Tinnitus

Ciba Foundation symposium 85

1981

Pitman
Tinnitus
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Tinnitus

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Chairman’s introduction

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In his autobiography, ‘Journey into silence’, Mr Jack Ashley MP has ably portrayed, from his own personal experience, the problem to which this symposium is directed: tinnitus—the head noises which ‘plague’ the sufferer, the ceaseless ‘racket’ which hinders concentration, prevents sleep and haunts the mental state of the sufferer. Most, if not all, of us experience tinnitus in a quiet room but for a significant proportion of the population with hearing impairment their tinnitus is sufficiently troublesome for them to request medical advice. But what advice can be given? This is the dilemma which faces general and specialist medical practitioners alike. Tinnitus is as much a mystery and a problem for them as for the patient! Apart from sympathy and reassurance, and exhortation to ‘learn to live with it’, little else seems to be done.

In this situation, the lay public has an understandable impatience with medical practitioners and scientists in the field of hearing research for what appears to be a total lack of interest in a problem of such severity. It is to Mr Ashley’s credit that, following his initiation of a related Ciba Foundation symposium, on ‘Sensorineural hearing loss’ in 1969, he wrote to the participants, and to others, urging them to adopt a special interest in the problem of tinnitus. And it is further to his credit that this present symposium has been organized. As a result of these and other initiatives, such as the formation of Tinnitus Associations in the UK and USA, there is undoubtedly an increased interest in the problem among the medical and scientific communities. As evidence of that interest, immediately after this symposium the British Society of Audiology is holding a one-day meeting on tinnitus.

It is easier, however, to talk about tinnitus than to know how to research into it and to treat it. Fowler, in his classic paper on ‘Head noises’ written in 1940, called the commonest (and least understood) form of tinnitus ‘a tickle


1
or itch of the basilar membrane' of the ear. While this description could be criticized on the grounds that it commits the error of confusion of categories, it nevertheless captures perfectly the problem facing medical practitioners and researchers alike. How do you get to grips with a phenomenon as subjective and changing as an itch or a tickle? How do you devise and conduct laboratory or clinical investigations on such a phenomenon? How do you carry out well controlled trials of treatment? These formidable problems, rather than wilful disregard, have inhibited researchers from tackling the important problem of tinnitus.

There are signs that ways round these difficulties may be becoming available. More precise methods are now available to assist in classification and measurement of tinnitus. Some forms of tinnitus can be reliably suppressed by tones, bands of noise, certain drugs, and electrical stimulation of the cochlea. Most exciting of all is the very recent discovery that at least some types of tinnitus can be objectively recorded as an acoustic signal in the subject's ear canal.

This symposium therefore takes place at an opportune moment, when scientific and medical interest is at a peak, and new scientific tools are emerging. But our meeting will be neither easy nor conclusive; we are treading on ground that has had more than its fair share of baseless speculation, unsupported claims and pure quackery; and where there is an abysmal lack of scientific data on the nature and origin of tinnitus and its treatment. It is my hope that, even if it does nothing else, this symposium will at least provide as honest and as critical a view of the several facets of the problem of tinnitus as is possible at present. As well as hearing about new data and ideas, I hope we shall be able to highlight clearly the significant gaps in our strategy and understanding. In particular, we badly need answers to the following questions.

(1) Tinnitus takes a variety of forms and has more than one cause. Can we establish a clinical classification that has scientific validity and/or therapeutic value?
(2) What are the factors that precipitate, or predispose towards, tinnitus?
(3) What are the underlying pathophysiological mechanisms?
(4) Are so-called physiological tinnitus and pathological tinnitus related?
(5) What determines how troublesome tinnitus is?
(6) For which types of tinnitus are there effective treatments, and why?

May I conclude on a personal note? The last Ciba Foundation symposium related to this topic, 'Sensorineural hearing loss', was the major impetus that directed my own interest into developing animal models of hearing loss and new tools for the investigation and rehabilitation of people with impaired
hearing. If this symposium succeeds in shedding light on some of the questions before us, and in conveying some of the excitement that is being currently felt in this field and, by so doing, triggers off new ideas and new scientific interest, then our time will have been well spent.

