Hand-arm vibration syndrome in the workplace

Hand-arm vibration syndrome (HAVS) is a condition caused by exposure to hand-arm vibration, primarily from the use of vibrating tools.[1] Exposure occurs most commonly in a workplace setting.

Prolonged contact with a vibrating tool or surface can result in exposure to vibration over a broad frequency range. The exposure action value is the daily amount of vibration exposure above which employers are required to act to control exposure. For hand-arm vibration, the exposure action value is a daily exposure of 2.5 $m/s^2A(8)$.[2]

The risk of developing HAVS depends on the intensity, frequency, and duration of vibration exposure.[1] These make up what is known as the "vibration dose" and are shown to be critical factors for developing HAVS.[3]

Pathophysiology

The three systems most commonly impacted are:

- Vascular: It has been proposed that hand-arm vibration likely causes local endothelial damage through mechanical trauma and oxidative stress and leads to peripheral vasoconstriction by activating the sympathetic nervous system.[4]
- Neurological: Vibration exposure might damage both large (myelinated) and small (unmyelinated and myelinated) nerve fibres of the fingers.
- Musculoskeletal: Symptoms might occur through direct vibration-induced damage to musculoskeletal tissues or sometimes secondary to local nerve damage.[5]

High-frequency vibration, largely absorbed by the fingers and hands, appears to be associated with vascular and sensorineural symptoms of HAVS,[1] while low-frequency vibration, transmitted to the arms and shoulders, might be associated with musculoskeletal symptoms.

According to the International Organization for Standardization, the risk of the vascular component of HAVS is largely determined by the cumulative exposure to hand-arm vibration over a working lifetime. The prevalence of HAVS in workers regularly exposed to vibration averages 50%. This increases over time if corrective measures are not implemented early and definitively. If exposure levels are high, latency can be quite short, with HAVS developing in less than 2 years.

Undiagnosed, uninvestigated, and more advanced cases of HAVS are associated with work-related disability, mainly involving the upper limbs, and a subsequent impact on other activities of daily living.

Clinical manifestations and measurement

The adverse effects of HAVS in the vascular, neurological, and musculoskeletal systems are as follows.

Vascular

The clinical outcome most associated with HAVS from a vascular perspective is secondary Raynaud's phenomenon. This, in addition to being present as a symptom in scleroderma and other connective tissue diseases that involve vascular system abnormalities, such as systemic lupus erythematosus, is a recognized occupational disorder that develops in individuals who use vibrating hand tools and machinery. It manifests as blanching of the fingers, either induced by cold or triggered by exposure to vibration. It begins in the tips of exposed fingers and may progress to involve the entire finger.

Cold exposure may be associated with cyanosis, with reactive hyperemia during rewarming. In severe cases, trophic changes take place in the fingers, which may become gangrenous, resulting in loss of digits.[1]

Clinically, workers may present with fingers becoming white, then red, and being painful on recovery. This will initially involve fingertips and be more pronounced in cold temperatures or when wet. Notably, the thumbs are least affected.

Measurement includes:

- A clinically relevant history of cold-induced finger blanching.
- Asking the worker to take color photographs of the hands, especially when symptomatic.
- Standard color photographs of blanched hands at different stages of HAVS have been developed. At the clinical assessment, workers can be asked to identify which image resembles the appearance of their hands when exposed to cold.
- Objective tests, including:
  – Digital plethysmography to assess the degree of cold-induced dampening of the finger or toe waveforms.
  – Arterial peripheral study, including ankle-brachial indices and triphasic to biphasic spectral waveform measurement.

Neurological

HAVS can cause damage to sensory nerve fibres in the fingers, producing digital sensory neuropathy.

The neurological component includes both a diffuse peripheral neurosensory injury and an entrapment of the median nerve at the wrist, entailing a symptom complex covered by carpal tunnel syndrome.[6]

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Clinically, workers may present with tingling, numbness, and paresthesia in the fingers, independent of cold temperatures.

