HAVS and CTS - Your questions answered

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When employees report finger blanching, does the lack of clear demarcation of pallor or a rewarming flush necessarily rule out a diagnosis of HAVS?
I understood that a history of blanching of toes indicated that any finger blanching is most likely to be due to primary Raynaud's rather than to HAVS. However, I have read that blanching of toes can also occur with HAVS. Can you clarify please?
How does HAVS & CTS manifest

HAVS

- Raynaud’s phenomenon (vasospasm) referred to as ‘vascular HAVS’
- Peripheral digital neuropathy referred to as ‘sensory or sensorineural HAVS’

CTS

- Regional neuropathy (median nerve)
Raynaud’s Phenomenon (RP)

- RP is descriptive term indicating episodes of reversible digital ischaemia (vasospasm) provoked by the cold.
- Triphasic pattern (white to blue to red) rarely described in practice.
- Is a common disorder (females 3>1) affecting 5-30% adult population.
- Less reports in warmer climates.
- Family history.
- Symptoms are usually bilateral, symmetrical with other periphery affected (50% fingers only)
- Rare to onset after 40.
- ‘Patchy’ appearance in Primary Raynaud’s?
Raynaud’s phenomenon

*International Consensus Criteria for the Diagnosis of Raynaud’s Phenomenon 2014*

- Step 1: Are your fingers unusually sensitive to cold?  
  Yes/No
- Step 2: Occurrence of biphasic color changes during vasospastic episodes (white and blue)  
  Yes/No
Step 3: If three or more then RP present

a) Episodes are triggered by things other than cold (i.e. emotional stressors)
b) Episodes involve both hands, even if involvement is asynchronous and/or asymptomatic
c) Episodes are accompanied by numbness and or paresthesias
d) Observed color changes are often characterized by a well demarcated border between affected and unaffected skin
e) Patient provided photograph(s) strongly support a diagnosis of RP
f) Episodes sometimes occur at other body sites (e.g. nose, ears, feet and areolas)
g) Occurrence of triphasic color changes during vasospastic episodes (white, blue, red)
Diagnostic criteria for Primary Raynaud’s

- Meets step 3
- Normal capillaroscopy
- Physical examination is negative for findings of secondary causes
- No history of existing connective tissue disease
- Negative or low ANA titre
HAVS : Civil case definition (‘Corus triad’)

- The diagnosis of HAVS is based on:

  a) the history of the symptoms provided by the employee,

  b) the history of relevant and significant vibration exposure, and

  c) no evidence of an underlying cause to account for the symptoms.
Vasospasm

Mobile phone photo
Cutaneous circulation controlled sympathetic vasoconstrictors and vasodilator nerves.

Precise location of circulatory interruption probably digital arteries

Vasospasm more often in glabrous skin (hairless)? (vasoconstrictor nerves only)

In my practice circumferential
Foot symptoms.

- ‘Vasospasm in the feet in workers assessed for HAVS’ (n 191) House et al 2011.
- ‘Vibration white foot in a worker with direct vibration exposure to the feet’ Thompson 2011 case study

Have to have symptoms in hands before can say symptoms in feet potentially related to vibration exposure. Sympathetic reflex activity?
CTS Question

I appreciate that all cases of CTS in employees working with vibrating tools are reportable to the HSE under RIDDOR. However, if the employee's vibration exposure is minimal, is it not more likely that their CTS is either idiopathic or due to some other cause such as repetitive hand and wrist movements or some other medical condition?
Carpal Tunnel Syndrome

- Paraesthesia or pain in the distribution of the median nerve that wakes the individual from sleep.