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Classification of tinnitus

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**Abstract.** Classification in general serves a number of purposes. In relation to tinnitus there are particular problems because the cause is only rarely known and the mechanism is not known at all. This means that firm classifications tend to be misleading and serve little purpose other than to delude the doctor and the patient. The aim in this paper therefore is to examine the various ways in which information (whether scientific or clinical) about tinnitus can be organized so as to help diagnosis, management or research towards recognition of the fundamental abnormalities. Attempts at classification based on the site of the lesion and on speculation about its cause are described. Classification is analysed according to (1) patients’ own reports, (2) doctors’ clinical observations, (3) various techniques of measurement, (4) associated phenomena and (5) results of treatment. From these various aspects a pattern emerges which, though incomplete, at least exposes rather than obscures the gaps in our knowledge.

Nature and natural phenomena have not come into existence in a classified manner. In the biological sciences we are perfectly familiar with the problems that result from the enforced groups and orders into which we attempt to mould reality. Yet certain patterns in nature not only exist but are repeated and reworked. The branching of trees, of rivers and of arteries forms a distinctive and perhaps important aspect of nature, as does the meandering of rivers, of snakes and, indeed, of coils of rope. If we were to classify the objects in our environment according to whether they branch or meander rather than according to whether they are alive or inanimate, or even natural or artifactual, we would at once seem to be wrong. If we fail to recognize these qualities, however, we may overlook some fundamental aspects of the phenomena we are attempting to observe, and the classification that was intended to clarify becomes dogmatic and obscures the pathway to further understanding.

With tinnitus we are faced with an extremely common condition where a large number of afflicted individuals demand at least an explanation for their 1981 *Tinnitus. Pitman Books Ltd, London (Ciba Foundation symposium 85) p 4-15*
symptoms. On the other hand the cause is unknown and all explanations are speculative. Thus, any classification will, at best, be incomplete or, at worst, will mislead because its general acceptance and frequent repetition will lull the clinician into complacency. Even the formal standard division of tinnitus into 'objective' and 'subjective', although not inherently wrong, sometimes gives the impression that elaboration of the former is undertaken only to postpone the difficulties of discussing the latter. In fact 'objective' tinnitus is present in only a tiny proportion of the patients we see and the relationship between the noise witnessed by the observer and that perceived by the patient remains uncertain.

To refuse to classify altogether is to invite chaos into our thoughts and offers a negative approach to the problem. In this paper, therefore, I shall avoid the danger of presenting yet another comprehensive classification, even one comprising the previous versions. Such an enterprise should be undertaken only when enough is known about the generation of tinnitus to enable it to be categorized at that level. Instead I shall look at tinnitus from different points of view, and classify each group of observations within its own limits, and then I shall consider the relationships between the groups as a whole.

'Sound' is the quite definite and specific sensation that we associate with stimulation of the auditory mechanism. The term also applies to the external cause of the sensation. We have had to consider separately the possibility that the external source is not sound at all, as in electrical stimulation of the cochlea, yet produces a sensation of sound. Of great interest has been the recent discovery that the cochlea itself can produce tiny but recordable acoustic oscillations. The relationship of these oscillations to the sensation of sound is discussed elsewhere in the symposium (Kemp 1981, Wilson & Sutton 1981) but, for the time being, unless the patient claims to hear them we should avoid calling them tinnitus for the purpose of classification.

I shall apply the term tinnitus only to those sensations of sound which are not produced by an external acoustic or electrical source.

Objective and subjective tinnitus

As already mentioned, the division into objective and subjective tinnitus is not as practical as it seems because objective tinnitus is so rare. Objective tinnitus is audible to an observer and has also been called 'pseudo-tinnitus', 'vibratory' or 'extrinsic'. It is due either to vascular phenomena or to muscle changes such as spasm of the muscles of the middle ear or palate. Subjective tinnitus, with which we are concerned here, is also termed 'true' or 'intrinsic' tinnitus. This distinction is of value only to exclude the objective type.
Site of the lesion

It is perfectly proper to classify lesions according to site, and there are few systems of classification that are more helpful to the clinician considering management of the condition. For tinnitus the following possible sites would emerge:

1. The outer ear
2. The middle ear
3. The organ of Corti
4. The auditory nerve
5. The brainstem or central auditory pathways.

Otitis externa, or even wax in the ear canal, can cause tinnitus, as can all pathological conditions of the middle and inner ear. Together with deafness, ear-ache, otorrhoea and vertigo, tinnitus is one of the symptoms of ear disease and offers little guidance as to diagnosis. Even in the presence of obvious middle-ear disease, such as otosclerosis or chronic otitis media, the actual site of the lesion which causes tinnitus remains obscure and correction of the deafness does not necessarily mean cessation of the tinnitus.