Measurement includes:

- A clinically relevant history of tingling, numbness, and paresthesia in the fingers.
- A neurological exam at the clinical assessment, including tactile sensory evaluation and reflexes.
- Objective tests, including:
  - Electromyography.
  - Nerve conduction studies to measure nerve conduction velocity, latency, and amplitude in large myelinated nerve fibres. This is especially useful for measurement of neuropathy proximal to the hand, such as median or ulnar neuropathy at the wrist.
  - Current perception threshold to measure the threshold of current perception of the distal digital branches of the ulnar and median nerves at three frequencies: 2000 Hz, 250 Hz, and 5 Hz. These correspond to large myelinated (A-beta), small myelinated (A-delta), and unmyelinated (C) fibres, respectively.

Musculoskeletal

Decreased grip strength is commonly reported by workers with HAVS and is related to a combination of direct muscle injury and nerve injury due to vibration. There is evidence to suggest vibration exposure is associated with direct damage to muscle via necrosis, fibrosis, and structural disorganization, as well as motor nerve injury.[1]

Clinically, workers may present with loss of strength in hands (mainly grip strength).

Measurement includes:

- A clinically relevant history of loss of strength in hands (mainly impacting grip strength).
- A thorough musculoskeletal exam of the upper extremities, including power and tone assessment.
- Objective tests, including:
  - Manual dexterity assessment using a Purdue Pegboard.
  - Grip strength, measured using a Jamar dynamometer, with three attempts, in both hands.

Clinical assessment in workers

The Stockholm Workshop scale for staging HAVS was the result of a 1986 workshop in Stockholm titled Symptomatology and Diagnostic Methods in Hand-Arm Vibration Syndrome. Classifications were developed based on history and physical examination. Objective tests are also needed to measure the various components of HAVS.

Clinical assessment of HAVS begins with a thorough and detailed occupational history. The history should determine the nature of work and the tools used, as well as the duration and intensity of exposure to vibrating tools. Actual measurements of hand-arm vibration from the work site also help in estimating exposure.

Industries most commonly involved include mining, construction, agriculture and forestry, foundries, shipbuilding and repair, motor vehicle manufacture and repair, and engineering. The tools considered to be high-frequency for vibration include impact drills, grinders, power and scaling hammers, mowers, floor saws, floor polishers, milling machines, sanders, and power saws, to name a few.

The clinical and medical history will identify the nature of symptoms, specifically any blanching, numbness, and tingling in the fingers and any additional musculoskeletal symptoms in the upper limbs. A history of other medical concerns associated with HAVS should also be assessed.

The physical examination should focus on the vascular, neurological, and musculoskeletal systems and is essential for diagnosis.

Blood tests help identify other causes of Raynaud's phenomenon, such as connective tissue disease, causes of neuropathy like diabetes mellitus, and any musculoskeletal comorbidity such as rheumatoid arthritis. Suggested blood tests include antinuclear antibody, rheumatoid factor, serum cryoglobulin, cold agglutinins, thyroid function (thyroid-stimulating hormone), blood glucose, complete blood count with erythrocyte sedimentation rate, vitamin B12, and red blood cell folate.

Objective assessment of the components of HAVS is conducted using the tests listed above.

Prognosis and management

The prognosis for HAVS depends on the cumulative effects of vibration exposure. If exposure continues, the severity of HAVS would be expected to worsen; if exposure is identified early and mitigated, some improvement may be expected within the different components of HAVS.

The clinical management of workers diagnosed with HAVS has two components: preventive, to stop ongoing exposure and deterioration of function, and symptom control, to improve functionality.

The more effective of the two might well be prevention. Identifying workers who are at risk of developing HAVS and providing advice on preventive measures can be helpful in limiting ongoing vibration exposure.

