Appendix: Full Overheads
LECTURE 1: OVERVIEW AND OBJECTIVES

Teacher’s notes

Overhead 1.1.  Basic concept of vibration
Overhead 1.2.  Occupational exposure to vibration
Overhead 1.3.  Example of a HAV exposure (1)
Overhead 1.4.  Example of a HAV exposure (2)
Overhead 1.5.  Example of a HAV exposure (3)
Overhead 1.6.  Example of a HAV exposure (4)
Overhead 1.7.  Example of a HAV exposure (5)
Overhead 1.8.  Effect categories of exposure to HAV
Overhead 1.9.  Effects of exposure to HAV (symptom summary)
Overhead 1.10. Objectives of the course

Suggested study activities

List and discuss possible sources of HAV at your own workplace.
Basic concept of vibration

By vibration is meant that an object swings to and from around a rest position A (point of equilibrium) between the end points (B and C).

Physical measurements needed to describe the motion:

- The size of the oscillation (level, amplitude)
- The number of oscillation occur per second (frequency)
- The type of oscillation
- Time during which the oscillation occurs
Occupational exposure to vibration

Hand-arm vibration (HAV)  Whole-Body vibration (WBV)

Example of a HAV exposure (1)

Ballast stop machine

- Heavy weight (30 – 50 kg)
- Low frequency (<100 Hz)
- Expose hands, arm and upper body.
- Construction workers
Example of a HAV exposure (2)

**Chain saw**

- Middle weight (about 5 kg)
- Frequency (around 100 Hz)
- Expose both hands and arm
- Forestry workers

Example of a HAV exposure (3)

**Straight grinder**

- Low weight (few kg)
- Frequency (100 - 150 Hz)
- Expose both hands and arm
- Mechanic workshop workers
Example of a HAV exposure (4)

Dental High-Speed Drill

- Very low weight (a few hg)
- Frequency (around 1000 Hz)
- Expose only fingers in contact with the hand piece
- Dentists

Example of a HAV exposure (5)

Ultrasonic Therapy Device

- Very low weight (a few hg)
- Frequency (above 10000 Hz)
- Expose skin and superficial tissue layers of fingers in contact with the device
- Physiotherapists
Effect categories of exposure to HAV

• **Vascular disturbances**
  - Vibration White Fingers (VWF)

• **Neurological disturbances**
  - Numbness
  - Reduced tactile sensitivity
  - Reduced manual dexterity

• **Effect on the locomotor system**
  - Muscles
  - Bones
  - Joints
  - Tendons

• **Comfort and performance**

Example of exposure to HAV (symptom summary)

Exposed hand may become:

- clumsy
- "blind"
- white
- "dead"
- stiff
- cold
- numb
- ...and more...
The objectives of the course

- To raise awareness of health risks associated with occupational exposure to vibration;
- To provide fundamental information on hazards and management practices for health and risk assessment;
- To provide a foundation for the formulation of policies, the development or improvement of legislation, and production of technical and medical guidelines;
- To promote the application of health and risk factor surveillance;
- To encourage the development of good working environments, management practices, and technologies;
- To enable participants to develop their own vibration management plans and training programs.
LECTURE 2: PHYSICAL CHARACTERISTICS

Teacher’s notes

Overhead 2.1. Basic concepts and definitions
Overhead 2.2. Vibration motion
Overhead 2.3. Vibration level
Overhead 2.4. Vibration type
Overhead 2.5. Vibration frequency and analysis
Overhead 2.6. Summation and weighting
Overhead 2.7. Vibration directions
Overhead 2.8. Duration (exposure time)

Suggested study activities

Try to calculate the 8-hour equivalent acceleration if we have a tool acceleration of 10 m/s² and the exposure time is 2 hours.

This could be calculated by using formula 2.6:

\[ a_{eq(8)} = \sqrt{\frac{T}{8}} \cdot a_T = \sqrt{\frac{2}{8}} \cdot 10 \]

The 8-hour equivalent acceleration is 5 m/s².
Basic concept of vibration

By vibration is meant that an object swings to and from around a rest position A (point of equilibrium) between the end points (B and C).

Physical measurements needed to describe the motion:

- The size of the oscillation (level, amplitude)
- The number of oscillation occur per second (frequency)
- The type of oscillation
- Time during which the oscillation occurs.
Vibration motion

The objects motion can also be describe as how the amplitude changes over time.

Vibration level

The peak and effective mean (RMS) values of the acceleration.
Vibration type

Relationship between different vibrations shown in the time schedule and corresponding representation on the frequency plan.

Vibration frequency and analysis

$\frac{1}{T}$
Frequency summation and weighting

\[ a = \sqrt{\sum_{n=1}^{i} a_i^2} \]

\[ a = \sqrt{\sum_{n=1}^{i} (K_i \cdot a_i)^2} \]

\( a \) is the sum of the acceleration and \( a_i \) the acceleration for the \( i \) frequency band.