Classification according to the patient’s own description

Here the main distinction lies between two forms of tinnitus:

1. Tinnitus aurium
2. Tinnitus cerebri.

In the former the noise seems to be definitely in the ears and in the latter it is in the head. It should remain clear, however, that the distinction is between two forms of a symptom and does not necessarily mean that tinnitus aurium, for instance, does not originate in the brain.

There is also the patient’s description of the nature of the tinnitus:

1. Low-pitched ‘noise of the sea’
2. High-pitched whistle
3. Roaring of machinery
4. Multiple sounds, together or separately
5. Complex sounds.

These are the most common descriptions, although many others are given, often depending on the patient’s imagination.

The degree of loudness also varies a good deal but, again, these descriptions rarely correlate with specific conditions or even with attempts at measurement.
Classification according to the physician's observation of the patient

To the clinician this is an important, if often subconscious, method of classification. Certain features take on particular relevance:

(1) The age of the patient
(2) The psychological state of the patient.

The importance of these aspects lies in their close relationship to management of symptoms.

Classification according to measurements of tinnitus

The two important features of tinnitus, its pitch and its loudness, have been measured by many techniques: Wegel (1931) used a masking technique with pure tones; Fowler (1938) used a loudness balance method and attempted to differentiate (Fowler 1944) between 'central' and 'peripheral' tinnitus according to the masking required.

Mortimer (1940) tried to match the tinnitus using a free-field method and Goodhill (1952) suggested the use of taped material to evoke the complexity of the tinnitus. This can now be superseded by the electronic music synthesizer (Douek & Reid 1968). In these experiments we attempt to classify diseases according to the pitch of the tinnitus, with some broad measure of success, provided that crude methods such as matching to the nearest pure tone were used. Attempts at separation by complex synthesized sounds fell into too many groups for this refinement to be practical.

The most important recent contribution has been that of Feldmann (1971), using a masking technique. His patients fell into five groups according to the masking pattern:

Type 1 High-pitched tinnitus and high-frequency hearing loss; threshold and masking curves converge from low to high frequencies; occurs mostly in industrial deafness

Type 2 Rare; divergence from low to high frequencies

Type 3 Common, and found in Menière's disease and otosclerosis; threshold and masking curves coincide (i.e. congruence)

Type 4 Relatively common; 'distance' curves: masking has to be considerably louder than threshold

Type 5 'Resistance' type; the tinnitus cannot be masked.
Classification according to associated phenomena

(1) The nature and type of hearing loss, if any, associated with the tinnitus
(2) The presence or absence of vestibular abnormalities
(3) More recently, great interest has been aroused by sounds generated in the inner ear itself.

Classification according to the response to treatment

The importance of this must be stressed, as tinnitus is a symptom and not a disease; symptomatic treatment is the only possible kind in many cases:

(1) Treatment of underlying condition, e.g. Menière’s disease
(2) Treatment of psychological problems
(3) Response to medication
(4) Response to masking
(5) Response to electrical stimulation
(6) Response to ablative surgery

Concluding remarks

My aim in this paper was first to stress that a single method of classifying a symptom of unknown and multiple aetiology is misleading. The greatest error that might ensue would be to forget this symptomatic nature and to consider tinnitus as a disease. The dangers that this produces in management are grave. Secondly, I have pointed out the many ways, nevertheless, in which tinnitus can be approached, in the hope that the various modes of classification will eventually converge into patterns representing diseases and syndromes and offering predictability in management of patients.

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CLASSIFICATION OF TINNITUS


DISCUSSION

Feldmann: Before we discuss methods of classifying tinnitus we should decide if we actually need a classification and, if so, what its aim should be. The ideal classification would be based on site of lesion and aetiology. If there is a clear-cut clinical diagnosis, e.g. industrial noise-induced hearing loss or Menière’s disease, the accompanying tinnitus is part of the disease and we can transfer our knowledge about site and aetiology of the disease to the tinnitus. In these cases we have a means of classification. But if the nature of the disease underlying the tinnitus is unknown, the question arises: do we actually need a classification of tinnitus?

Coles: I believe we do need a classification, if for no other reason than that it helps us to teach others about tinnitus (e.g. medical students or audiologists). I cannot think of a classification better than the traditional one based on the major cause, which may be physiological, or due to middle-ear disorders (which perhaps enhance physiological noise), or of sensorineural origin.

