Acoustic Shock

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A “new” syndrome: pain, tinnitus, balance disturbance and phobic symptoms following exposure to sudden, unexpected noise.
Introduction

- Acoustic shock is a recently recognised clinical entity.
- **Call centers workers** has developing a pattern of both physical and psychological symptoms arising immediately after or soon after exposure to sudden, unexpected noise from headset or handset.
- The majority of reports of acoustic shock have come from Denmark and Australia.
Introduction

- Acoustic shock has become firmly associated with the use of telecommunications equipment.

- It is likely that exposure to other forms of sudden, unexpected sound can generate similar symptoms.

  - However, these types of exposure form a much more heterogeneous set.

  - Largely excluded from formal definitions of the syndrome.
Introduction

- Acoustic shock is unrelated to noise-induced hearing loss

- Repeated exposure to sounds of an intensity greater than 85 dB causes cochlear damage.
Definitions

- International Telecommunications Union and European Transmission Standards Institute

- “Any temporary or permanent disturbance of the functioning of the ear, or of the nervous system, which may be caused to the user of a telephone earphone by a sudden sharp rise in the acoustic pressure produced by it”
Definitions

• The Health Services Australia Group

• “Acoustic shock refers to the combination of exposure to a brief, sudden, unexpected, high frequency, high intensity sound emitted (the stimulus) and the subsequent symptoms (the response) which can develop”

• The causative sound or ‘acoustic incident’:
  • A sudden, unexpected, high-pitched sound of high intensity.
  • It may be emitted from a headset or handset and is commonly reported as a ‘shriek’
Definitions

- In the United Kingdom, the Acoustic Safety Programme
- “An acoustic incident is a sudden, unexpected, noise event which is perceived as loud, transmitted through a telephone or headset”
- “Acoustic shock is an adverse response to an acoustic incident resulting in alteration of auditory function”
Acoustic Incidents

- There are many potential ways that such sounds may arise within a call centre workplace.
  - Faulty telephone or headset equipment
  - Transmission faults within the network.
  - Positive feedback with some cordless and mobile phones.
  - Tones from facsimile machines or modems
  - Maliciously generated sounds: shouting or blowing a whistle into their telephone.
Acoustic Incidents

- Characteristics of the sounds.
  - Intensity and Frequency
    - A Danish study:
      - Intensity: 56 to 108 dB; frequency: 100 Hz to 3.8 kHz.
    - An Australia study:
      - Intensity: 82 to 120 dB; frequency: 2.3 to 3.4 kHz

An investigation of the telephone services of the call centre of TeleDanmark in Aabenraa, 1999

Milhinch JC. Acoustic shock injury: real or imaginary.
Acoustic Incidents

- Characteristics of the sounds.
  - Rise time: very short, varying between 0 and 20 milliseconds.

- Duration: Difficult to estimate
  - Removing a headset from the head takes longer than moving a handset away from the ear
  - It seems likely that wearing a headset carries more risk of incurring acoustic shock.
Clinical Features

• Immediately or soon after exposure to an acoustic incident
  • Ear pain — 81%
  • Tinnitus — 50%
  • Balance problems — 48%
  • Hearing loss — 18.4%

• No statistically significant audiological difference between exposed and non-exposed ears except at a frequency of 1.5 kHz.

Milhinch JC. Acoustic shock injury: real or imaginary.
Clinical Features

- Immediately or soon after exposure to an acoustic incident
- Pain in the neck or jaw — 11%
- Pain in the face — 7%
- Sensation of blockage or aural fullness
- Numbness
Clinical Features

- Longer to emerge
  - Anxiety
  - Depression
  - Headache
  - Sensitivity to previously tolerated sounds (hyperacusis)
  - Hypervigilance
  - Anger

Milhinch JC. Acoustic shock injury: real or imaginary.
Clinical Features

- Examination and tests
  - Mostly normal
  - May have sensorineural hearing loss but may be low/mid frequency rather than 4-6 kHz loss of noise-induced hearing loss
Epidemiology

- There are no reliable data available regarding the prevalence and incidence of acoustic shock.
- Call centre workers at increased risk
  - Increased prevalence in those with stress, smoking, neck and shoulder pain
- However, no evidence of pre-existing psychological or psychiatric morbidity

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Epidemiology

- More women than men even allowing for skewed sex distribution within call centre workplaces

- Exposure to an acoustic incident does not automatically result in the development of acoustic shock symptoms.
Pathophysiology

- The pathophysiological mechanisms underpinning acoustic shock remain obscure.
- Complex and Multifactorial.
  - Middle ear
  - Cochlear
  - Central auditory pathway
  - Psychological mechanisms
Middle Ear

- Protecting the cochlea from intense sound exposure
  - Stapedius muscle and tensor tympani muscle
- Both of these muscles have been implicated in acoustic shock, with a particularly important role proposed for the tensor tympani muscle.
  - Spontaneous contractions of the tensor tympani (similar to blepharospasm) give rise to a fluttering or beating sensation.
- There is evidence that middle-ear muscle function is influenced by the serotoninergic system
  - There is a potential link between emotional state and middle-ear muscle contraction.