\( a \) is the sum of the frequency weighted acceleration, \( a_i \) the acceleration for the \( i \) frequency band and \( K_i \) the weighting factor for the \( i \) frequency band.

Vibration direction

The vibration’s summation vector, \( a_v \),

\[ a_v = \sqrt{a_x^2 + a_y^2 + a_z^2} \]

\( a_x, a_y, \) and \( a_z \) are the acceleration in the \( x, y \) and \( z \) directions respectively.
Duration (exposure time)

The equivalent 8-hour acceleration

\[ a_{eq(8)} = \sqrt{\frac{T}{8}} \cdot a_T \]

\( a_{eq(8)} \) is the 8-hour equivalent acceleration, \( T \) the actual exposure time in hours and \( a_T \) acceleration during the period \( T \) hours.
Lecture 3: The effects on human performance

Teacher’s notes

Overhead 3.1. Effects on human performance
Overhead 3.2. The motor control problem (1)
Overhead 3.3. The motor control problem (2)
Overhead 3.4. Combating the motor control problem (1)
Overhead 3.5. Combating the motor control problem (2)
Overhead 3.6. The tactile problem (1)
Overhead 3.7. The tactile problem (2)
Overhead 3.8. Combating the tactile problem

Suggested study activities

Two point threshold demonstration

Both motor and tactile effects on performance can be demonstrated by allowing the students to operate a hand held tool for a while and then having them perform tasks that require precision or good finger sensitivity. For example, before using a power tool ask students to check their two-point threshold. A two-point threshold is the distance that is needed in order for the perceiver to feel that there are two distinct objects touching the skin surface. During a medical exam, thin, round plastic strands with dull ends are often used for such threshold determinations, but any similar type of items may be used in this demonstration. For example, you could use pen or pencil tips or the ends of wooden matches.

Start by placing the two objects very close (almost touching each other) on the surface of one finger. Both objects should touch the finger surface at the same time. When asked, the students will probably respond that they felt only one point of contact. Begin moving the objects slightly apart each time until the student can feel two distinct objects. Measure the distance between the two objects; this is the two-point threshold for this person. Now let the students work with a power tool for approximately 5 minutes. Afterwards, measure the two-point threshold again. Has it changed? What happens if you measure the two-point threshold several minutes after stopping work with a power tool? If you increase the work time to 10 minutes, what happens to the threshold?
Effects on human performance

- The motor control problem - vibration may make it difficult to maintain control over the instrument or tool being used.
- The tactile problem - both short and long term exposure to hand-arm vibration may cause a loss of sensitivity in the fingers and hand.
The motor control problem (1)

• The **proprioceptive system** conveys information about the joint angles. The brain calculates the position in space of the hand or arm.

• The **kinaesthetic system** conveys a sense of motion of the limbs to the brain. This information is necessary for the brain to coordinate motion.

The motor control problem (2)

Because most tasks become more difficult to complete the worker has to devote more mental effort to the task, which in turn:

• Increases the likelihood of accidents and injuries

• Decreases the comfort level experienced by the worker

• Mental fatigue reduces the amount of time that worker can continue to work in such an environment.
Combating the motor control problem (1)

• Avoid or minimize exposure
• Isolate or dampen the vibration
  – Machine side - Changes can be made to the tool or instrument, e.g. adding better grip to tool
  – User side - These interventions can include teaching workers better grips and working positions.

Combating the motor control problem (2)

• Training can improve performance on almost any motor skill.
• Accuracy in a skilled motor task can be improved by increasing the amount time available to complete the task.
The tactile problem (1)

• The result of prolonged exposure and are most problematic in fine motor activity.
• Typically, tactile problems are most obvious directly after exposure.

The tactile problem (2)

• The loss of sensitivity in the fingers makes it more difficult to make judgments of texture, weight and form of the objects being handled.
• In extreme cases, permanent damage may occur and sensitivity will never return.
Combating the tactile problem

• Eliminating or minimize the exposure
• Ensure proper recovery times.
• Complete as many fine motor movements as possible before using power tools.
• Looking directly at the hands while performing a task can compensate for some sensitivity loss.
LECTURE 4: EFFECTS ON HUMAN BODY - VASCULAR SYSTEM