Shulman: It has been helpful, clinically, for us to classify tinnitus according to the site of lesion and also as a symptom of neuro-otological disease, using the methods of analysis Mr Douek described. For example, in a patient with a middle-ear infection, the medical site of the lesion is the middle ear, although the tinnitus may not necessarily come from the middle ear. Thus, one must differentiate the audiological site of the tinnitus complaint from the medical site of lesion. We must also consider objective methods of analysis, e.g. evoked-response audiometry, which can allow us to establish the electrophysiological indices of the tinnitus patient’s subjective response(s). We consider vestibular evaluation to be essential in the neuro-otological investigation of patients with tinnitus. Such tests, with or without cochlear findings, may help to establish the site of lesion of eighth nerve disorders that produce tinnitus and thus may help in the control of subjective idiopathic tinnitus. The
vestibular battery of tests has proved most useful to us in detection of endolymphatic hydrops, a disease involving both cochlear and vestibular systems. In our patients the most frequent aetiology of the endolymphatic hydrops was vascular.

We have attempted to correlate the tinnitus with objective test findings for hearing loss and vertigo in 74 patients with subjective idiopathic tinnitus. Table 1 shows that 66 of these patients had abnormal hearing loss or vertigo in the objective tests while only 21 of those complained of hearing and balance problems. In all the 74 patients tested objectively, none had completely normal functioning of both the cochlear and the vestibular systems. This supports the need for these tests, even when there is no subjective complaint of hearing loss or vertigo.

**TABLE 1 (Shulman) Correlation between tinnitus and objective or subjective reports of hearing loss and vertigo**

<table>
<thead>
<tr>
<th>Tinnitus</th>
<th>Objective test findings</th>
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<td>Hearing loss</td>
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+, present; -, absent

**Goodey:** Clinically, one must also distinguish between an ongoing disease process that results in tinnitus and a tinnitus arising from the residual damage that is revealed once the disease process has been controlled.

**Tyler:** We should avoid strict classifications until we understand more about tinnitus. In the meantime, we should describe the tinnitus in our patients as comprehensively as we can in various ways; for example, in terms of pitch, loudness, residual inhibition, frequency characteristics of masking, and ipsilateral and contralateral masking similarities. We shall probably remain at this 'data-gathering' stage for some time.

**Evans:** The difficulty is that we need a descriptive framework in which to present our results; otherwise each of us will be using different terms to express the same ideas.

**Tonndorf:** The danger of forming a dogmatic classification system before we fully understand tinnitus is that it may inhibit our thinking. On the other hand, I agree that unless we have classification of some sort, which should be fairly open, we cannot communicate effectively with each other!

**Douek:** I would have liked to have provided an all-embracing classification and am sorry that I was unable to suggest one. Perhaps we ought to strive towards such a classification but continue, at present, to use our different
CLASSIFICATION OF TINNITUS

ones. One type of classification may be more useful to, say, an electrophysiologist and another to a clinician.

Hazell: I agree. Professor Coles gave a classification some years ago (Coles et al 1975) which I have found useful in teaching but it may not be adequate for research purposes, where the emphasis is different.

Kemp: In the old clinical classification of tinnitus into an objective and a subjective type, objective tinnitus is the rare condition caused by muscular and vascular problems, in which the clinician can readily hear the sound reported by the patient by listening to the ear canal. Now, with instrumentation, we can detect much smaller sounds emanating from the cochlea, which also give rise to (mild) tinnitus (Kemp, this volume, p 54–76, Wilson & Sutton, this volume p 82–100). Should we call this ‘objective tinnitus’? I think not, and would prefer that the term objective tinnitus be discarded altogether.

Tinnitus is, after all, the sensation and not the activity giving rise to the sensation. It is tempting to say of the new measurements that we have measured cochlear tinnitus objectively by acoustic methods but frequently we find these sounds in ears when the subject cannot hear any noise, i.e. there is no tinnitus. We should therefore re-define our terminology and refer to objective measurements as ‘measuring the tinnitogenic activity’. We should use the word ‘tinnitus’ only for the sensation. The term ‘objective tinnitus’ is confusing in the light of recent developments.

Coles: I agree. Tinnitus is a complaint by a patient who hears sounds that are not produced by the external environment or by electrical stimulation. The curious phenomenon of tonal sounds emitted by some patients has been called tinnitus for want of a better word, but it is a misnomer. The phenomenon has some relevance to the possible causes of tinnitus, but we should not call it objective tinnitus.