- Look out for other risk factors: diabetes, pregnancy, hypothyroidism.
Carpal Tunnel Syndrome in vibration exposed

- 28% prevalence (n 100 Stromberg et al, 1996)
- 15% prevalence (n 26,842 Burke et al, 2005)
  General population 7-18% (Ferry et al, 1998)

Case for vibration
- Palmer et al, RR>2 (systematic review, 2007)
- Barcenilla et al OR 5.4 (meta-analysis, 2011)

Case against vibration
- Lazano-Calderon (score based BH lit review, 2008)

No ‘de minimus’ level of vibration has been determined by epidemiology.
CTS, Non-Occupational Risks; Odds Ratios

Doubling of relative risk is the epidemiological equivalent of a ‘balance of probability’

- Wrist Ratio: 1.12
- Smoking : 1.6
- Diabetes : 1.36-1.4
- Hypothyroidism : 1.7
- Inflammatory Arthritis : 2.9 (Osteoarthritis)
- Obesity, BMI >30 : 2.1-8.2
- Beta-blockers(case reports)

- Vibration : 2.4 – 8.3
Diseases with multiple known causes and rebuttal  
*IIAC position paper No 34, 2015*

 Firstly, a disease which is caused by an occupational risk factor, ‘X’, can also be caused in the same individual by a non-occupational risk factor, ‘Y’. The presence of ‘Y’ does not mean that ‘X’ can be dismissed as a cause of the disease.

Secondly, even if ‘Y’ is a more potent risk factor for the disease in question than ‘X’, ‘X’ may still be causal in claimants on the balance of probabilities….

Thirdly, causal probabilities can sum to more than 100%. It may seem reasonable to assume that, if ‘Y’ is known to cause 90% of cases of the disease, ‘X’ can at most account for only 10% of cases – meaning that ‘Y’ is more likely than ‘X’ to be the cause of disease in a claimant with both exposures. In fact this logic does not apply.
HAVS Question

- Purdue pegboard—what might you expect in terms of results (particularly with both hands) for someone who was trying to throw the test result?

- How do we distinguish pain and stiffness in the hand and forearm caused by vibration exposure, from WRULD type II, i.e. non-specific upper limb pain?
Examination/’Office’ tests  (References in FOM review, 2004, Mason; Poole 2009)

<table>
<thead>
<tr>
<th>Exam/test</th>
<th>Sensitivity%</th>
<th>Specificity%</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>West monofilaments 0.2g</td>
<td>78</td>
<td>74</td>
<td>Single study</td>
</tr>
<tr>
<td>PPT</td>
<td>57</td>
<td>80</td>
<td>Single study</td>
</tr>
<tr>
<td>Jamar</td>
<td>17</td>
<td>99</td>
<td>Single study</td>
</tr>
</tbody>
</table>

Purdue Pegboard Test-Retest Estimates, Reddon et al 1988
Grip strength testing

- Those with symptoms consistent with Hand Arm Vibration Syndrome complain of weakness of grip.

  McGeoch and Gilmour 2000
  Farkila et al 1986

- Vibration causes damage to the muscle fibres and the motor nerves.

  Necking et al 2004
Mean grip by age band: Miners compared with UK and USA norms (Burke et al n= 97,581)
Non-specific symptoms

- Pain in forearms and hands (acute nerve damage?)
- Tremor (*Edland et al* 2014)
- Swollen fingers (*Wener et al* 1983)
- Cramping with gripping (focal dystonia)
- Triggering of the fingers (*Pelmear 1988*)
HAVS Question

- How valuable are the Tier 5 standardised tests in diagnosing HAVS?
Pathophysiology

HAVS

- Mechanoreceptor or thermal nerve ending damage. *Ekenvall 1986*
- Demyelination /oedema/fibrosis of nerves *Takeuchi 1984*
- Dysregulation of vaso-dilatation/constriction/ *Stoyneva 2003*

CTS

- Low myelinated nerve fibre density. *Dahlin 2014*
- Oedema, swelling of synovial linings. *Lundborg 1987*
## Sensorineural Tests

(Rewards in FOM review, 2004, Mason; Poole 2009, and other reports in literature)