Teacher’s notes

Overhead 4.1. Work with vibrating machines
Overhead 4.2. Hand-arm vibration syndrome (HAVS)
Overhead 4.3. Vibration and the upper extremity
Overhead 4.4. Temporary vascular effects
Overhead 4.5. Permanent effects: Vibration white fingers
Overhead 4.6. What goes wrong?
Overhead 4.7. Regulation of the peripheral vascular system
Overhead 4.8. Vascular system of the upper extremity
Overhead 4.9. Who is at risk for VWF?
Overhead 4.10. What could elicit the vascular symptoms?
Overhead 4.11. What modifies the vascular symptoms?
Overhead 4.12. Possible disability and handicap
Overhead 4.13. What will the physician do?
Overhead 4.15. Assessment of the medical history
Overhead 4.16. Staging of the vascular symptoms (1)
Overhead 4.17. Staging of the vascular symptoms (2)
Overhead 4.18. Assessment of physical status
Overhead 4.19. Assessment with laboratory tests
Overhead 4.20. Other causes of “white fingers”
Overhead 4.21. Clinical evaluation of vascular symptoms
Overhead 4.22. Management and treatment of vascular effects
Overhead 4.23. Prognosis for vascular symptoms

Suggested study activities

Assess finger temperature before and after exposure to vibrating tools and before and after tobacco use and in combination.
Work with vibrating machines

Health hazards:

- Hand-arm vibration syndrome
- Vibration-related upper extremity disorders
- Work-related musculoskeletal disorders
- Stress-related health effects
- Noise-related hearing loss
- Dust-related lung disorders
- Vapour-related skin or mucous disorders.
Hand-arm vibration syndrome (HAVS)

- Shift in vascular function
  “Vibration White Fingers” (VWF)
- Shift in neurosensory function
- Shift in musculoskeletal function

Collectively addressed as: “Hand-arm vibration syndrome” (HAVS)

Vibration and the upper extremity

Red colour indicate area under impact of vibration.
Temporary vascular effects

Vibration source:

• Close effects
• Remote effects

Permanent effects: Vibration white fingers “VWF”

“Secondary Raynaud's Phenomenon”
What goes wrong?

Regulation of the peripheral vascular system

Central Autonomic system

Stress
Noise
Emotion

Temperature
Vibration

Local: endothelial
Vascular system of the upper extremity

Who is at risk for VWF?

- Exposed to vibration?
- Within latency time to contract symptoms?
- Are some people more susceptible?
- What about age?
- What about the use of tobacco?
- What about climate?
What could elicit the vascular symptoms?

- Exposure to cold
- Exposure to cold damp, high humidity and water
- Stress
- Vibration
- Local pressure and stress on the hands

What modifies the vascular symptoms?

- Time of day
- Stress level
- Nutrition
- Nicotine use
- Metabolic activity
- Blood pressure
- Medication
Possible disability and handicap

- Difficulty in performing manual tasks
- Difficulty in withstanding cold and damp
- Difficulty in withstanding exposure to vibration
- Difficulty in withstanding stress
- Restrictions due to pain, or loss of function

What will the physician do?

- Assess occupational and medical history
- Assess physical examination status
- Assess laboratory tests
- Care for possible treatment and management
- Inform on:
  - prognosis
  - contributory factors
  - factors affecting improvement of symptoms
  - preventive measures
  - workers-compensation and litigation.
Assessment of the occupational history

- Vibration exposure
- Ergonomic exposure
- Other vasoactive exposures: (e.g. lead, polyvinyl chloride, stress)

Assessment of the medical history

- Symptom description
- Times and durations
- Other diseases
- Colour chart
- Medication
- Tobacco use
### Staging of the vascular symptoms (1)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-</td>
<td>No attacks</td>
</tr>
<tr>
<td>1</td>
<td>Mild</td>
<td>Occasional attacks affecting only the tip of one or more fingers</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
<td>Occasional attacks affecting distal and medial (rarely also proximal) phalanges of one or more fingers</td>
</tr>
<tr>
<td>3</td>
<td>Severe</td>
<td>Frequent attacks affecting all phalanges of most fingers</td>
</tr>
<tr>
<td>4</td>
<td>Very severe</td>
<td>Symptoms identified in stage 3 and addition trophic skin changes in the fingertips</td>
</tr>
</tbody>
</table>

### Staging of the vascular symptoms (2)

- Trophic skin

04 EFFECTS ON HUMAN BODY - VASCULAR SYSTEM
A TEACHING GUIDE ON HEALTH EFFECTS, RISK ASSESSMENT AND PREVENTION: OCCUPATIONAL EXPOSURE TO HAND-TRANSMITTED VIBRATION
Assessment of physical status

In addition to a general screening the physical examination is specifically focused on:

- The appearance of the distal parts of the hands and fingers including possible scarring, trophies, or nail aberrations
- The peripheral vascular system
- Provocation tests of vascular patency
- The cardiovascular system
- Signs of other diseases associated to Raynaud's phenomenon

Assessment with laboratory tests

Cold provocation tests
Increased sensitivity of the peripheral vascular system as presented by episodes of white fingers is assessed by standardised cooling and measurement of re-warming or by comparison of distal blood pressure before and after cooling (Critical Opening Pressure).