Evans: There is a slight difficulty here in that the term objective tinnitus has, classically, been used to include cases where an unaided observer can hear sounds coming from the patient’s ear. David Kemp and Pat Wilson have been examining patients who subjectively report tinnitus, in quiet rooms for example, and from whom sounds can be recorded. We cannot therefore reject the category of so-called objective tinnitus—we probably need a new name for it.

Kemp: I don’t see ‘objective tinnitus’ as a meaningful category any more. All forms of tinnitus may eventually be found to have an objectively detectable correlate—if not a vibratory one then certainly an electrophysiological one. It just depends on the instrumentation used. We do need some new terms here.

Hazell: One category of patients have noises in the ear which are clearly audible, but only with a stethoscope. These noises are produced in and
around the ear by mechanisms that we do not always fully understand, and
they present an important problem to the patient. They are often difficult
to treat. They are ‘objective’, but do not fall into David Kemp’s group—they do
not actually come from the cochlea.

Kemp: Would the term ‘extra-cochlear tinnitus’ cover those sorts of
tinnitus?

Tonndorf: That term would also include ‘central’ tinnitus.

Hazell: There is a variety of different sounds; for instance one patient
experienced a sound rather like the cracking of an egg when the upper part of
the sternomastoid muscle was pressed or when the head was moved. Symptoms
like this seem not to fall into any sort of classification.

Graham: The question then arises of how far away from the ear the origin
of the sound has to be for the sound to be classifiable as tinnitus!

Coles: Some patients I have reported (Glanville et al 1971) emitted a
high-pitched whistle that could be heard across the room, but they could not
hear it themselves. This is not tinnitus as I understand it. In calling it
‘objective tinnitus’, I have always recognized the term as a misnomer.

Tyler: When one records sound pressure in the external auditory meatus,
this is a physical measurement. I think it is valid to call this ‘objective’, but we
should refrain from calling it tinnitus, which is a perceptual phenomenon. It
would then be necessary to determine if these objective sounds were
originating from blood vessels, muscle spasms, or the cochlea. We do not yet
know the relationship between ‘spontaneous cochlear acoustic emissions’ and
tinnitus.

Evans: I have used the term ‘tinnitus signal’ in an attempt to get around
that, but it is not entirely satisfactory.

Aran: One could use the term ‘acoustic tinnitus’ which implies that there is
a physical support to it.

For instance, in a 9-year-old child presenting with a small high-frequency
hearing loss in both ears, we could hear and record with a microphone at the
external auditory meatus a clear 8500 Hz pure tone of about 30 dB sound
pressure level, yet the child did not hear it.

Vernon: We must, in addition to any classification of tinnitus, have a
standardized form of testing for tinnitus—otherwise we can never evaluate
any form of therapy, which is the final goal.

Published work on masking or on pitch-matching does not readily apply to
tinnitus, yet I do not think that we are dealing with a capricious activity but
simply with a different activity. It is conceivable that a classification for
tinnitus might result from standardized measurement procedures.

Tonndorf: Mr Douek rightly attacked psychophysical methods for pitch-
matching or loudness-matching as a means of classifying tinnitus because
when untrained patients are asked to match the pitch of their tinnitus they
often choose any harmonic of the pitch that sounds right. Robert Bilger in our
country has reduced psychophysical tests to simple ‘yes’ or ‘no’ answers.
Feldmann’s masking experiments (1971) are also superior to psychophysical
methods because the patients are simply asked whether or not they hear the
tinnitus.

Douek: I agree that Feldmann’s methods are superior. This is why I
pointed out, perhaps in rather flowery language, that to classify structures
according to whether or not they are branched is not necessarily incorrect.
However, by asking patients to do psychophysical tests, which they may do
wrongly, we may detect something that we had not previously considered at
all.

Tyler: We have studied different tinnitus pitch-matching procedures and
find that most people can match the pitch of their tinnitus to the pitch of a
pure tone within about ±half an octave (Tyler & Conrad-Armes 1980). Using
the method of adjustment, we have obtained a reliable pitch-match within ±one-sixth of an octave on two different occasions, four months apart. One
must use a valid psychophysical method, instruct the patient clearly, repeat
the method several times, and check for octave confusions. The precision
required for the estimate of tinnitus pitch will also influence the reliability.
For example, if one simply wants to find out if the tinnitus pitch is low-, mid-,
or high-frequency, one can do this quickly, with good reliability.

Hazell: In my experience, pitch-matching and analysis of frequency have
been the least useful in the classification of tinnitus patients. We have used
extensive computer analysis with these methods and found no relationship
between the dominant frequency, or the frequency content, and any other
measured factor (Hazell 1980, 1981). However, we should continue to
develop these techniques.

