Epidemiology of tinnitus

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Front row, left to right, seated: Ellis Douek, Patricia House, Mary Meikle, Joan Box

Front row, standing: Abe Shulman, David Kemp, Harold Feldmann, Jonathan Hazell, Ron Goody, Richard Tyler, Charles Berlin, Gloria Reich

Back Row, standing: William Burns, Don Brown, Jurgen Tonndorf, Ross Coles, John House, John Emmett, Jack Vernon, Pat Wilson, Jean-Marie Aran, Ted Evans
Overview

• Introduction
• Prevalence, incidence, and natural history in adults
• Prevalence, incidence, and natural history in childhood
• Clinical questions
• Unanswered research questions
Audiologists Are...
A. Intelligent
B. Funny
C. Attractive
☑ All of the Above
Introduction: definitions

- CDCP
- Epidemiology
  - GK *epi (on), demos (people), logos (study of)*
  - the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems
Introduction: definitions

• Prevalence
  – The number of cases of a particular symptom, condition, or disease in a specific population

• Point prevalence
  – The number of cases of a particular symptom, condition, or disease in a specific population at a specific time

• Incidence
  – The number of new cases arising of a particular symptom, condition, or disease in a specific population over a specific time period
Introduction: definitions

- Natural History
  - the progression of a disease process in an individual over time, in the absence of treatment (CDCP, 2017)
Introduction: definitions

• Tinnitus
  – ‘a sound in the ears or head that occurs in the absence of any external stimulus’ (Baguley et al., 2013)

• Hyperacusis
  – “unusual tolerance to ordinary environmental sounds” (Vernon, 1987)
  – “abnormal reduced tolerance to environmental sound” (Baguley, 2003)
Tinnitus prevalence in adults
Tinnitus in adults

Tyler and Baker (1983)

Davis and Refaie (2000)

CHAPTER 1

Epidemiology of Tinnitus

Adrian Davis
El Amr Rafaie
Tyler and Baker (1983)

- n=97 self help group members, n=72 respondents
- M= 22, F 48, mean age 60.7 y (sd 13.1y)
- Open ended questions, mean 4.6 (sd 2.2)
- Association between >problems, >length of history
- Most issues with
  - Sleep
  - Persistence of T
  - Family problems
Davis and Rafaie, 2000

- National Study of Hearing, UK MRC
- n=34,050
- Have you ever had noises in your head or ears?
- Nowadays do you get noises in your head or ears?
- Do these noises usually last for longer than 5 minutes?
- PST =10.1%, 5.1% unilateral, 5% bilateral
• A third of all adults report some tinnitus
• About 10% of all adults report prolonged (> 5 mins) spontaneous tinnitus by questionnaire
• About 1 in 20 (5%) adults report tinnitus that is moderately or severely annoying
• 2 – 4% of adults have been referred to a hospital concerning tinnitus
• In 0.5% of adults tinnitus has a severe effect on QoL
Prevalence of any tinnitus nowadays as a function of age group

Nowadays, do you get noises in your head or ears? Yes / No
Age and tinnitus

Davis and Refaie, 2000
Percentage of those with PST who report no, mild, moderate or severe annoyance, NSH (n=6476)
Population trends and tinnitus

- Increasing age associated with increasing tinnitus annoyance
  - Davis and Rafaie (2000)
- More women than men (ibid)
  - Not statistically significant
- Women have more complex tinnitus than men
  - Meikle and Greist (1989)
- Association with noise exposure and class
  - Davis and Rafaie (2000)
Localisation of tinnitus

• Why is left tinnitus more common than right?
  – Not explained by noise (Meikle and Greist, 1992)
  – Somatic symptoms in general are more common on the left
    • (Min and Lee, 1997)
  – No evidence that left tinnitus is more annoying
  – Is there any such thing as unilateral/localised tinnitus?
    • (Tyler, 1997)
Hearing loss and tinnitus

• Hearing impairment is the dominant factor in predicting PST
  – (Davis and Rafaie, 2000)

• Conductive loss
  – Bigger the air-bone gap, higher possibility of tinnitus
    • (Davis, 1995)
Median HTL as a function of PST annoyance

Better ear

Worse ear

Median ages: None=56, Slight=51, Moderate=57, Severe=58
Systematic review

- McCormack et al. (2016)
- 39 studies reviewed, 16 countries
  - Major bias towards developed world
  - ‘Lack of reliable prevalence data’
  - ‘High risk of bias’
  - ‘Available prevalence data is heterogeneous’
Is tinnitus ubiquitous?