Chemical laboratory screening
Because rheumatologic diseases are related to an increased risk of Raynaud's syndrome sedimentation rate could be used as one rough screening test.
Other causes of “white fingers”

- Primary Raynauds phenomenon
- Other diseases;
  - Obstructive vascular disease
  - Connective tissue disease
- Medication;
  - Heart and blood pressure
  - Asthma
- Other occupational exposures;
  - lead, vinyl chloride, arsenic
- Trauma or compression

Clinical evaluation of vascular symptoms

- Are the vascular symptoms consistent with secondary Raynaud’s phenomenon?
- Are the vibration exposure characteristics consistent with hand-arm vibration syndrome?
- Are there any other confounding exposures?
- What stage should the symptoms be classified as?
- The demands on diagnostic precision depends on the aim of the investigation.
Management and treatment

- Primary prevention by exposure reduction.
- Secondary prevention by actions that could modify symptoms; reduce tobacco use, stress management, heating, nutrition, noise reduction, optimized work technique.
- Possible medical treatment restricted to specific cases.
- Documentation for workers compensation.

Prognosis for vascular symptoms

- Improvement after discontinued exposure to vibration.
- Almost every other diseased could reach improvement.
- The chance for improvement is higher for subjects with low stage classification, few exposure years and low age.
- Continued tobacco use after cessation of exposure still results in an unfavourable prognosis.
LECTURE 5: EFFECTS ON HUMAN BODY - NEUROSENSORY SYSTEM

Teacher’s notes

Overhead 5.1. Work, vibration & the neurosensory system
Overhead 5.2. Temporary neurosensory effects
Overhead 5.3. Permanent effects: neurosensory shift
Overhead 5.4. Neurosensory system
Overhead 5.5. Motor system
Overhead 5.6. What goes wrong (1)?
Overhead 5.7. What goes wrong (2)?
Overhead 5.8. Who is at risk for neurological effects?
Overhead 5.9. What elicits the neurosensory symptoms?
Overhead 5.10. What modifies the neurosensory symptoms?
Overhead 5.11. Possible disability and handicap
Overhead 5.12. What will the physician do?
Overhead 5.13. Assessment of the occupational history
Overhead 5.14. Assessment of the medical history
Overhead 5.15. Staging of neurosensory symptoms
Overhead 5.16. Assessment of physical status
Overhead 5.17. Assessment with laboratory tests
Overhead 5.18. Other causes of “neuropathy”
Overhead 5.19. Clinical evaluation of neurosensory effects
Overhead 5.20. Management & treatment of nerve effects
Overhead 5.21. Prognosis of neurosensory effects

Suggested study activities

With open eyes, try to put your second fingertip on three predefined spots.
With your eyes blindfolded and with simultaneous exposure to vibration, try to point to these spots. Do you notice any differences?
Work, vibration, & the neurosensory system

- Close effects
- Remote effects
- Stress and pressure
**Temporary neurosensory effects**

- Reduced sensibility due to:
  - Temporary threshold shift
- Reduced motor control due to:
  - The tonic vibration reflex
  - Impaired proprioception
  - Impaired sensibility

---

**Permanent effects: neurosensory shift**

- **Symptoms**
  - **Negative manifestations:**
    - Loss of manual dexterity
    - Loss of sensibility
  - **Positive manifestations:**
    - Symptoms of “Pain, tingling, numbness”
  - **Provocable manifestations:**
    - Symptoms elicited only in specific postures, tasks
- **Self-reported signs**
  - Shift in neurosensory function
- **Clinical findings**
Neurosensory system

Motor system
What goes wrong (1)?

What goes wrong (2)?

Sites of possible Entrapment

Sweat gland

Meissner corpuscle
Pacinian corpuscle
Ruffin’s corpuscle
Merkel’s disks
Free nerve endings

Median nerve
Ulnar nerve

05 EFFECTS ON HUMAN BODY - NEUROSENSORY SYSTEM
A TEACHING GUIDE ON HEALTH EFFECTS, RISK ASSESSMENT AND PREVENTION: OCCUPATIONAL EXPOSURE TO HAND-TRANSMITTED VIBRATION

39
Who is at risk for neurological effects?

- Exposed to work with vibrating machines?
- Within latency times to contract symptoms?
- Are some people more susceptible?
- What about the use of alcohol?
- What about age?
- What about body constitution or injuries?

What elicits the neurosensory symptoms?

- Demands revealing reduced function or impairment
- Exposure to local stress
- Exposure to cold
What modifies the neurosensory symptoms?

- Other neurosensory disorders or diseases
- Ambient temperature
- Time of day
  - Night-time redistribution of vascular body volumes

Possible disability and handicap

- Difficulty in performing manual tasks
- Restrictions due to pain, or loss of function
- Difficulty in withstanding cold and damp due to pain
What will the physician do?

