Hearing and Vestibular Disorders in the Workplace

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Definitions

• **Hearing loss** – loss of sensitivity to sounds between 250 and 8000Hz in one or both ears

• **Tinnitus** – perception of sound in the absence of an external stimulus

• **Dizziness** – lightheadedness

• **Vertigo** – illusion of movement

• **Imbalance** – perception of instability
Epidemiology

• **Hearing loss** ~17% of population
  – 10 million in UK/3.7 m working age
  – 14.5 m by 2031
  – 800K severe/profound HL
    : 4x more likely to be unemployed

• **Tinnitus** ~10% of population
  – 4% present to doctor
  – <1% intrusive and intolerable
  – Higher prevalence in those with HL
  – Intrusiveness more related to psychological than psychoacoustic factors.
Central Auditory Pathway

Unilateral SNHL

Bilateral auditory disorder

Auditory cortex

Brainstem

Cochlear nuclei

Cochlea

Eighth nerve
Normal Hearing

0 dB (0 "decibels")

20 decibels. Between 0 and 20 dB is normal for an adult

50 decibels

90 dB (90 decibels)

www.earinfo.com

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Risk Factors for Acquired Hearing Impairment

• Age
• Gender (M>F)
• Race
• Lower social class
• Hazardous noise
• Smoking
• Head injury
• Hypertension
• Diabetes
• Alcohol
# Causes of Hearing Loss

<table>
<thead>
<tr>
<th>Category</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic</td>
<td>Nonsyndromal, Syndromal</td>
</tr>
<tr>
<td>Trauma</td>
<td>Physical, Barotrauma, Acoustic trauma</td>
</tr>
<tr>
<td>Vascular</td>
<td>Malformation, Cardiovascular ischaemia, Cerebrovascular ischaemia</td>
</tr>
<tr>
<td>Autoimmune</td>
<td>Isolated inner ear disease, Systemic disorder, eg SLE, PAN</td>
</tr>
<tr>
<td>Infection</td>
<td>Bacterial, Viral, Fungal</td>
</tr>
<tr>
<td>Degenerative</td>
<td>Cochlea, Neuropathy, Neurological</td>
</tr>
<tr>
<td>Iatrogenic</td>
<td>Drugs, Surgical, Radiotherapy, Organic chemicals</td>
</tr>
</tbody>
</table>
### WHO descriptors of hearing impairment

<table>
<thead>
<tr>
<th>Grade of impairment</th>
<th>Corresponding audiometric ISO value</th>
<th>Performance</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - No impairment</td>
<td>25 dB or better (better ear)</td>
<td>No or very slight hearing problems. Able to hear whispers.</td>
<td></td>
</tr>
<tr>
<td>1 - Slight /mild impairment</td>
<td>26-40 dB (better ear)</td>
<td>Able to hear and repeat words spoken in normal voice at 1 metre.</td>
<td>Counselling. Hearing aids may be needed.</td>
</tr>
<tr>
<td>2 - Moderate impairment</td>
<td>41-60 dB (better ear)</td>
<td>Able to hear and repeat words spoken in raised voice at 1 metre.</td>
<td>Hearing aids usually recommended.</td>
</tr>
<tr>
<td>3 - Severe impairment</td>
<td>61-80 dB (better ear)</td>
<td>Able to hear some words when shouted into better ear.</td>
<td>Hearing aids needed. If no hearing aids available, lip-reading and signing should be taught.</td>
</tr>
<tr>
<td>4 - Profound impairment</td>
<td>81 dB or greater (better ear)</td>
<td>Unable to hear and understand even a shouted voice.</td>
<td>Hearing aids may help understanding words. Additional rehabilitation needed. Lip-reading and sometimes signing essential.</td>
</tr>
</tbody>
</table>

Grades 2, 3 and 4 are classified as **disabling hearing impairment**.
The audiometric ISO values are averages of values at 500, 1000, 2000, 4000 Hz.
Types of Hearing Impairment

- Conductive HL
- SNHL
- Neural
- Sensory
- VIII nerve
- Central auditory pathway

External → Middle → Internal → VIII nerve

Cochlea → VIII nerve → Brainstem → Cortex

Auditory Processing
Simple Assessment of Hearing Loss?