Berlin: We tend to expect pitch-matching and maskability of tinnitus to
follow certain familiar laws and rules. I used to believe that all patients were
bad judges of pitch, and that one cannot do psychophysical testing with them,
until I examined musicians with tinnitus and found that they were excellent
judges of ordinary pitch differences but bad judges of pitch-match in tinnitus.
This is probably because their tinnitus isn’t matchable; it isn’t the same pitch
all the time.

Tonndorf: I have found that even musicians can be poor at pitch-matching
at high frequencies (e.g. 4000 or 8000 Hz), which is a faculty that they do not
normally require professionally.

Berlin: If someone can pitch-match an external frequency within a narrow
range by using interrupted tones or narrow bands of noise, yet cannot match
the tinnitus head noises, then the head noises may not be produced in the
usual way i.e. from displacement of basilar membrane and hair cells. We
know of people whose ears have been destroyed and who still ‘hear’ head
DISCUSSION

noises. We therefore should remember that various chemical and non-mechanical stimuli can elicit auditory sensations by as yet obscure mechanisms. Thus, the patient may experience novel auditory sensations which may not be constantly matchable in the ordinary sense: they may be fluctuating, oscillating and unstable.

Tyler: We know from psychoacoustics that when normal listeners (without tinnitus) are presented with a narrow band of noise, a pitch can be heard at either the low- or high-frequency cut-off (Small & Daniloff 1967, Békésy 1961) or at the centre frequency of the multitone complex (Ekdahl & Boring 1934). Therefore, it is not surprising that people with tinnitus who hear something like a narrow band of noise (or possibly something even more complex), would experience some difficulty in pitch matching. We ask the patient to match the pitch of a pure tone to the ‘most prominent pitch’ of the tinnitus.

J. W. House: Another classification you mentioned, Mr Douek, was based on the subjective reaction of the patient. As you pointed out, the loudness of the measured tinnitus is about the same in most patients and yet their description of the tinnitus can vary from ‘mild’ to ‘hardly noticeable’ to ‘extremely severe’. In treatment of tinnitus we are concerned most with the people who are greatly disturbed by it.

Shulman: These are the problems that clinicians face. We should distinguish between the need for a clinical classification based on standardized methods of analysis and one based on electrophysiological and/or psychoacoustical methods. In other words we should establish how each of these is useful in a research and clinical setting. For example, the terms objective and subjective tinnitus have been vitally important clinically in the identification of what, if anything, the patient hears, but they may be useless in the future, in the light of recent advances.

REFERENCES

Ekdahl AG, Boring EG 1934 The pitch of tonal masses. Am J Psychol 46:452-455
Glanville JD, Coles RRA, Sullivan BM 1971 A family with high-tonal objective tinnitus. J Laryngol Otol 85:1-10
Hazell JWP 1980 Medical and audiological findings in subjective tinnitus. Clin Otolaryngol Allied Sci (Oxf) 5:75

Editors' note
After the start of the symposium, two working parties were set up to produce a definition and classification of tinnitus (Appendix I, p 300-302) and some guidelines for recommended procedures in tinnitus testing (Appendix II, p 303-306). These Appendices were discussed in detail by all participants at the symposium and, on most issues, their content represents the collective view of the participants. Some relevant acoustical terms are given in Appendix III, p 307-311.
Epidemiology of tinnitus

MEDICAL RESEARCH COUNCIL'S INSTITUTE OF HEARING RESEARCH*

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Abstract. The Institute of Hearing Research is now in the first of a three-year clinical characterization of hearing in the adult British population. One aim of this study is to obtain epidemiological data on the prevalence, and the handicapping effects and rehabilitational requirements for persons with hearing impairment, tinnitus, or both. The material presented here relates chiefly to the main pilot study. In Tier A, 6804 copies of a brief questionnaire were posted to random samples of people on the electoral rolls in Cardiff, Glasgow, Nottingham and Southampton. In Tier B, a stratified sample (n = 272) from the people who replied to the questionnaire was chosen for audiological and otological examination. The prevalence of tinnitus was 15.5–18.6% in the four cities, markedly less than the 39% found in the pre-pilot study, in which the wording of the questionnaire had not excluded spontaneous tinnitus of less than five minutes' duration or temporary sound-induced tinnitus. In the four populations sampled, tinnitus causing severe annoyance was reported by 0.4–2.8%, while a severe loss of the ability to lead a normal life was reported by 0.4–0.5%. The percentage reporting tinnitus increased significantly with age and with exposure to noise.