- Assess occupational and medical history
- Assess physical examination status
- Assess laboratory tests
- Care for possible treatment and management
- Inform on:
  - prognosis
  - contributory factors
  - factors affecting improvement of symptoms
  - preventive measures
  - workers compensation and litigation

Assessment of the occupational history

1. With reference to vibration exposure
2. With reference to other ergonomic load factors
3. With reference to other exposures with possible influence the neurological system (Neurotoxic agents)
Assessment of the medical history

- Symptom description
- Times and durations
- Other diseases
- Medication

Staging of neurosensory symptoms

<table>
<thead>
<tr>
<th>Stage</th>
<th>Symptoms and signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>0SN</td>
<td>Exposed to vibration but no symptoms</td>
</tr>
<tr>
<td>1SN</td>
<td>Intermittent numbness with or without tingling</td>
</tr>
<tr>
<td>2SN</td>
<td>Intermittent or persistent numbness, reduced</td>
</tr>
<tr>
<td></td>
<td>sensory perception</td>
</tr>
<tr>
<td>3SN</td>
<td>Intermittent or persistent numbness, reduced</td>
</tr>
<tr>
<td></td>
<td>tactile discrimination and/or manipulative dexterity</td>
</tr>
</tbody>
</table>
Assessment of physical status

Besides from a general screening the physical examination is specifically focused on:

• The neurological system
  - The peripheral sensory system (touch, pain, thermal perception)
  - The motor system
  - The appearance of the distal parts of the hands and fingers including muscle and nerve aberrations
  - Provocation tests

• Signs of other diseases associated to mono- or polyneuropathy

Assessment with laboratory tests

• Quantitative sensory testing (QST)
  – Thermal perception
  – Vibratory perception

• Electro diagnostic methods
  – Electroneurography
  – Electromyography

• Chemical screening
  – Chemical laboratory screening
Other causes of “neuropathy”

- Focal neuropathies
  - Compression and entrapment
- Ischaemia
- Other diseases
  - Endocrine-/metabolic-disorders, infections, immune states
  - Genetically determined disorders
- Drugs, and pharmaceutical agents
- Neurotoxic agents, toxins, solvents, metals

Clinical evaluation of neurosensory effects

- Are the symptoms consistent with local or polyneuropathy?
- Are the vibration exposure characteristics consistent with the disorder?
- Are there other confounding exposures?
- What stage should the neurosensory symptoms be classified as?
- The demands for diagnostic precision depends on the aim of the neurosensorial work-up
Management & treatment of nerve effects

• Primary prevention by exposure reduction.

• Information on personal prevention actions that could modify exposure (e.g. local- stress, ergonomic work technique, posture)

• Possible surgical intervention or medical treatment

• Possible documentation for workers compensation or litigation

Prognosis of neurosensory effects

• After discontinued exposure to vibration:

• Positive manifestations such as tingling, pain could in mild cases be improved

• The chance for improvement is inconsiderable in severe cases where structural changes has appeared

• Continued exposure at work results in an unfavourable prognosis
LECTURE 6: EFFECTS ON HUMAN BODY - MUSCULOSKELETAL SYSTEM

Teacher’s notes

Overhead 6.1. Work, vibration, and the musculoskeletal system
Overhead 6.2. Temporary musculoskeletal effects
Overhead 6.3. Permanent musculoskeletal shift
Overhead 6.4. Musculoskeletal system
Overhead 6.5. Manifestations of musculoskeletal shift
Overhead 6.6. What goes wrong?
Overhead 6.7. Who is at risk for musculoskeletal effects?
Overhead 6.8. What elicits musculoskeletal symptoms?
Overhead 6.9. What modifies musculoskeletal symptoms?
Overhead 6.10. Possible disability and handicap
Overhead 6.11. What will the physician do?
Overhead 6.12. Assessment of the occupational history
Overhead 6.13. Assessment of the medical history
Overhead 6.15. Assessment of physical status
Overhead 6.16. Assessment with laboratory tests
Overhead 6.17. Other causes of “musculoskeletal” disorders
Overhead 6.18. Clinical evaluation of musculoskeletal effects
Overhead 6.19. Management & treatment of musculoskeletal effects
Overhead 6.20. Prognosis of musculoskeletal effects
Work, vibration & the musculoskeletal system
Temporary neurosensory effects

- Reduced motor control
- Temporary increase of strength
- Reduced endurance

Permanent musculoskeletal shift

- Shift in muscular function
  - Reduced neuromuscular function
  - Loss of manual dexterity
- Shift in joint and bone function
  - “Pain”
- Osteoarthritis
Manifestations of musculoskeletal shift

- **Symptoms and signs:**
  - Reduced force and muscular function
  - Reduced manual dexterity
  - Possible muscular pain or tendonitis
  - Symptoms of arthritis from joints
  - Joint or tendon degeneration
  - Tendon disorders: Dupuytan´s contracture

- **Clinical laboratory findings:**
  - X-ray (osteoarthritis?)
What goes wrong?