- Presence of “tinnitus” in silence in normal hearing
  - Heller and Bergman (1953) n=80
    - 94%
  - Graham and Newby (1962)
    - 40%
  - Levine (2001) n=unstated
    - 55%
  - Tucker et al. (2005) n=120
    - 64%
  - Del Bo et al. (2008) n=53
    - 83%
Tinnitus incidence in adults

- Martinez et al. (2014)
- Anonymised patient-based primary care data from UK
- 4.7 million patients <85 years old
- Clinically significant tinnitus
  - Discharge from hospital with T as primary diagnosis
  - Primary care recording with follow-up within 28 days
- 5.4 new cases within 10,000 person years
- No gender difference
- Increase with age (11.4 incident cases age 60-69 years)
- 324,00 new cases in UK 2012 -2021
Studies of referral

- Economic evaluation in Netherlands (Maes et al., 2013)
  - 21 visits per patient, 15 days pa absent from work
  - Average cost of tinnitus care: Euro 1544
  - Healthcare cost pa: Euro 1.9 billion
  - Societal cost pa: Euro 6.8 billion

- Economic evaluation in UK (Stockdale et al., 2017)
  - 1.05 million Primary Care consultations pa
  - Average cost of tinnitus care: £717
  - Healthcare cost pa: £750 million
  - Societal cost pa: £2.7 billion
Updated prevalence data

- Bhatt et al., 2017
- National Health Interview Survey data, collected 2014
- N= 75,764 respondents
- Tinnitus in last 12/12: 9.6%
- Greater prevalence, severity with age
- Greater prevalence with noise
- Of those with tinnitus, only half had discussed with GP (49.4%)
- Most had never tried any remedy (84.8%)
Table 1. Sex Stratification of Tinnitus Symptoms

<table>
<thead>
<tr>
<th>Tinnitus Symptom</th>
<th>Population in Millions (%)</th>
<th>Men</th>
<th>Women</th>
<th>P Value^{b}</th>
</tr>
</thead>
<tbody>
<tr>
<td>During past year</td>
<td></td>
<td>11.3 (10.5)</td>
<td>10.1 (8.8)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Extent of problem</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td>3.6 (31.7)</td>
<td>3.0 (30.2)</td>
<td></td>
</tr>
<tr>
<td>Small or moderate</td>
<td></td>
<td>6.9 (61.1)</td>
<td>6.3 (62.5)</td>
<td>.11</td>
</tr>
<tr>
<td>Big or very big</td>
<td></td>
<td>0.8 (7.2)</td>
<td>0.7 (7.2)</td>
<td></td>
</tr>
<tr>
<td>Discussed with physician</td>
<td></td>
<td>6.0 (52.8)</td>
<td>4.8 (48.0)</td>
<td>.04</td>
</tr>
</tbody>
</table>

^{a} Numbers of respondents represent a weighted national sample of adults who reported tinnitus in the 2007 National Health Interview Survey (raw sample, 75 764 respondents).

^{b} Calculated using \( \chi^2 \) tests.

Table Title:
Sex Stratification of Tinnitus Symptoms
Subjective Severity of Tinnitus Symptoms by Age

Numbers of respondents represent a weighted national sample of adults who reported tinnitus in the 2007 National Health Interview Survey (raw sample, 75,764 respondents). A direct correlation is seen between subjective perception of increased tinnitus severity and increased age ($r = 0.083$; 95% CI, 0.042-0.125).
### Table 3. Treatment Options Discussed With Physicians Among Respondents Reporting Tinnitus

<table>
<thead>
<tr>
<th>Type of Therapy Discussed</th>
<th>Population in Millions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Included in AAO-HNSF guidelines</td>
<td></td>
</tr>
<tr>
<td>Medications</td>
<td>1.45 (45.4)</td>
</tr>
<tr>
<td>Hearing aids</td>
<td>0.30 (9.2)</td>
</tr>
<tr>
<td>Nutritional supplements</td>
<td>0.25 (7.8)</td>
</tr>
<tr>
<td>Stress reduction methods</td>
<td>0.21 (6.7)</td>
</tr>
<tr>
<td>Music treatment</td>
<td>0.13 (4.0)</td>
</tr>
<tr>
<td>Tinnitus retraining therapy</td>
<td>0.10 (3.0)</td>
</tr>
<tr>
<td>Biofeedback therapy</td>
<td>0.09 (2.8)</td>
</tr>
<tr>
<td>Wearable masking device</td>
<td>0.08 (2.6)</td>
</tr>
<tr>
<td>Nonwearable masking device</td>
<td>0.07 (2.3)</td>
</tr>
<tr>
<td>CBT</td>
<td>0.01 (0.2)</td>
</tr>
<tr>
<td>All</td>
<td>2.68 (83.8)</td>
</tr>
<tr>
<td>Not included in AAO-HNSF guidelines</td>
<td></td>
</tr>
<tr>
<td>Psychiatric therapy</td>
<td>0.01 (0.3)</td>
</tr>
<tr>
<td>Surgical transection of auditory nerve</td>
<td>0.04 (1.2)</td>
</tr>
<tr>
<td>Alternative medicine</td>
<td>0.12 (3.9)</td>
</tr>
<tr>
<td>Other</td>
<td>0.94 (29.5)</td>
</tr>
<tr>
<td>All</td>
<td>1.11 (34.9)</td>
</tr>
</tbody>
</table>

**Abbreviations:** AAO-HNSF, Academy of Otolaryngology–Head and Neck Surgery Foundation; CBT, cognitive behavioral therapy.