- Self report
- Whisper test
- Action on Hearing Loss
  “Hearing Check”
- Audioscopy
Auditory Tests

- **PTA** – time consuming, subjective, variable
- **Tympanometry** – objective
- **Otoacoustic emissions** – stable, objective, highly reproducible, quick, dependent upon outer hair cell function, but influenced by middle ear function
- **Evoked potentials** – objective, site of lesion, time consuming.
- **Speech audiometry** – variable, subjective
Speech Audiometry

Curves for normal

% Recognition

0 10 20 30 40 50 60 70 80 90 100

Amplification (dB)

0 10 20 30 40 50 60 70 80 90 100

Conversations (loud)

Conversations (ordinary at 3 ft)

Church level

40% Critical level for words

HPL

ODS

HPLE

A

B

Sentences

Words
Limitations of Pure Tone Audiometry

• Skilled task
• Appropriate environment essential
• Time consuming
• Affected by colds, recent loud noise
• Subjective
• 6-11dB variability
• Measured in 5 dB steps
• no information about site of lesion
Impact of hearing loss

- Specific impacts on communication
- Self image and perception by others
- Associations with generic health-related quality of life
- Personal reaction to the problem
- Occupationally – liability to miss warning noise, moving vehicles or alarms
- Increased risk of accidents
Hearing loss ≠ Disability

- Motivation
- Situation
- Environmental factors
- Experience
- Complexity and predictability
Genetic- “cookie-bite” Audiogram
Conductive Hearing Loss
Age related- Presbyacusis
Noise Induced Hearing Loss

Graphs showing hearing levels (dBISO) vs. frequency (Hz) for the right and left ears.
Relationship of noise level and duration of exposure to NIHL

Taylor 1965
## Sources of hazardous Noise

<table>
<thead>
<tr>
<th>Source</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupational noise</td>
<td>Heavy industry, public services, transport</td>
</tr>
<tr>
<td>Military exposure</td>
<td>Combat, training</td>
</tr>
<tr>
<td>Leisure noise</td>
<td>Discos, PMP, rock concerts, fireworks</td>
</tr>
<tr>
<td>Medical noise</td>
<td>SCBU, bone drills, MRI scanners</td>
</tr>
<tr>
<td>Accidents</td>
<td>Explosions, noise feedback</td>
</tr>
</tbody>
</table>
Prevention of NIHL

• Legislation
• Identification and limitation of risk

• Pre-employment screening programmes
• Identification of subclinical damage
• Therapeutic interventions
• Education
Decisions regarding work

- Individual basis
- Access to Work scheme
- Change of position, compensation, medical retirement – objective testing mandatory
- Maritime and Coastguard Agency - “Hearing Check” + audiometry
- DVLA – for GRP 2 licensing: communication in emergency essential
- Military - PULHHEEMS classification
Management

• Hearing tactics
• Environmental aids + support
• Conductive loss- surgery, bone conduction aid, BAHA
• Bilateral SNHL - digital hearing aids (2, AGC, ANR, localisation)
• Unilateral SNHL- CROS aid
• Profound loss- cochlear implants
Balance

Vision

Vestibular

Integration and modulation

Posture/gait

Perception

VOR
Dizziness/Vertigo

- Vague complaint
- Plethora of causes
- Lack of diagnostic strategy
- Treatment not specific/effective
- Not life-threatening
- Spontaneous resolution
Demographics of Dizziness/Vertigo

- 1/3 population by age of 65 years (Roydhouse, 1974)
- 48% women and 37% men by 80 years (Pemberton, 1956)
- 5/1000 consult GP for vertigo (RCGP/OPCS 1986)
- 10/1000 consult GP for dizziness (RCGP/OPCS 1986)
- 1 in 4 adults in community report dizziness (Yardley et al. 1998)
# Causes of Dizziness

## GENERAL MEDICAL
- **Haematological** - Anaemia  
  Hyperviscosity  
  Miscellaneous
- **Cardiovascular** - Postural hypotension  
  Carotid sinus syndrome  
  Dysrhythmia  
  Mechanical dysfunction
- **Metabolic** - Hypoglycaemia  
  Hyperventilation

## OTOLOGICAL
- Positional nystagmus
- Vestibular neuritis
- Vascular accidents
- Post-traumatic syndrome
- Drug intoxication
- Tumours
- Menière disease
- Infection
- Otosclerosis and Paget’s disease
- Auto-immune disorders

## NEUROLOGICAL

### Supratentorial
- Epilepsy  
  Syncope  
  Psychogenic

### Infratentorial
- Multiple sclerosis  
  VBI  
  Infective disorders  
  Degenerative disorders  
  Tumours  
  Foramen magnum abnormalities