Who is at risk for musculoskeletal effects?

- Exposed to work with vibrating machines?
- Intensive vibration exposure of high magnitude, low frequency or percussive character, sustained over long time.
What elicits musculoskeletal symptoms?

• Muscular
  - Increased, sustained muscular load

• Joints
  - Intensive, percussive vibration exposure
  - Local pressure, increased, sustained load

What modifies musculoskeletal symptoms?

• Ergonomic loads

• Time of day
  - Morning stiffness

• Excitability
  - Somatosensory pain system
Possible disability and handicap

- Difficulty in performing manual tasks
- Difficulty in exerting force
- Restrictions due to pain, or loss of function

What will the physician do?

- Assess occupational and medical history
- Assess physical examination status
- Assess laboratory tests
- Care for possible treatment and management
- Inform on:
  - prognosis
  - contributory factors
  - factors affecting improvement of symptoms
  - preventive measures
  - workers compensation and litigation.
Assessment of the occupational history

1. With reference to vibration exposure
2. With reference to other ergonomic load factors
3. With reference to other exposures with possible influence the neurological system (Neurotoxic agents)

Assessment of the medical history

- Symptom description
- Times and durations
- Aggravating and relieving activities
Staging of musculoskeletal symptoms

- Assessment of medical history.
- As yet, there is no present staging of musculoskeletal symptoms

Assessment of physical status

The physical examination is specifically focused on:

- The locomotor system
  - muscles, tendons
  - joints
  - bone structures
- Signs of other diseases
Assessment with laboratory tests

- Imaging
  - Radiographic imaging
  - Magnetic resonance imaging

- Electro-diagnostic methods
  - Electromyography

- Chemical screening
  - Chemical laboratory screening for inflammatory diseases

Other causes of “musculoskeletal” disorders

- Work related neuromusculoskeletal disorders
- Stress related muscular strain
- Inflammatory diseases
Clinical evaluation of musculoskeletal effects

- Are the symptoms consistent with arthritis, tendonitis, myopathy?

- Are the vibration exposure characteristics consistent with the hand-arm vibration syndrome?

- Are there any other confounding exposures?

- How can the magnitude of the disorder be classified?

Management and treatment

- Primary prevention by exposure reduction.

- Information on personal prevention actions that could modify load (e.g. posture, ergonomic work technique)

- Possible surgical intervention or medical treatment

- Possible documentation for workers compensation or litigation
Prognosis of musculoskeletal effects

- If discontinued exposure to work with vibration

- The chance for improvement is inconsiderable in severe cases where structural changes has appeared

- If continued work with vibration exposure
LECTURE 7: MEASUREMENT AND RISK ASSESSMENTS

Teacher’s notes

Overhead 7.1. Measurement and risk assessments
Overhead 7.2. Measurement and evaluation strategy
Overhead 7.3. Identifying the operations
Overhead 7.4. Daily exposure time
Overhead 7.5. Duration of vibration measurements
Overhead 7.6. Choice of accelerometer
Overhead 7.7. Accelerometer mounting and position
Overhead 7.8. Measurement directions
Overhead 7.9. Frequency range and weighting
Overhead 7.10. Measurement equipment
Overhead 7.11. Eliminating sources of uncertainty
Overhead 7.12. Calculating the 8-hour energy-equivalent vibration
Overhead 7.13. Risk assessments
Measurement and risk assessments

International Standard ISO 5349.
Part 1 General requirements
Part 2 Practical guidelines for measurement at the workplace

ISO 5349 is based on the measurement of vibration magnitude (m/s²) and exposure times (hours)
Measurement and evaluation strategy

- Identifying the vibrating operations
- Evaluation of the daily exposure time
- Selection of operations to be measured
- Measuring the frequency weighted acceleration
- Calculating the 8-hour energy-equivalent acceleration
- Risk assessment

Identifying the operations

Identify the sources of the vibration, operations, machines, tools
Daily exposure time

Evaluation of the daily exposure time

Stopwatch
Time Study

Duration of vibration measurements

Measurement of vibration exposures from more than one hand-held tool
Choice of accelerometer

Accelerometer weight less than 5% of the mass of that part of the structure on which the accelerometer is mounted.

Accelerometer mounting and position

Example of accelerometer mounting positions.
Measurement directions

Frequency range and weighting

Frequency range: 5 Hz to 1500 Hz.

Frequency weighting according to ISO 5349-1
Measurement equipment

Eliminating sources of uncertainty

• Most common sources of uncertainty:
  - cable connector problems
  - triboelectric effect
  - DC-shift
Calculating the 8-hour energy-equivalent vibration

The equivalent 8-hour acceleration

\[ a_{eq(8)} = \sqrt{\frac{T}{8}} \cdot a_T \]

\( a_{eq(8)} \) is the 8-hour equivalent acceleration, \( T \) the actual exposure time in hours and \( a_T \) acceleration during the period \( T \) hours.