Serotoninergic innervation of stapedial and tensor tympani motoneurons. Brain Res 1998;787:175-8
The tensor tympani reflex

Startle reflex

The tensor tympani muscle contracts immediately preceding the sounds produced during self-vocalization

It has an established protective function to loud sounds, assists in the discrimination of low frequency sounds
Middle Ear: Tonic Tensor Tympani Syndrome (TTTS)

- In 1961, Dr. I. Klockhoff

- An involuntary and anxiety-based condition

- The centrally mediated reflex threshold for tensor tympani muscle activity becomes reduced

- Continually and rhythmically contracting and relaxing.

- Physiological reactions in and around the ear without objectively measurable dysfunction or pathology.

Middle Ear: Symptom of TTTS

- Tinnitus

- Rhythmic aural sensations such as clicks and tympanic membrane flutter

- Alterations in ventilation of the middle ear cavity leading to a sense of aural blockage or fullness, a frequent aural “popping” sensation and mild vertigo

- Irritation of the trigeminal nerve innervating the tensor tympani muscle

  - leading to pain, numbness and burning sensations in and around the ear, along the cheek, neck and temporomandibular joint (TMJ) area

Acoustic Shock

- Acoustic shock was defined as an acoustic incident trigger for tinnitus/hyperacusis onset plus the presence of one or more symptoms consistent with TTTS.

- Without underlying aural or TMJ pathology.
Cochlea

• The high incidence of tinnitus in the acoustic shock population may cause one to consider cochlear dysfunction as a potential mechanism

• Paucity of cochlear damage mitigates against cochlear mechanism
Central Auditory System

- Disturbance of central auditory serotonergic pathways may result in altered sound tolerance
  - No involvement of the middle-ear muscles
  - Auditory hypersensitivity (such as hyperacusis and phonophobia) is seen to be due to abnormal function within serotonin pathways
Central Auditory System

- **Medial efferent system dysfunction** has also been suggested as a possible cause of hyperacusis
  - Nerve fibers from the medial efferent system terminate on the outer hair cells in the cochlea.
  - This system has been proposed as being important in modulating auditory gain.
  - Dysfunction of this system could result in the auditory system being kept in a state of abnormally high sensitivity.
  - Such central auditory system mechanisms have the merit of suggesting how acoustic shock could arise without any evidence of accompanying peripheral auditory deficit.
Psychological Mechanisms

- Auditory startle is potentiated by anxiety and arousal.
- It may be that the onset of acoustic shock is triggered by a hyperintense startle to an unanticipated noise.
- Aversive reaction to sound can occur and that this reaction is independent of the intensity of the sound.
- Mediated by the limbic system and autonomic nervous system.
Psychological Mechanisms

- Fear-avoidance pathway
  - Fear of sound can result in avoidance of sound, which in turn causes increased central auditory sensitivity, thereby enhancing the fear.
Prevention

- Output limiters

- Reducing level too much causes intelligibility problems – operative strains to hear and raises central auditory gain.
  - Potentially counterproductive as if high central auditory gain may be more prone to acoustic shock.

- Acoustic incident filtering — awaited firm scientific proof
Prevention

- The call centre environment
- To design low impact working environments
- To utilise working practices that do not cause or exacerbate stress.
- Staff education
  - Set the output level of their headset to the lowest level commensurate with satisfactory speech intelligibility.
Treatment

- One of the common complaints of patients who have experienced an acoustic shock is that their symptoms are ignored or minimised by medical staff.

- Following normal audiological tests, many patients are simply reassured that no damage has been sustained and are dismissed.
Treatment

• Avoid sound by protecting their ears with plugs and muffs.
  • Counter-productive
    • Reducing the amount of incoming auditory information—increasing the hypersensitivity of the auditory system.
  • Tinnitus and hyperacusis model—tinnitus retraining therapy
    • Explanation, counselling, desensitization using low level sound
  • Psychological therapies
    • Conventional psychological tools including cognitive behavioural therapy
  • Job
Summary

- A pattern of symptoms has emerged in people who are exposed to sudden, intense, unexpected noises from telecommunications equipment.
- Clinical picture is often not recognised.
- Therefore under-reported.
Summary

- Distinct from NIHL/acoustic trauma
- Tests often within normal range
- Information is difficult to find and nothing published to date meets evidence based medicine criteria.
- Pathophysiology and management uncertain
Thank You