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A critical review of evidence related to hand-arm vibration syndrome and the extent of exposure to vibration – a HSE Report

To: contacts in England, Northern Ireland, Scotland and Wales.

Key issues
Literature review found no strong evidence of a precise quantitative relationship between exposure to vibration and health outcomes, either for vascular or neurosensory HAVS. Limited evidence of reversibility of symptoms.

1. Introduction

The Health and Safety Laboratory has recently issued a report which is a literature review of hand arm vibration syndrome (HAVS) and the full report can be found here.

This report describes a systematic literature review on the nature of the exposure-response relationship between hand-transmitted vibration and the elements of hand-arm vibration syndrome (HAVS), i.e. the vascular, neurosensory and musculoskeletal components.

2. Main Aims

The aims of the report were :

- to seek out and critically appraise information relating to the relationship between exposure to vibration and HAVS;
- to establish areas of consensus of opinion and identify gaps in the evidence;
- to consult with international experts in the area to establish if any further information is likely to become available;
- to produce a report outlining the evidence available, any consensus of opinion and any gaps in knowledge.

3. Key Findings

Annex C of ISO 5349-1:2001 contains an exposure-response relationship for vascular HAVS, yet this review of the literature has not found any strong evidence of a precise quantitative relationship between exposure to vibration and health outcomes, either for vascular or neurosensory HAVS.

There is some evidence that suggests possible limited reversibility of vascular HAVS after cessation of exposure.

However, the limited evidence concerning neurosensory HAVS does not indicate any reversibility of the condition.

The review indicates that there are a number of unknowns with regard to the exposure-response relationships for HAVS. Despite on-going research in the area of HAVS, quantitative exposure-response relationships for HAVS remain elusive and ill-defined.

The report notes that there does not appear to be a significant body of appropriate research currently underway that would further our understanding of the quantitative relationship for either vascular or neurosensory HAVS.

It also notes that it has still not been possible to establish if there is a no effect level for vibration exposure, other than the somewhat obvious zero exposure level.

The review states that there are still a number of unknowns with regard to the exposure-response relationship for HAVS and these include;

- how best to quantify exposure,
- the inter-relationship between cumulative exposure, current exposure and periods of non-exposure in the development of the symptoms of HAVS,
- the relative importance of different vibration characteristics, such as frequency or impulsiveness, in relation to the different health outcomes.

Vascular HAVS

A meta-analysis of studies by Brammer [1, 2] was used as the basis to develop the ISO 5349:1986 exposure-response relationship, which related to vascular HAVS only. The British Standard BS 6842:1987 [3] contained a more cautious interpretation of this relationship, which did not include so much data as the 1986 version of ISO 5349. By 2001, when the current version of ISO 5349-1 was published, the information contained on the exposure-response relationship had been greatly reduced and was accompanied by a large number of qualifying statements and notes. This reflected the known uncertainty in the exposure-response relationship at the time of publication. This uncertainty still persists today. This review has confirmed that the quantitative relationship suggested in ISO 5349-1 is not universally applicable. Some studies show agreement, whilst others show, in roughly equal proportions, that the ISO 5349-1 relationship both over-and under-predicts the risk of vascular HAVS. There are many possible reasons for this, which are explored in the report.

Neurosensory HAVS

Over recent years as understanding has developed, the importance of the neurosensory component, in comparison with vascular HAVS, has been recognised with regard to disability and quality-of-life. Most of the studies that have looked at the neurosensory effects of vibration exposure have found that there is a relationship between vibration exposure and the onset of neurological symptoms. However, any quantitative relationship is not well defined. There are in fact very few good quality, published epidemiological studies that investigate the quantitative relationship between exposure to vibration and severity of neurological symptoms. There is still very little information available on the quantitative relationship between exposure and health outcomes for neurological HAVS. Evidence suggests that there is a relationship between cumulative exposure and quantitative tests of physiological damage, such as vibrotactile perception threshold (VPT) and thermal perception threshold (TPT). TPT may also be related to daily vibration exposure and appears more sensitive to cumulative vibration exposure than VPT.