Risk assessments

- Vibration exposure for predicted 10% prevalence of vibration-induced white finger in a group of exposed persons.
LECTURE 8: HEALTH AND RISK FACTOR SURVEILLANCE

Teacher’s notes

Overhead 8.1. Health and risk factor surveillance (HRFS)
Overhead 8.2. Definition of surveillance
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Suggested study activities

Identify and discuss possible methods for risk factor data collection in your country and at your workplace.

How can HRFS be implemented at your workplace?
Health and risk factor surveillance (HRFS)

- Aim for early detection of signs and symptoms
- Part of a health and safety program
- Stand alone activity
- Important tool to preserve or improve health and productivity
Definition of surveillance

• Health and risk factor surveillance (HRFS) is the ongoing systematic collection, analysis and interpretation of health and exposure data in the process of describing and monitoring a health event.

Purpose of surveillance

• Surveillance data are used to:
  - determine the need for occupational safety and health action
  - plan, implement and evaluate ergonomic interventions and programs
Nine goals with surveillance

- Identify new or previously unrecognised problem
- Determine the magnitude of the disorder
- Identify occupational groups, departments, work sites to target control measures
- Track trends over time
- Describe health and risk factors for management and work sites to initiate preventative changes
- Identify potential control measures by observing low risk groups
- Basis for prioritising preventative actions
- Evaluate the progress of preventative actions
- Generate hypotheses for research

Benefits with surveillance

- A good tool for improving workers’ health and well-being
- Possibility to monitor incidence of sick leave
- Prompt the employer to undertake preventative actions reveal earnings for the company
- Identification of work sites with production problems
- Increase production and quality
Data Collection instruments

• There are in principal two methods for collecting surveillance data:

  Passive - relies on information in existing data
  Active - involves active seeking of information using specifically designed methods

• Which are characterized by practicality, uniformity, rapidity rather than full accuracy

Health surveillance

• Pre-employment examination:
  - Obtain baseline health data
  - Verify presence of possible medical contra-indications for HAVD
  - Make awareness of the risk for developing HAVD
  - Includes case history, physical examination and, if necessary screening test and special diagnostic investigations

• Periodic health surveillance assessments follow regularly
Risk factor surveillance

• Pre-employment risk factor examination:
  - Estimation of expected vibration exposure by using passive RFS methods
  - Workplace measurements may be needed
  - Workplace or job intervention if expected vibration exposure is too high

• Periodic risk factor surveillance assessments should follow regularly

HAV HFRS: Flow chart for step 1
HAV HFRS: Flow chart for step 2

HAVD surveillance: Symptom questionnaire
RF surveillance: Job analysis

No action

+ HAVD - RF
- HAVD + RF
+ HAVD + RF
- HAVD - RF

HAV HFRS: Flow chart for step 3

Health interviews
Physical exam

Referral to doctor and medical management if indicated

When no

Work place / job intervention

Examine success of intervention

RF? Yes* No

Do step1 every 2 years or if change in workplace

No action
Surveillance case definitions

- To be able to apply a HRFS model surveillance case definitions are needed for exposure (+/- RF) as well as symptoms (+/- HAVD).

- At present, no consensus on case definitions exists.

- In the mean time the following case definition is suggested:
  Exposure: A +RF is defined as an 8-hour equivalent acceleration level above 1 m/s² (ISO 5349-1).

- Symptoms: A +HAVD is defined as SN1 for neurological symptoms and Stage 1 for vascular symptoms (Stockholm workshop scales).

- For musculo-skeletal symptoms no scale or staging is available so the decision must be based on the doctor's own evaluation of symptoms and signs.

Ethical and legal aspects on HRFS

- The employers should provide a HFRS program for their employees and necessary facilities for running it.

- The management of the HFRS program should be under the supervision of persons with certified training.

- The ICOH Code of Ethics for Occupational Health Professionals provides guidance for ethical and legal aspects on HRFS.
Reporting

• It is very important that surveillance results are documented and/or reported.