* Numbers of respondents represent a weighted national sample of adults who reported tinnitus in the 2007 National Health Interview Survey (raw sample, 75,764 respondents).
Natural history: adults

- Philips et al. (2017)
  - 21 studies with waiting list controls
  - No change in depression, QOL
  - Modest improvements in ‘global tinnitus’, impact, loudness

- Bogo et al. (2017)
  - Longitudinal twin study, n=1084
  - Overall prevalence: 13.5%
  - Prevalence at baseline (mean 50y): 13.5%, f/u (m67y): 34.4%
  - At follow up, 4.2% reported resolution
Tinnitus prevalence in childhood
Tinnitus prevalence in childhood

BMJ Open Prevalence of tinnitus and hyperacusis in children and adolescents: a systematic review

Susanne Nemholt Rosing, Jesper Hvass Schmidt, Niels Wedderkopp, David M Baguley

Nemholt Rosing et al., 2016

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Tinnitus prevalence in childhood

- Nemholt Rosing et al., 2016
- 25 articles
- Prevalence in general population: 4.6 - 47%
- Prevalence in SNHL: 23.5 - 62.2%
- Very substantial challenges in
  - Population studied (age)
  - Definition of tinnitus
  - Reporting
- Coelho et al. (2007): sensation in 37.5%, ‘suffering’ in 19.6%
Tinnitus in childhood

• Hall et al. (2016)
  – 218/7092 (3.1%) 11 year old children experienced clinically significant tinnitus (present in 28.1%)
  – 21 of the 218 (9.6%) with tinnitus reported hyperacusis

• Humphriss et al. (2016)
  – 261/7093 (3.7%) 11 year old children reported hyperacusis
  – 109 (41.7%) of these reported (any) tinnitus
  – Risk factors: male, higher maternal education, readmission to hospital in first 4/52
Tinnitus incidence in childhood

• Baguley et al., 2013
  – 88 cases per year in 4 major European centres
  – 3.9% of paediatric workload
  – 93% >= 10y
  – Severe in 18%
  – Accompanied by hyperacusis in 39%

• Why so few referrals?
Ask every child?

- British Tinnitus Association Good Practice Guide (2016)
- Kennedy et al., 2016, response to Hall et al., 2016

As the paper mentions, the Tinnitus in Children Practice Guidance document recommends that children attending an audiology service are routinely asked about noises in their ear, just as adults are. We disagree that the figures in the paper support the view that such would lead to over-reporting.
Ask every child?

- Humphriss, Hall, Baguley (2016)

Second, you argue for the case for all children attending an Audiology or ENT facility being asked about tinnitus, indicating that rather than over-reporting, this will facilitate the identification of children with troublesome tinnitus. This discussion has been ongoing, but was not illuminated by data until now: our paper indicates that 28.1% of 11-year-olds in the general population will answer that they do have tinnitus, but this will be clinically significant in 3.1%, thus 25% of children would have their attention drawn to their non-significant tinnitus. It is up to the individual clinician to come to his/her own view on this matter.
Has this caused my tinnitus?

- I had ear problems as a child
- I am a musician
- Is my diet involved?
- I am a dentist
- My sleep is poor
- I have headaches
- I had chemotherapy
I had ear problems as a child

- Dawes et al. (2010)
  - New Zealand, n=970
  - Those with OME and CHL, increased likelihood of adult tinnitus

- Aarhus et al., (2015)
  - Cross sectional study, childhood hearing and adult tinnitus
  - If childhood HL, more likelihood of adult tinnitus
  - Effect reduced if adult noise accounted for
I am a rock musician

- Stormer et al. (2015)
- n=111, ‘active musicians’ in Norway, 102 M, 15 F
- Tinnitus: “have you experienced tinnitus?”
  - n= 19.6%
  - None ‘severe’
- Stormer et al., (2017)
  - Greater T in musicians than controls
  - More anxiety in musicians than controls
  - ‘drug abuse was not more prevalent in musicians than controls’!
Is my diet involved?

