# 10.2.6 Vibration 1673

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10.2.6 Vibration 1673 There might be symptoms of annoyance, distraction, fatigue, sleep disturbance, and feelings of isolation. These can combine to re- duce work output and efficiency. Accidents in noisy workplaces have been attributed partly to inability to hear verbal warnings or instructions clearly. Prolonged exposure to community noise might be associated with increased mortality from cardiovascular disease. Diagnosis A diagnosis of noise-induced hearing loss is established by noise exposure assessment, a history of hearing difficulty that might be accompanied by tinnitus, and an audiogram showing the classical sensorineural 4-kHz dip. Where abnormalities are detected, it is important to establish the history of occupational, leisure, and community noise exposure, exposure to ototoxic drugs and chemicals, previous ear pathology or surgery, other relevant medical history, and the compliance with use of hearing protection. Management and prevention Otoscopic examination, tuning fork tests, and bone-conduction audiometry should be carried out to exclude conductive hearing loss. Unusual asymmetrical audiograms with vertigo or unilat- eral tinnitus require otorhinolaryngologist referral to exclude cerebellopontine angle pathology (e.g. acoustic neuroma). People with hearing loss and tinnitus might benefit from using hearing aids, counselling, and a tinnitus-masking device. The emphasis in dealing with noise-induced hearing loss must be on prevention. Employers whose workplaces are noisy should es- tablish a hearing conservation programme, with commitment to a robust ‘noise policy’, at the highest level of management. To control noise at source, engineering controls can be used to make equip- ment less noisy, or processes can be redesigned to reduce noise output. Exposure to noise can be limited by separating its source from the workers using soundproof enclosures or shelters. In the United Kingdom a limit for noise exposure has been set at 87 dB(A) averaged over an 8-h day or 140 dB(A) for any instantaneous im- pulse noise. Hearing protection using ear plugs or ear muffs can reduce noise exposure at the ear by 3 dB(A) to 15 dB(A), but it must be fitted and used correctly to be effective. The diagnosis of workplace noise-induced hearing loss in a worker should be treated as a sentinel event indicating that other workers were at similar risk and that prompt preventive measures should be implemented. After reduction of noise at source, any re- sidual noise exposure of workers (exceeding 85 dB(A) as defined by the United Kingdom Control of Noise at Work Regulations 2005) warrants health surveillance. This involves symptom review and annual audiometry. In some cases, it may be necessary to consider changing jobs. Clinicians should also advise affected people about benefits available from state compensation schemes. For control of community noise and exposure to personal music players, other preventive measures are required. These include urban planning, restriction of flight paths, and flight timings for air- ports, and innovative health education to reduce listening time and volume of personal music players. FURTHER READING Basner M, et al. (2014). Auditory and non-

auditory effects of noise on health. Lancet, 383, 1325–32. Hammer MS, Swinburn TK, Neitzel RL (2014). Environmental noise pollution in the United States: developing an effective public health response. Environ Health Perspect, 122, 115. 10.2.6 Vibration Tar-Ching Aw† ESSENTIALS Various occupations can lead to exposure to vibration, which can be transmitted to the whole body or localized to the hands. The main clinical effect of whole-body vibration exposure is low back pain. Effects from hand-transmitted vibration can be (1) vascular, with manifestations of secondary Raynaud's phenomenon; (2) neuro- logical, often presenting as paraesthesia and reduced sensory percep- tion; and (3) musculoskeletal, including reduced grip strength and loss of manual dexterity. In tropical countries, as opposed to temperate climates, the clinical manifestations are predominantly neurological and musculoskeletal, instead of vascular. Management requires ex- clusion of differential diagnoses, and the identification and reduction of exposure to vibration at source. Diagnosis of an index case should prompt further investigation and where possible, modification of the system of work to prevent other cases from occurring. Introduction Vibration is 'the mechanical oscillation of a surface around its refer- ence point'. Workplace exposure to vibration results in local effects, mainly on the hands when the vibration is transmitted to the upper limbs. The clinical syndrome used to be termed 'vibration white finger', highlighting the vascular features. The current term is 'hand– arm vibration syndrome', reflecting a combination of vascular, sen- sorineural, and musculoskeletal components. When vibration is transmitted to the whole body, systemic effects, mainly low back pain, result.† It is with great regret that we report that Tar-Ching Aw died on 18 July, 2017. Exposure It has been estimated that 5–25% of the workforce in Europe is exposed to whole-body vibration, while up to 11% are exposed to hand-transmitted vibration. Occupational exposure to whole- body vibration occurs in helicopter pilots, and in drivers of heavy vehicles (e.g. tractors, forklift trucks, mobile cranes, and buses). † It is with great regret that we report that Tar-Ching Aw died on 18 July, 2017.