<table>
<thead>
<tr>
<th>Test</th>
<th>ISO</th>
<th>Sensitivity%</th>
<th>Specificity%</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPT(VTT)</td>
<td>YES</td>
<td>35-80</td>
<td>80-94</td>
<td>staging</td>
</tr>
<tr>
<td>125Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TNZ(TA)</td>
<td>YES</td>
<td>52-57</td>
<td>70-98</td>
<td>Early?/staging</td>
</tr>
</tbody>
</table>

Not diagnostic: VPT and TNZ should be combined for staging purposes as no individual test ‘better’ than the other
<table>
<thead>
<tr>
<th>Nerve Fibres</th>
<th>Myelinated</th>
<th>Un-myelinated</th>
<th>Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aα</td>
<td>Aβ</td>
<td>Aγ</td>
<td>Aδ</td>
</tr>
<tr>
<td>Touch</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Tinel’s Phalen’s</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>VTT</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Cold TA</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Hot TA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCV</td>
<td>+</td>
<td></td>
<td></td>
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Requirement to test receptors and pathways

Nerve conduction studies test abnormalities at wrist level

Vibrotactile thresholds and thermal threshold test abnormalities of ‘receptors’ at fingertips
Nerve conduction velocities (Neurometrix)
SWS – clinical staging
Stockholm Workshop Scale

- The scale has both vascular and sensorineural staging criteria. Adjectives such as 'intermittent', 'persistent', 'occasional' and 'frequent' and an adverb 'rarely' were introduced with the presumption that these would be helpful.
SWS

- Ex-miners compensation scheme led to a systematic interpretation; blanching scores, standard sensorineural test scores and definitions of the troublesome adjectives were adopted and the adverb ‘usually’.

- VAWR 2005: SWS modification rather than assist by defining adjectives may have led to a prescriptive interpretation by some clinicians.
<table>
<thead>
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<th>Stage</th>
<th>Vasospastic attacks</th>
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<tbody>
<tr>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>1V</td>
<td>Fingertips only (blanching score 1-4)</td>
</tr>
<tr>
<td>2 V early</td>
<td>Occasional distal and middle, (rarely proximal), phalanges (usually blanching score 5-9)</td>
</tr>
<tr>
<td>2 V late</td>
<td>Frequent distal and, middle (rarely proximal), phalanges (usually blanching score 10-16)</td>
</tr>
<tr>
<td>3</td>
<td>Frequent attacks all fingers most, digits all year (usually blanching score 18)</td>
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Frequent > 3 per week
Sensorineural SWS modification

0\textsubscript{SN}  Exposed no symptoms

1\textsubscript{SN}  Intermittent numbness and/or tingling (SN score >3 and <6)

2\textsubscript{SN early}  Intermittent numbness and/or tingling, reduced sensory perception (\textit{usually} an SN score $\geq 6 < 9$)*

2\textsubscript{SN late}  Persistent numbness and/or tingling, reduced sensory perception (\textit{usually} an SN score $\geq 9 < 16$)*

3\textsubscript{SN}  Constant numbness and/or tingling reduced sensory perception and manipulative dexterity in warmth (and an SN score $\geq 19$)*

Persistent $\geq$ 2 hours, Constant = all the time

* West monofilament and PPT in ‘office’ diagnosis
SWS confusion

- Most notably occurs in the vascular staging, where frequency and extent of blanching often do not coincide and interpretation of the word 'rarely' and sensory staging where over reliance on symptom length and office tests.
- The extent of blanching which is a better indication of disease progression, and should generally override frequency of attacks.
- The adverb 'usually' was designed to alert the practitioner to what extent of scoring would be consistent with the stage.
SWS

- The adverb 'rarely' is a legacy from the original SWS for the inclusion of proximal phalange blanching in stage 2. (original descriptor was just an acknowledgement the broad spread of stage 2 and preceded any thoughts about dividing the stage).