• This can, however, be done in many different ways, from a simple oral report to the employer to an extensive written report and/or detailed discussions with employer and employees in order to initiate and promote preventative measures.
LECTURE 9: PREVENTATIVE MEASURES

Teacher’s notes

Overhead 9.1. Preventative measures
Overhead 9.2. Alternative production techniques
Overhead 9.3. Design and layout of workplaces and workstations
Overhead 9.4. Reduce exposure times to minimise prolonged exposure
Overhead 9.5. Choose the right handheld tool
Overhead 9.6. Choose the right accessories
Overhead 9.7. Reducing vibration on existing machines
Overhead 9.8. Replacing and/or buying a new machine
Overhead 9.9. Service and maintenance
Overhead 9.10. Training and work techniques
Overhead 9.11. Personal safety equipment

Suggested study activities

List and discuss possible preventative measures at your own workplace.
Preventative measures

Reduce or avoid exposure by:

- Alternative production techniques
- Design and layout of workplaces and work stations
- Avoiding prolonged exposure
- Choose the right handheld tool
- Choose the right accessories
- Reducing vibration on existing machines
- Replacing and/or buying a new machine
- Training and work techniques
- Service and maintenance
- Personal safety equipment
Alternative production techniques

• Could the work be done without use of vibrating tools?
• Is other techniques available?
• Could automation or remote control be used?
• Could the work task be achieved in a different way?
• Could the construction be changed?

Design and layout of workplaces/work station

• Always strive for good ergonomic design and layout
• Suitable working positions with no bent wrists
• Reduce the weight of the machine by balancing block
• Store the tools in warm places
Avoiding prolonged exposure

• Spread out the vibration exposure over the whole day
• Introduce work breaks
• Take advantages of job rotation

Choose the right handheld tool

• Is the machine appropriate for the work task?
• Gives the machine a good ergonomic work posture?
Choose the right accessories

- Sharp drills, saw chains, chisels etc
- Good balance in the grinding disc

Reducing vibration on existing machines

- Balance unit for grinding machines
- Anti-vibration support handles
- Clad the machine with insulating material
Replacing and/or buying a new machine

Consider for instance:

- Suitable for intended purpose
- Information about the tool vibration
- Information about the tool efficient
- Good ergonomic machine and handle design
- Insulation against heat and cold
- Starter design and the forces required
- Weight of the machine

Service and maintenance

- Programme for regular service and maintenance of both machine and accessories
- Vibration measurement as part of the inspection routine
Training and work techniques

• Training to use correct and safe work techniques
• Reduced grip and feed forces
• Position of the hand on the machine's handle
• Avoiding to guide for instance the chisel by the hand
• Knowledge about choosing the right accessories

Personal safety equipment

• Personal safety equipment can be helpful although alone they are not the solution to a vibration problem.

Example:
- Anti vibration gloves
- Heated handles
- Warm and weatherproof clothing
- Heating pads
LECTURE 10: LEGAL AND COMPENSATION ASPECTS

Teacher’s notes

Overhead 10.1. Vibration as risk factor
Overhead 10.2. Standards
Overhead 10.3. Standards for vibration
Overhead 10.4. Occupational Exposure Limits (OELs)
Overhead 10.5. Threshold Limit Values (TLVs)
Overhead 10.6. European vibration directive
Overhead 10.7. Compensation aspects 1
Overhead 10.8. Compensation aspects 2

Suggested study activities

Try to find out if there is any occupational exposure limits to vibration in your country and the possibilities for compensation for an occupational disease related to the exposure of hand-transmitted vibration.
Vibration as risk factor

- WHO has classified vibration as an occupational disease
  - labour safety
  - health surveillance
  - compensation.

- ILO has listed vibration as an occupational hazard
  - measures
  - exposure limits
  - supervision
  - medical examination.
Standards

• A standard is a **recommendation** for finding mutually applicable solutions for recurrent problems.

• A global standard is drawn up at worldwide, international level, by the ISO (Intentional Organization for Standardization).

Standards for vibration

• **Example:**

  Appendix with a relationship between daily exposure and finger blanching.

  The contents of the standard are only recommendations and have no legal implications.
Occupational Exposure Limits (OELs)

Threshold Limit Values (TLVs)
European vibration directive

Compensation aspects 1

• Compensation to the worker for:
  – loss of salary
  – physical suffering
  – disability benefits
  – medical care
  – rehabilitation etc.
Compensation aspects 2

• Compensation for an occupational disease could come from:
  - general social insurance system
  - compulsory or voluntary insurance
  - civil court
Practical approaches for environmental or health and safety regulators; occupational health professionals and trainers; occupational health services; and employers and worker representatives

This Teacher’s Guide can be used to assist in the preparation and delivery of a 2-day course, adapted to provide a one-day introductory course, or expanded to 3 days that also include technical visits. The guide contains sufficient resource material to initiate, organize, deliver, and evaluate courses of different lengths. The course material includes overhead transparencies and handouts necessary for lectures and workshops.

Most importantly the present guide stands on its own: it does not require further background information with respect to occupational vibration from hand-held tools, management principles, training, etc. To increase the benefit for the course participants, a course coordinator should include local issues that address concerns such as legal frameworks, general practices, etc. The course coordinator may also want to invite guests or course participants to prepare specific local topics. For example, national authorities could present current legal frameworks or current policies, and occupational health managers could present their general practices. In this case, invited presenters should be contacted well in advance and agree to the presentation.