While existing epidemiological results on the characteristics and prevalence of hearing disorders, including tinnitus, in adults are useful, they are of limited value for drawing conclusions about its causation and implications for health services in the UK. Some of the available information either cannot be generalized to include the British population (e.g. National Center for Health Statistics (USA) 1967, 1980) or is becoming out of date (Wilkins 1948, Hinchcliffe 1959). The usefulness of other results is limited because arbitrary

* This paper was delivered by Professor R. R. A. Coles and prepared by R. R. A. Coles, A. C. Davis and M. P. Haggard. Data analysis was greatly assisted by Pauline Smith. The principal investigators for the study were: at Glasgow, G. G. Browning, S. Gatehouse and M. E. Lutman; at Southampton, P. B. Ashcroft and A. R. D. Thornton. The audiological support staff directly involved in the testing for the pilot study were: at Glasgow, Grace Hardie and A. Taylor; at Southampton, I. E. Bell, S. Goodsell and Susan Cunningham.

criteria of hearing impairment were defined at diverse audiometric levels (e.g. Wilkins 1948, Ward et al 1977) or because hearing disorders were studied only as an adjunct to some other primary purpose (e.g. Hinchcliffe 1959, M. Maclean—personal communication to A. C. Davis—1979). To help counter some of these problems, and for a number of purposes, the Institute of Hearing Research has embarked upon a large-scale study of the characteristics and prevalence of hearing disorders in adults among the British population.

The results reported here are from the pilot study for a multi-centre investigation of the clinical characteristics and epidemiology of hearing disorders in adults. The aspects concerning tinnitus thus form only part, but an interesting and important part, of the more general study. The data are worth reporting, as the pilot study was preceded by a pre-pilot study and many of the methods had been proven previously in the clinic or in laboratory studies. The corresponding data on hearing impairment are given in another paper (A. C. Davis, R. R. A. Coles, unpublished paper, 15th Int Congr Audiol, 2–6 Sept 1980).

Methodology and rationale of the population studies

The general plan of the main study, as at the time of writing, is illustrated in Fig. 1. Economic and sampling considerations require two tiers. These comprise postal questionnaires (Tier A) and audiological and clinical investigations (Tier B).

Tier A, a postal questionnaire accompanied by an explanatory letter, is used to elicit self-reports of hearing problems, including tinnitus. A number of biographical questions are also asked: these include age, dominant hand, occupation and history of exposure to noise. Non-response to the postal questionnaire is countered by two means: two further postal reminders are sent to individuals not returning their questionnaires; and, where possible, people not responding within six weeks of the initial letter are followed up by telephone.

The postal questionnaire has three main purposes: (1) it gives directly the prevalence of self-reported hearing disorders; (2) it enables us to send further detailed questionnaires to special groups of interest, e.g. hearing-aid users and tinnitus sufferers; and (3) it provides an efficient screening process, and enables us to group individuals rationally according to variables of interest, and thereby to construct a frame for two-stage sampling. The pilot study, from which the present data are drawn, had the same general plan as the main study. However, since part of the objective of the pilot study was to refine the questions asked in Tier A, the sampling proportions for Tier B, and the range
of tests and details of test methods in Tier B, there have been some changes in the main study.

The questionnaires allowed us to group respondents into four strata: N, who reported no hearing impairment or tinnitus; HI, who reported hearing impairment; T, who reported tinnitus; and HIT, who reported hearing impairment and tinnitus. Two versions of the questionnaire defined the HI response. In one, the question enquired whether there was no, slight or great difficulty, or total inability, to 'hear a person who is talking to you when he is sitting on your left-hand side in a quiet room'; there was a second question for the right-hand side. The other version had the single question: 'Can you usually hear and understand what a person says to you in a quiet room, if he whispers to you?' Both questions were similar to those developed by the National Center for Health Statistics (USA, 1970) and by Schein & Delk (1974), and subsequently used in Great Britain by Ward et al (1977) and ourselves. The T stratum was defined by an affirmative response to a question
enquiring whether ‘you get ringing or buzzing noises in your head or ears. The occasional whistling or ringing in the ears of less than 5 minutes duration should not be counted. Also do not count those times when this happens just after very loud sounds, e.g. discos, shooting or noise at work’.