- Regardless of terms the modified SWS should be applied in a common, consistent and usual fashion.
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Stage 2 early
## Vascular SWS modification

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Frequent > 3 per week
2V(late)L,2 ; 1VR,3
The only exception to a ‘usual’ staging is when there is a sound functional justification:

A right handed worker using a pencil grinder in a tripod grip in a cold environment who has frequent attacks of blanching affecting the whole of his right index finger and has to stop working, would be a late stage 2; the blanching score is 6 (unusual) and with the proximal phalanx involved (rare).
HAVS Question

The guidance to the Control of Vibration at Work Regulations recommends that people with Raynaud's disease should not be exposed to vibration at work, when identified at a Tier 1 initial or pre-employment assessment. What advice do you give to employees with Raynaud's disease who are already working with vibrating tools and whose job requires the use of such tools?
Pre-employment and vibration exposure

- Primary Raynaud’s: not a bar
- Secondary Raynaud’s: depends on the cause
- HAVS: ‘treat as if employed’
- CTS: in remission
- Cervical radiculopathy: theoretical risk of double crush??
- Diabetic neuropathy (low myelinated nerve fibre density same as vibration induced Dahlin 2014)
- Diabetics, Smokers, Beta-blockers?
HAVS Question

- At what point does someone with established HAVS need to stop working with vibration? When do you redeploy as opposed to continued work with monitoring?
- How frequently would you review employees with early HAVS who are still working with vibrating tools?
- Should I recommend that maximum vibration exposure for employees diagnosed with stage 1 or early stage 2 HAVS be kept below the Exposure Action Value, rather than the Exposure Limit Value?
Management of HAVS — most important factor is confidence in staging.

**Fifth Edition ‘Fitness for work’ 2013**

- ‘The shift from early stage 2 to late stage 2 will indicate the need to avoid further exposure to HTV’....
- Speed of progression
- Age.’

**HSE Guidance : L140, 2005**

- ‘An older worker, close to retirement age with no indication of recent rapid progression of symptoms and who fully understands the risks involved in ongoing exposures, may be allowed to continue work with limited exposure under regular health surveillance’.

**IJL**

- Depends.....on individual preferences and employer support.
HAVS

- Early HAVS reviewed annually unless rapid onset i.e. 6 months after commencing exposure.
- Stage 1 and early 2 advise can continue: see six monthly.
- Restriction Phrase:

  Although I recommend that X can continue working with hand held vibrating tools and equipment this should be kept as low as reasonably practicable and ideally below an A(8) value of 1.5 ms\(^{-2}\) (or 36 points)
CTS Question

- Do employees who have undergone successful CTS surgery require any restrictions in relation to their future exposure to vibration?
Management of CTS

Fifth Edition ‘Fitness for work’ 2013

- ‘Those with CTS in symptomatic remission – whether through treatment or not can use vibratory tools, although recurrence of symptoms will raise the question of whether that is due to vibration or the pre-existing condition.’

HSE Guidance : L140, 2005

If carpal tunnel is diagnosed, the employee may need to be removed from exposure…return to work on an individual basis.

IJL

- Poor response to surgery advise against further exposure. (>12/12)
- Good response to temporary restriction then cautious re-exposure (cause-effect association made).
- Other risk factors: forceful gripping, flexion and extension at the wrist should be considered.
- Advise on weight reduction?
CTS Question

- Whilst employees identified with symptoms of CTS are waiting further specialist assessment or surgical treatment, should they refrain from any work with vibrating tools or should exposure to vibrating tools be kept to a low level (eg below the EAV)?
CTS

- Clear diagnosis of CTS (NCV / positive steroid injection / waiting for surgical release) should be restricted temporarily………

- But….IJL experience of two ‘types’ of CTS. Those that improve rapidly off vibration (? HTV just and adjuvant) and those that do not recover until surgical release. Different pathological processes??
Alice Hamilton – 1918
‘Dead Fingers’ in ‘Exploring the dangerous Trades’