SECTION 10 Environmental medicine, occupational medicine, and poisoning 1674 The nature of the surface over which land vehicles are driven, as well as the characteristics of the vehicle cabs, contribute to the vibration. Hand–arm vibration exposure occurs in factory workers involved in fettling, chipping, grinding (Fig. 10.2.6.1), riveting, swaging, and using handheld pneumatic hammers, drills, chisels, and rotary tools. Forestry, agricultural, and wood workers using chain saws, miners drilling rock surfaces, and construction and road workers using drills (Fig. 10.2.6.2), and compactors are also at risk. Clinical effects Whole-body vibration Exposure to whole-body vibration has been linked to physiological changes to the cardiovascular, respiratory, and musculoskeletal sys- tems. Clinical effects include headache, motion sickness, sleep and visual disturbances, and urinary and abdominal complaints. However, low back pain is the only effect reliably associated with whole-body vi- bration. In vocational drivers, low back pain can occur as a result of vibration, poor posture within the vehicle cab, and from additional tasks, such as frequent handling or lifting of heavy loads. Hand–arm transmitted vibration This causes secondary Raynaud's phenomenon presenting as prom- inent episodic digital pallor, usually on exposure to cold or following contact with cold objects (Fig. 10.2.6.3). These symptoms often occur in the morning, or following outdoor activity such as fishing or gardening, especially in cold weather. The vascular changes might be accompanied by neurological and musculoskeletal effects that con- tribute to disability. Vascular and sensorineural effects might appear and progress independently. The latent period between initial exposure and development of symptoms is usually 5–10 years, but can range from between 6 months and 20 years depending on intensity and dur- ation of exposure. The sequence of colour changes in the affected digits starts with pallor, followed by a

bluish hue due to cyanosis, and then redness on reversal of the vascular spasm. Reversal can be spontaneous or can follow warming of the hands. Each episode usually lasts several minutes, and there can be several episodes per day or week. Neurological effects include paraesthesia, reduced temperature perception, loss of manual dexterity, and pain. Severe tingling and discomfort often follow rapid warming of the hands. Loss of the ability to distinguish and hold small objects, such as coins, or to button up clothing causes physical and social disability. Musculoskeletal effects are not as well established, although effects such as muscle weakness, bony exostoses, carpal tunnel syndrome, and Dupuytren's contrac- ture have been associated with exposure to vibration. Diagnosis The criteria for a diagnosis of hand–arm vibration syndrome are: • evidence of sufficient exposure to vibration; guides to the amount of exposure to vibration from various tools are available (e.g. on the National Institute of Working Life website, http://umetech.niwl.se)
Fig. 10.2.6.1 Exposure to vibration from grinding a metal component against a rotating wheel with an abrasive surface. Fig. 10.2.6.2 Exposure to vibration in a road worker from use of a handheld drill. Fig. 10.2.6.3 Patient with hand–arm vibration syndrome showing prominent digital pallor.