The apparently elaborate wording of the tinnitus question arose from results of our pre-pilot study, done in 1977–78 in Glasgow. There, 39% of 522 persons sampled had reported that they had tinnitus, but the wording on the questionnaire had not excluded spontaneous tinnitus of short duration or temporary noise-induced tinnitus. Likewise, Hinchcliffe (1961) had found a prevalence of tinnitus ranging from 21–39% for different age-groups of people who, at one time or another, had noticed noises in their ears or ‘head’. These figures are obviously too high to refer to the forms of tinnitus that have real or even potential clinical significance. We justify imposing this preconception upon the data because incautious use of the word ‘tinnitus’, associated with a prevalence rate of 39%, would unduly undermine professional and public concern, owing to the manifestly smaller numbers of people with life-disrupting tinnitus. The wording of the questions was thus altered to that described in the previous paragraph, to exclude ‘normal’ tinnitus and tinnitus occurring as an immediate sequel to noise exposure.

Where tinnitus was reported, the questionnaire went on to request the extent of the annoyance caused (nil, slight, moderate, severe), the effect on ability to lead a normal life (nil, slight, moderate, severe), any interference with getting to sleep (yes, no), and the site (left ear, right ear, both ears, ‘head’).

The pilot study was carried out in 1979–80 and was based on 6804 questionnaires sent to a random sample of those on the electoral rolls for 1979–80 (aged 17 and over when the electoral rolls were compiled in Autumn 1978) of the four cities, Cardiff, Glasgow, Nottingham and Southampton, in which the Institute of Hearing Research has its clinical out-stations. After we had discounted those who had moved or died, or who were otherwise unavailable, the response rate was 81%. Possible biases among the non-responders were checked by telephone (Cardiff and Nottingham) and by domiciliary visit (Cardiff). No substantial biases became apparent, but the proportion of people reporting tinnitus was slightly higher in the respondents. This will be checked further in the main study.

A full Tier-B-type audiological and clinical assessment was made on a small sample of 272 Tier-A respondents in Glasgow and Southampton, so stratified from the questionnaire responses that data derived from the further assessment can be projected back to the overall populations from which they were sampled. The attendance rate of those invited varied, around 50%, in successive samples. Domiciliary visits were paid to a high proportion of the non-attenders in all four cities, and a brief clinical and audiometric examina-
tion was carried out. Some slight attendance biases were detected, which will need further documentation so that we can make allowances for them when we derive population estimates from the main study.

In any multi-centre study, great attention must be paid to the standardization of testing and calibration protocols and of the apparatus used in the clinics concerned. The pure-tone thresholds quoted in this paper are relative to the current British Standard (BS 2497(2), 1969) and, for pure-tone air-conduction audiometry, are the same as in the International Standard (ISO 389, 1975). Our standardized test procedures have been developed over an 18-month period and agreed by the staff of all four centres taking part, and so a great deal of potential error and conflict has been eliminated from the study.

Results

The effective response rate to the postal questionnaires was essentially uniform between the four cities. (There were some statistically significant differences between detailed questionnaire format, but these are procedural only). Table 1 shows the percentage of the respondents, at each of the centres, that fell into each stratum. Glasgow had the highest percentage of people who reported abnormality. To summarize all the results, about one in three reported some hearing disorder. One in twelve reported tinnitus alone, another one in twelve reported tinnitus and a hearing problem, and about one in six reported a hearing difficulty alone. Table 2 gives the findings on the severity of the tinnitus reported.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Cardiff</th>
<th>Glasgow</th>
<th>Nottingham</th>
<th>Southampton</th>
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<tbody>
<tr>
<td>T</td>
<td>9.6</td>
<td>9.2</td>
<td>9.5</td>
<td>8.3</td>
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<tr>
<td>HI</td>
<td>15.2</td>
<td>18.9</td>
<td>18.5</td>
<td>16.7</td>
</tr>
<tr>
<td>HIT</td>
<td>8.6</td>
<td>9.4</td>
<td>8.6</td>
<td>7.2</td>
</tr>
<tr>
<td>N</td>
<td>66.5</td>
<td>62.4</td>
<td>63.5</td>
<td>67.7</td>
</tr>
</tbody>
</table>

Left-sided tinnitus (4.6%) was more prevalent than right-sided tinnitus (3.4%), and the 8% reporting a unilateral tinnitus were outnumbered by the 9.7% who reported that tinnitus was in both ears or 'in the head'. These findings were similar between the left-handed and right-handed people, but larger numbers are needed to define the exact influence of the dominant hand on the side of the tinnitus. However, only 14.8% of the left-handed (who