## MISCELLANEOUS
- **Ocular**
- **Multisensory**
Vertigo – Diagnosis in 466 cases

- 27% No vestibular abnormality
- 27% Peripheral Vest. Disorder
- 12% Migraine
- 16% BPPV
- 3% Menière disease
- 3% Central pathologies
- 4% Ear diseases
- 3% CVS causes
- 2% Viral labyrinthitis, psychogenic
- 1% Ocular, acoustic neuroma, multisensory dizziness, vestibular failure.
“Medical” Mechanisms of Vertigo/Dizziness

<table>
<thead>
<tr>
<th>Type</th>
<th>Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presyncopal</td>
<td>Diffuse cerebral ischaemia eg hypotension, cardiac dysrhythmia</td>
</tr>
<tr>
<td>Hypoglycaemic</td>
<td>Low blood glucose eg diabetes mellitus, insulinoma, elevated catecholamines</td>
</tr>
<tr>
<td>Drug induced</td>
<td>CNS depression, cerebellar/labyrinthine toxicity, change in SG of cupula (C\textsubscript{2}H\textsubscript{5}OH)</td>
</tr>
</tbody>
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After Baloh and Honrubia, 2001
"Vestibular" Mechanisms of vertigo/dizziness

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<tr>
<th>Type</th>
<th>Mechanism</th>
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<tr>
<td>Physiological</td>
<td>Sensory conflict due to unusual combination of sensory inputs eg motion</td>
</tr>
<tr>
<td>Vertigo</td>
<td>Imbalance in tonic vestibular signals</td>
</tr>
<tr>
<td>Multisensory</td>
<td>Impairment in 2 or more sensory inputs for balance</td>
</tr>
<tr>
<td>Visual</td>
<td>Mismatch of visual and vestibular signals eg ocular pathology, vestibular asymmetry</td>
</tr>
</tbody>
</table>

After Baloh and Honrubia, 2001
“Neurological” Mechanisms of vertigo/dizziness

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<tr>
<th>Type</th>
<th>Mechanism</th>
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</thead>
<tbody>
<tr>
<td>Psycho-physiological</td>
<td>Impaired central integration of sensory inputs</td>
</tr>
<tr>
<td>Dysequilibrium/ataxia</td>
<td>Loss of neurological function(s): VS, cerebellar, proprioceptive, motor.</td>
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After Baloh and Honrubia, 2001
Diagnosis

- **Triggers:**
  - URTI, head injury, movement, visual stimuli

- **Symptom:** vertigo, dizziness

- **Duration** – each episode, whole problem

- **Associated symptoms:**
  - Headache, vision, palps, anxiety
“Short” Episodes of Vertigo

Vertigo
< 5mins

No associated symptoms: BPPV, BVF, Migraine,

Associated symptoms: Cardiovascular, Atypical MD, Post circulation ischaemia
“Medium” Episodes of Vertigo

Vertigo < 24 hours

- No associated symptoms: Migraine, Decompensation
- Associated symptoms: Meniere Disease, Migraine, TIA
"Long" Episodes of Vertigo

Vertigo > 24 hours

- No associated symptoms: Decompression, Vestibular neuritis
- Associated symptoms: Neurological, Systemic medical, Otological disease
Balance Examination

- Stance and gait
- Eye movements
- Hearing
- Cerebellar signs
- Posterior column signs
- Cardiovascular assessment
- Eye/vision assessment
- Musculoskeletal assessment
Vestibular Tests

- Caloric
- Vestibular evoked myogenic potentials
- Eye movement recording
- Rotation testing
- Optokinetic testing
- Posturography
Equitest Test Conditions

Condition 1  Condition 2  Condition 3

Condition 4  Condition 5  Condition 6

Reproduced from Neurocom, 2002
Peripheral Vestibular Disorder

- Infection
- Vascular
- Autoimmune
- Neoplastic
- Ototoxic
- Traumatic
- Idiopathic
- Genetic
Mismatch Hypothesis of Vertigo

- \text{corollary discharge}
- \text{voluntary motion}

\text{RE-AFFERENCES} \quad \text{EXPECTED AFFERENCES}

\text{CENTRAL STORE}

\text{comparison}

- space constancy
- mismatch
- vertigo

\text{habituation}
Vestibular compensation

- Viral labyrinthitis
- Vascular event
- Trauma

Peripheral vestibular dysfunction and symptoms

- Cerebral compensation
- Asymptomatic state

- Physical or psychological stress

Luxon 1998
Causes of failure of compensation

- Poor eye / head stabilisation
- Inadequate / inappropriate CNS activity
- Disordered perception of stability
- Impaired sensory inputs
- Fluctuating vestibular activity
- Psychological dysfunction
- Impaired / inadequate musculoskeletal functions
- Impaired / inappropriate balance strategies