No effect level

Early work by Brammer [4] suggested the possibility of a no effect level of exposure in the range $1 m/s^2 < aK < 2 m/s^2$ where aK is the single axis, frequency weighted acceleration magnitude. ISO 5349-1:2001 records that

reports of ill-health are rare below 2m/s^2 A(8) and not known at exposures below 1m/s2 A(8). This review has not found any recent evidence to either substantiate or refute this implied no effect level.

Reversibility

Evidence suggests some possible reversibility of vascular HAVS after cessation or reduction of exposure, which may happen over a period of years and depend on the initial severity of the symptoms. As there is evidence that the risk of vascular HAVS also relates to recent or current daily exposure, this suggests that the risk of vascular HAVS may not be simply driven by the extent of cumulative vibration exposure over a working lifetime.

The possibility remains that, if the diagnosis is solely based on reported extent and frequency of blanching, the apparent reversibility of vascular HAVS over time, may simply reflect life-style modifications made by sufferers to avoid blanching attacks.

There is less evidence concerning reversibility of neurosensory HAVS than for vascular HAVS, but that which is available does not indicate any reversibility of the condition. The prevalence of the key, but non-specific, symptoms of tingling and numbness in the hands and fingers of workers has been reported as being around 15-20% in the general working population. This is higher than estimates of Raynaud's Phenomenon, especially for males. The prevalence of the key symptoms in the general population makes defining the complete reversibility of neurosensory HAVS problematic in both absolute terms and relative to vascular HAVS.

Frequency weighting

Most evidence from good quality epidemiological studies, measurements of finger systolic blood pressure, biodynamics, and limited experimental data, lends support to consideration of frequencies higher than those emphasised by the current frequency weighting defined in ISO 5349-1:2001, when estimating the risk of vascular HAVS. Evidence does not however point to a universally better alternative to the ISO 5349-1 frequency weighting in defining exposure.

Other Musculo-Skeletal Disorders

The extent and quality of the evidence for cumulative vibration exposure causing disorders such as Carpal Tunnel Syndrome (CTS), Dupuytren's contracture and other upper limb problems, is much lower than for vascular and neurosensory HAVS. However, there is evidence for a causal link specifically between CTS and Dupuytren's contracture and exposure to vibration.

Quantitative relationships

The review has found no strong evidence that establishes precise quantitative relationships between exposure to vibration and associated health outcomes, including the key well recognised endpoints of vascular or neurosensory HAVS.

There are a number of factors that may influence success in investigating exposure-response relationships for HAV from workplace studies including a lack of consensus as to appropriate measuring metrics, unreliability in retrospective estimates for exposure, a lack of longitudinal studies and the fact that diagnosis of HAVS is still based on reported symptoms, rather than on quantifiable measures of damage or physiological deficit and so is open to misclassification through confounding conditions, which are relatively common in the general working population.

Recommendations

The report notes that HAVS and vibration-associated ill-health remains an international problem, where knowledge of current and future research work and pooling of appropriate data across national boundaries

remains important and despite the fact that there are difficulties in mounting workplace studies that focus on exposure response relationships, there remains a need for such work.

Given the continuing prevalence of some degree of HAVS in workforces and the continuing reliance on health surveillance to prevent progression, better definition of the influence of current exposure on progression of HAVS would aid occupational physicians with management of affected individuals.

In terms of wider research an alternative approach to setting up new longitudinal studies, with their inherent problems and significant costs, might be analysis within the large amount of on-going physician-led health surveillance data. This could be combined with appropriate estimates of relevant workplace current exposure levels, to better define exposure-response relationships for risk of HAVS and its progression or regression.

6. APSE Support

HAVS remains a condition which impacts local government frontline workers and it is important for managers and operatives to keep up to date with developments. Whilst this report goes into a lot of detail the main findings noted in this briefing are relevant for managers of those potentially affected and should be made known to them.

This literature review did not find any strong evidence of a precise quantitative relationship between exposure to vibration and health outcomes, either for vascular or neurosensory HAVS. It would be more straightforward to claim that a certain amount of exposure results in a specified level of damage but this is not the case. Many factors impact upon the damage caused and it will differ in each case.

It highlights the difficulties of acting upon the recommendations of a single study without looking at the wider context. It appears that there is only limited evidence to suggest possible reversibility of vascular and neurosensory HAVS after exposure has ceased, in other words once it is established it is unlikely to disappear. Of course prevention is the watchword and this means vigilance and regular reminders for operatives and managerial staff.

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