Hand-Arm Vibration Exposure in Industry

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Rebecca Devine
Vibration Exposure

- Everyday exposure
  - Car, bus, train ...
- Beneficial, comfortable, uncomfortable & harmful
  - Intensity, frequency and exposure
- WBV
  - Feet, buttocks & back
  - Mobile equipment - terrain
- HAV
  - Hands & arms
  - Powered hand tools and hand guided machinery
  - Impact, non-impact, striking tools
Health Effects

• Hand-Arm Vibration Syndrome (HAVS)
  – Sensory, neurological and musculoskeletal
  – 1911, first reported in Italian stonemasons
  – 1918, clinical ID in USA stone-carvers and cutters
  – 1983, vibration white finger, VWF (Raynaud’s of occupational origin)
  – Signs and symptoms
    • Numbness
    • Aches and pain
    • Blanching (turning pale and ashen)
    • Pins and needles (tingling)
    • Stiffness
    • Loss of grip strength, sensitivity and dexterity
    • Sleep disturbances
    • Neck and shoulder pain
Circulatory Effects

- **Vasoconstriction**
  - Response to cold, damp or vibration
- **Increasing vibration intensity** – greater sympathetic response
- **Blanching attacks** more frequent in winter and in morning or night when metabolic rate is lower
- **May last** a few minutes to hours
- **Genetic condition**
  - Raynaud’s Phenomenon
  - More prevalent in cooler regions (30% v 10%) and females (77% v 5%)
Neurological Effects

• Sensory and motor nerves
  – Pins and needles
  – Coordination and dexterity

• Symptoms difficult to distinguish from Carpal Tunnel Syndrome
  – Tingling after using vibrating tools and at night
  – Nuisance, painful and could be dangerous

• Both have significant impact on home and work life
Musculoskeletal Effects

- Co-existence of HAVS with:
  - Carpal Tunnel Syndrome
  - Dupuytren’s disease
  - Tendonitis and Tenosynovitis
  - Hearing loss

- Symptoms include:
  - Stiffness and pain in the hands, wrists, elbows and shoulder
  - Impaired grip strength

- Often working in sustained or awkward postures and with forceful exertions
Prevalence of HAVS

- UK – HAVS is widely promoted and strict legislation enacted in 1993
  - Sharp increase in reporting, but now it is low
- Australia – HAVS is not well known and little specific legislation (until now...)
  - Presume there is under-reporting
- Most research on prevalence in cooler climates with focus on VWF
  - Not common in Australia (warm climate)
  - Not relevant?
Control Measures

Avoid Exposure to HAV

• Alternative work methods
  – Automating the work
  – Using alternative equipment
  – Using alternative work processes

• Equipment selection
  – Selecting the lower vibration tool that is suitable
  – Selecting equipment with appropriate suspension

• Purchasing policy
  – Replacing old equipment
  – Testing equipment before buying
  – Asking manufacturers to provide the declared vibration value
Control Measures

Reduce Exposure to HAV

• Isolation
  – Using vibration-isolating handles or gloves

• Reducing impulsiveness
  – By product selection

• Work methods
  – Using equipment appropriate for the job

• Workplace design
  – Improve workplace design to limit load on hand and wrist
  – Suspend tools to balance weight

• Maintenance
  – Maintenance programs to keep equipment in good order
  – Sharpen tools (blunt tools do not work efficiently)
Control Measures

Reduce the effects of HAV

• Working posture
  – Appropriate working posture
  – Training for workers

• Physical condition
  – Physical exercises

• Equipment
  – Gloves to warm hands
  – Heated handles

• Work organisation
  – Limit exposure time and/or adapt work schedules

• Health surveillance
  – Health monitoring
Anti-vibration Gloves

• Pros
  – Commercially available
  – Designed to lower acceleration levels and shift vibration to less harmful frequency range
  – Air bladder design better at medium and high frequency
  – Wrist support is helpful

• Cons
  – Thickness is bulky
  – Reduces tactile ability and grip strength
  – May amplify vibration at low frequency
Anti-vibration Gloves

- Vibration attenuating materials
  - Viscoelastic material (gel)
  - Air bladder
- ISO10819
  - Grip force: maintained at 30N (+- 5N)
  - Feed force: maintained at 50 N (+- 8N)
  - Room temperature: 20°C (+- 5°C)
  - Humidity: below 70%
  - Conditioning of gloves: stored at room temperature for at least 30 minutes and worn by subject for at least three minutes before testing
  - Test period: at least 30 seconds
  - Posture: standing upright on a horizontal surface; forearm in the axis of vibration; elbow at 90° (+-10°) and not touching the body during the test; wrist bent from 0° (neutral) to 40° (dorsal) maximum
Anti-vibration Gloves

• Alternative testing methods
  – Pathological changes and subjective judgement
  – Hand-glove interface measurement (palm adapter)
  – On-the-hand measurements: biodynamic responses of the hand-arm system and validity of measuring at specified points along the hand-arm system
  – On-the-hand measurements: alternative methods for testing effectiveness of gloves
Industry Study

• Questionnaire on self-reported symptoms
  – Identified:
    • Self-reported symptoms
    • Workgroups with highest prevalence of symptoms
      – Study population – 12 workers for each tool
    • Tools these workgroups used
      – 7 tools identified

• 4 anti-vibration gloves plus ‘normal’ glove
• Workshop conditions simulating usual work activities
1” D handle
1” pistol
½” pistol
Rivet Buster
7” air grinder
5” electric grinder
Air Drill
Impacto
Elliott
Decade
Ansell
Leather
Hyd-tuff
Samples of postures adopted during accelerometer testing for (left to right) impact wrench, grinder, rivet buster and air drill
Recommendations

• Investigate the influence of:
  – Variables on results of ISO10819
    • Body mass, hand size, temperature, humidity, grip and feed forces, posture and stance
  – BMI on vibration transfer in the hand-arm system
  – Hand-size on contact forces on vibrating tools
  – Contact forces on effectiveness of gloves
  – Position / posture of shoulder, elbow and wrist on vibration transfer in the hand-arm system
  – Temperature / humidity on vibration isolation performance of dampening materials
  – Longevity of dampening materials
Recommendations

• Investigate prevalence of HAVS in warmer climates and consider co-existence of CTS
• Challenge the relevance of guidelines based on prevalence of VWF
• Investigate correlations between HAVS and NIHL
Questions?

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