAV hazard awareness and knowledge of prevention strategies that can be customized for the construction, mining and forestry sectors.
2. Health & Safety Associations (Infrastructure Health & Safety Association & Workplace Safety North) will focus educational campaigns and HAV training programs on targeted high risk industries (construction, mining and forestry)

Medium Term

1. Make HAV a focus of a Ministry of Labour enforcement, targeting the construction, mining and forestry sectors.
2. Identify other industries, in particular in manufacturing, with high exposure to HAV in Ontario

Long Term

1. Expand educational interventions and MOL assessments to include all industries with exposure to HAV in Ontario.

Objective 6: Promote Ongoing Engagement and Strategic Partnerships

The key stakeholders for HAVS prevention are employers, workers, organized labour, Health and Safety Associations, in particular the Infrastructure Health and Safety Association and Workplace Safety North, occupational health and safety professionals, the Ontario Ministry of Labour, the WSIB, health care professionals, tool manufacturers and the occupational health research community. In order to promote ongoing engagement and strategic partnerships for HAVS prevention, it would be useful to establish a working group that includes key stakeholder representatives to discuss and make recommendations about the development and implementation of high priority prevention initiatives.

CREOD has taken an important first step to bring together key strategic partners in the area of HAV/HAVS by organizing a discussion at its January 29, 2015 meeting to assess the level of interest in the development of a HAVS Prevention Tool Box (modelled on the Skin Health at Work Tool Box) and to hear thoughts on how best to proceed. The process of development of such a HAVS Prevention Tool Box would bring together key stakeholders and promote the ongoing engagement and strategic partnerships needed to develop and implement a comprehensive strategy for HAV prevention in Ontario. The focus of this group would be building awareness of the hazard of HAV and increasing knowledge of prevention opportunities.

CREOD also recently partnered with the Centre of Research Expertise for Prevention of Musculoskeletal Disease (CRE-MSD) and the Centre for Research in Occupational Safety and Health (CROSH) to hold two Vibration Workshops in Ontario in 2014. The first took place at the Centre for Health and Safety Innovation in Mississauga on February 25th and the second was held at Laurentian University in Sudbury on December 2nd. The workshops focused on vibration hazard awareness (both hand-arm and whole body vibration), measurement, risk assessment and control strategies. They brought together occupational health and safety practitioners from various work environments and, in addition to increasing hazard and prevention awareness, also helped to promote ongoing engagement and development of strategic partnerships.

Objective 6: Key Actions

Short Term and continuing

1. Establish a working group consisting of key stakeholder representatives to address HAVS awareness and prevention. The CREOD initiative to develop a HAVS Prevention Tool Box is an important step in establishing such a working group. Over time there can be a progressive increase in the involvement of stakeholders and the development of strategic partnerships focused on HAVS prevention.

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6. Annual screening questionnaire for health surveillance (for HAVS). Health and Safety Executive (HSE), United Kingdom.

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OTHER RESOURCES

For additional information on HAVS and its prevention (HSE Hand-Arm Vibration at Work Website):
http://www.hse.gov.uk/vibration/hav/advicetoemployers/index.htm

For information on the vibration characteristics of tools (NIOSH Power Tools Database):
www.cdc.gov/niosh-sound-vibration

For additional information on vibration measurement, controls and standards (Canadian Centre for Occupational Health and Safety Website):
http://www.ccohs.ca/oshanswers/phys_agents/vibration/vibration_measure.html