 • confirmed episodic pallor of the digits and/or sensorineural effects • documented latent period between initial exposure to vibration and onset of symptoms 5–10 years • assessing the likelihood of other causes of Raynaud's phenomenon or sensory abnormalities The presence of associated musculoskeletal features supports the diagnosis. Physical examination might show callosities on the hands, loss of light touch sensation or two-point discrimination in the affected digits, and poor grip strength, although there might be no obvious abnormalities, especially in the early stages of the disease. Various clinical and special tests have been used in the evalu- ation of patients with hand–arm vibration syndrome. These in- clude digital blood pressure measurements, vibrotactile thresholds, sensory aesthesiometry, and cold provocation tests. However, the clinical and occupational history is of greater importance than the results of any of these tests in the diagnosis of hand–arm vibration syndrome. The differential diagnosis should consider other causes of Raynaud's phenomenon. The cause might be constitutional or it might be secondary to rheumatoid arthritis, systemic lupus erythematosus, scleroderma, and other autoimmune disorders, cryoglobulinaemia, frostbite, or thoracic outlet syndrome. Use of ergot, clonidine, and β-blockers, occupational exposure to vinyl chloride monomer, and heavy cigarette smoking are other recog- nized causal factors. Management, treatment, and prevention The severity of hand–arm vibration syndrome can be staged using the Stockholm Workshop Scale (Table 10.2.6.1). This scale provides separate staging for the vascular and the sensorineural effects. For example, stage '2L(3)/1R(3)' for the vascular component refers to three digits at stage 2 in the left hand; and three digits at stage 1 in the right hand (i.e. stage/hand/number of digits). Further subdivision of stage 2 into early and late effects has been suggested as a basis for deciding on a change of job duties. An alternative scoring system (the Griffin scale) summarizes severity of effect by giving a higher score for affected terminal phalanges and the thumbs. Such scoring systems provide a more objective basis for following up patients with hand–arm vibration syndrome. Engineering controls can minimize the transmission of vibra- tion from machinery to the body or hands. The Health and Safety Executive in the United Kingdom has defined action values and limit values for exposure to vibration. Action values refer to steps that have to be put in place at these exposure levels, and limit values are legally binding standards that should not be exceeded. Patients with hand–arm vibration syndrome might be able to con- tinue in the same job following reduction of exposure to vibration. Workers with continuing exposure to hand-transmitted

vibration should be under regular health surveillance. Where the condi- tion is severe and the source of vibration cannot be eliminated, redeployment should be considered. In early cases, redeployment might arrest or reverse the progression of symptoms. In severe cases, the disease might progress regardless of removal from fur- ther exposure to vibration. Advice to the patient includes avoidance or reduction of fur- ther exposure to vibration, use of appropriate gloves, keeping the body and hands warm especially in cold weather, and cessation of cigarette smoking. Vasodilatory drugs such as tolazoline, inositol, and cyclandelate, and calcium channel antagonists such as verapamil and nifedipine, angiotensin-converting enzyme inhibitors, prosta- glandins, and stanazolol have been tried with varying success. In the United Kingdom, the patient should also be advised about entitle- ment to prescribed diseases benefits, which are awarded depending on severity. This UK scheme is administered by the Department for Work and Pensions through local social security offices. Other coun- tries have their own workmen's compensation schemes for diseases of occupational origin. A diagnosis of Raynaud's phenomenon should always include de- tailed inquiry into occupational exposure to vibration. Diagnosis of hand–arm vibration syndrome should be viewed as a sentinel event warranting further investigation of the workplace to assess whether improvements in work practices can be implemented to prevent the occurrence of other cases. Table 10.2.6.1 The Stockholm Workshop Scale for hand–arm vibration syndrome A. Vascular component Stage Grade Description 0 No attacks 1 Mild Occasional attacks affecting only tips of one or more fingers 2 Moderate Occasional attacks affecting distal and middle (rarely proximal) phalanges of one or more fingers 3 Severe Frequent attacks affecting all phalanges of most fingers 4 Very severe As in stage 3, with trophic changes in the fingertips B. Sensorineural component Stage Description 0SN Vibration-exposed but no symptoms 1SN Intermittent numbness with or without tingling 2SN Intermittent or persistent numbness, reduced sensory perception 3SN Intermittent or persistent numbness, reduced tactile discrimination, and/or manipulative dexterity

 FURTHER READING European Agency for Safety and Health at Work (2008). Workplace exposure to vibration in Europe: an expert review. Office of Official Publications of the European Communities, Luxembourg. Health and Safety Executive (2005). Hand-arm vibration: the control of vibration at work regulations 2005 & guidance on regulation. HSE Books, Sudbury. Health and Safety Executive (2016). Hand-arm vibration exposure calculator. http://www.hse.gov.uk/vibration/hav/vibrationcalc.htm Mason H, Poole K (2004). Clinical testing and management of indi- viduals exposed to hand-transmitted vibration: an evidence review. Faculty of Occupational Medicine, London.

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