Luxon (after Herdman) 1998
Psychological, vestibular and physical interactions

- Reduction in social activities
- Inability to work
- Lack of exercise
- Vertigo
- Hyperventilation
- Failure of compensation
- Immobility
- Anxiety
- Phobias
- Depression
- Depression
- Reduction in social activities
- Inability to work
- Lack of exercise
- Vertigo
- Hyperventilation
- Failure of compensation
- Immobility
Poor Vestibular Compensation

![Diagram of balance with phases of recovery and decompensation following a labyrinthine insult.](image)

- **Balance**
  - (Normal) 100%
  - (Severe impairment) 0%
  - Recovery: $\frac{6}{52} - \frac{6}{12}$
  - Decompression: days to weeks
  - Periods of freedom: weeks to months

- **Time**
Poor Vestibular Compensation

(balance)

(normal) 100%

(Severe impairment) 0%

Labyrinthine insult

"Fluctuations"

Time
Poor Vestibular Compensation
Vestibular pathology

- Dizziness/vertigo across age range
- Common symptom both in primary care
- Pathologies in almost all systems
- Broad diagnostic strategy required
- Appropriate diagnostic strategy allows effective management
- Rarely result of psychological factors
- Frequently associated with psychological factors
- Rehabilitation is effective
Work Related Effects

• Personal safety
  – Increased risk of psychological disorder
  – Increased risk of falls
  – DVLA

• Poor attendance
  – Time off
  – Change of job
  – Early retirement

• Productivity reduced
  – Reduced cognition, multitasking, localisation skills
Occupational Summary

• Hearing and balance disorders- hidden handicaps
• Poorly managed medically
• Poor levels of knowledge
• Often bounce between specialties
• Psychological disorders become prominent diagnosis
• Workplace adjustments frequently not in place.
Thank you for your attention
Vestibular Neuritis/
Labyrinthitis

VN – vertigo without cochlear symptoms
Labyrinthitis – vertigo with cochlear symptoms

Age: all ages
Gender: M=F
Vertigo: acute onset

Preceding infection
Unidirectional horizontal nystagmus
Presentation Vestibular Neuritis

- Acute onset
- 2-3 days
  - difficulty moving,
  - nausea, vomiting
  - ± fever
- Gradual recovery 2-6 weeks
Treatment of Acute Episode

• Reassurance and support
• Anti-emetics
  – Buccastem
• Vestibular sedatives
  – Cinnarizine 1-2 days ONLY

Start vestibular exercises
Encourage activity
Failure of vestibular compensation

• Primary and secondary symptoms
  – Neck pain
  – Fatigue
  – Headache
  – Depression/anxiety/avoidance behaviour

• Bizarre symptomatology
Meniere’s Disease

Clinical diagnosis:

- Episodes of acute vertigo
- Hearing loss
- Tinnitus
- (Fullness/pressure)
Migraine

• Common migraine
• Classical Migraine
• Migraine with and without aura
Presentation

- Acute onset
- < 24 hours
- Nausea + vomiting
- ± Headache
- + Photophobia/phonophobia

- Background unsteadiness
- Positional exacerbation
Migraine + Vertigo

- History of migrainous headaches
- Space/motion discomfort
- Phonophobia + photophobia
  (rarely fluctuating hearing loss)
- Unsteadiness
- Variety of vestibular symptoms
- Nausea and vomiting
Treatment of Migrainous Vertigo

• Lifestyle advice

• Treatment of acute attacks
  – Abortive
  – Prophylactic

• Treatment of background unsteadiness/visual vertigo
Benign Paroxysmal Positonal Vertigo (BPPV)

- Short, acute episodes of dizziness
- Critical head position
- Autonomic symptoms
- Clusters of attacks
- Frightening ++++
- Spontaneous remission
History of BPPV

- Turning in bed
- Erratic
- Sleeping on 4 pillows
- Getting things off the shelf in cupboard
- Frightened to go out alone
- Not sleeping well
Hallpike Manoeuvre
Anatomical Disposition of Posterior Semicircular Canal
Treatment of BPPV

- Epley manoeuvre
Chronic Dizziness

- Drugs
- Uncompensated PVD
- Bilateral vestibular failure
- Neurological disorder
- Multiple comorbidities