- McCormack et al. (2014)
  - UK BioBank Data, 40-69y, n=171,722
  - Persistent tinnitus associated with
    - Bread
    - Dairy avoidance
    - Past and never smokers
  - Decreased tinnitus with
    - Fish
    - Egg avoidance
    - Caffeinated coffee
Is my diet involved?

- Spankovich et al., (2017)
  - National Health and Nutrition Examination Survey (NHANES), 1999-2002
  - n=2176
  - Any T in last year: 21.1%, persistent: 11.7%
  - Better diet associated with less tinnitus
I am a dentist

• Myers et al., (2016)
  – High levels of sound deriving from suction
  – T prevalence : 31% (n=144/395)
My sleep is poor

- Long known that tinnitus associated with poor sleep
  - Tyler and Baker (1983)
  - Cronlein et al. (2016)
- Koo and Kwang (2017)
  - n=130,788, 21,798 with tinnitus
  - Higher incidence of tinnitus with
    - sleep disturbance
    - Sleep apnea
I have headaches

- Langguth et al. (2015)
  - TRI database, n=193 T+ headache, 765 T no headache
  - T+ headache
    - Greater impact
    - Reduced QoL
    - Pain hyperacusis
    - Depression
  - Propose additive effect
I had chemotherapy

- Frisina et al., (2016)
- Bothersome tinnitus in 40%
Ethnicity

- New Zealand
  - n=69,976, random telephone survey, 2007-2013
  - T in last 12/12: 6.0%
  - M>F
  - Highest European, lowest Asian
- Adults from a Pacific Northwest Tribe
  - Gellert et al., 2017,
  - N=217, tinnitus in 33%
  - M=F, risk factors >3 ear infections, noise
Tinnitus and hyperacusis

- Seem to have become linked inextricably

- Explore the association
Relationship with tinnitus: adults

- 86% of hyperacusis patients report tinnitus
  - (Anari et al, 1999)
- 40% of tinnitus patients report hyperacusis
  - (Jastreboff et al, 1996)
- Scheckelman et al. (2014)
  - N=1713 patients with primary complaint of tinnitus
  - Do sounds cause you pain or physical discomfort?
  - 55% positive
  - Ti+H > Ti distress than Ti alone
Relationship with tinnitus – adults

- Yang et al. (2015)
  - N= 207 patients with a primary complaint of tinnitus
    - N=105 unilateral
    - N=102 bilateral
  - Hyperacusis
    - Unilateral t= 12.74%
    - Bilateral t= 4.76%
    - P=0.23 NS

- Degeest et al. (2015)
  - N=81 patients with a primary complaint of tinnitus
  - N=26 (32%) with sound tolerance issues usually/always
  - Hyperacusis Q score correlated with Tinnitus Handicap Inventory (r=0.73)
Convergence with tinnitus

• Co-incidence
• Same referral pathway
• Same clinical skill set
• Relationship with anxiety
Fear and anxiety

- Until recently, no quantitative data
- High levels of anxiety states
  - Juris et al., 2012
  - 47% anxiety disorder
- “emotional exhaustion”
  - Wallen et al., 2012
  - N=348 with EE, n=4 (1.1%) with hyperacusis
- Acute stress changes loudness tolerance in women with EE (Hasson et al., 2013)
Divergence with tinnitus

• Unilateral and strongly lateralised hyperacusis is very rare, unlike tinnitus
  – Specific event/trigger
  – Acoustic Shock
  – Specific lesion
    • Insular cortex, Boucher et al., 2015
Divergence with tinnitus

• Hyperacusis is less labile than tinnitus
• Little traction for self help in severe hyperacusis
  – Hyperacusis.net
• Possible themes of
  – Self inflicted
  – Shame
  – Social isolation
• Perceptual salience rather than formless
  – (Auerbach et al., 2014)
Divergence with tinnitus

- Somatic modulation of hyperacusis is rare
- Intermittent hyperacusis is rare

- Some associations with hyperacusis have no relation to tinnitus
  - Misophonia
  - Autistic Spectrum Disorder
Tinnitus and hyperacusis

• Cousins, not siblings, nor twins
• Some neurobiological overlap
• Some behavioural overlap

• Implications for treatment
  – Which is the primary problem?
  – Explore the topography of the individual problem
Unanswered research questions

- Reliable tinnitus prevalence
  - Young children, adolescence, young adults, middle age, elderly
- Particular communities
  - Non-first world
  - Ethnicity
  - Behaviours
- Risk factors
  - Combination, multi-factorial
Unanswered research questions

• Natural history
  – Habituation?
  – Barriers

• Help seeking behaviour
  – Patient perceived needs
  – Self help
  – Internet delivered (Beukes et al. 2016, 2017)
Unanswered research questions

- On the increase?
Looking ahead

- Opportunities for robust research
- Many crucial questions remain unanswered
- Build upon collaborations