Prevention strategies aim to reduce the amount, duration, and intensity of vibration a worker is exposed to. These include using antivibration gloves, better-designed tools, and vibration-damping techniques such as gripping tools lightly, alternating hand positions on a tool, and limiting the time spent doing a task with high vibration exposure potential.

Temporary work modification to reduce exposure to cold temperatures and high-amplitude, low-frequency vibrating handheld tools may be helpful.[7] In the workplace, threshold limit values based on International Organization for Standardization recommendations should be observed.[8] The US Occupational Safety and Health Administration also recommends periodic rest breaks away from vibratory tool use for 10 to 15 minutes every hour to perform nonvibratory tasks.[9]

Treatments for secondary Raynaud's phenomenon, such as vasodilation medications (e.g., calcium channel blockers), may also be tried. In all cases, workers who smoke tobacco are encouraged to seek smoking cessation strategies.

For further assistance

If you have questions about your patients and occupational diseases, you can reach a medical advisor via the RACE app or call 604 696-2131 or 1 877 696-2131 toll-free. Physicians are available Monday to Friday, 8 a.m. to 5 p.m. We will call you back within 2 hours. ■

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Additional reading

Health and Safety Executive. Hand-arm vibration at work: A brief guide. Accessed 24 January 2023. www.hse.gov.uk/pubns/indg175.pdf.

Recently deceased physicians

doctors of bc

March 2022–February 2023

The following Doctors of BC members died between March 2022 and February 2023. Thank you to their families for sharing this information with the Membership Department. If you knew any of the deceased, please consider submitting an obituary for the *BCMJ* to journal@doctorsofbc.ca.

Dr Glen John Ankenman
21 February 1926–6 November 2022
Obituary: www.dignitymemorial.com/obituaries/vancouver-bc/glen-ankenman-11005820

Dr Vivian Baker
16 March 1930–29 November 2022
Obituary: https://vancouversunandprovince.remembering.ca/obituary/vivian-baker-1086766996

Dr Roger Kingswell Crittenden
30 November 1950–23 January 2023
Obituary: www.dignitymemorial.com/obituaries/kelowna-bc/roger-crittenden-11121614

Dr Paul Joseph Dubord
5 May 1951–5 September 2022
Obituary: https://globalsurgery.med.ubc.ca/remembering-dr-paul-dubord

Dr H. Martin Gough
23 June 1927–26 June 2022
Obituary: www.dignitymemorial.com/obituaries/victoria-bc/hugh-gough-10811758

Dr Donald Gene Hedges
15 July 1950–30 December 2022

Dr Brenda Anne Huff
22 December 1961–22 January 2023

Dr Lee-Anna Huisman
1 August 1981–3 November 2022

Dr Chong Won Lim
20 June 1932–4 June 2022

Dr James Robert MacLean
1 July 1925–14 March 2022

Dr Michael Mbuye Mthandazo
7 March 1981–30 July 2022

Dr Mairi MacDonald Narod
28 October 1927–3 September 2022
Obituary: www.surreynowleader.com/obituaries/dr-mairi-macdonald-narod/

Dr Jaime Patricio Paredes
4 March 1943–16 December 2022

Dr Colin Paul Sabiston
21 September 1954–8 November 2022
Obituary: www.echovita.com/ca/obituaries/bc/west-vancouver/colin-paul-sabiston-15489511

Dr Michael Templeton Scott-Kerr
19 October 1935–26 February 2023

Dr David Smit
4 June 1935–9 January 2023

Dr Edwin Stockdale
29 August 1931–22 September 2022
Obituary: https://vancouversunandprovince.remembering.ca/obituary/dr-edwin-stockdale-1086369610

Dr Lionel Tenby
11 April 1932–22 December 2022

Dr Esias Renier van Rensburg
6 September 1963–2 November 2022
Obituary: www.dignitymemorial.com/obituaries/burnaby-bc/esias-van-rensburg-10998686

Dr Upendra Kumar Vyas
10 October 1941–30 October 2022