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"Progress Towards the Unification of Noise Criteria"

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"Criteria for the assessment of Aircraft Noise Nuisance in Hospitals"

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There is no doubt that noise can be trying to both patients and staff in hospitals and as the Final Report of the Committee on the Problem of Noise pointed out, due attention ought to be paid to noise reduction in hospital buildings, and especially in new hospital building programmes. Since that time it appears that relatively little coordinated effort has been devoted to these problems, as the Commission on the third London Airport point out. The evidence submitted to them suggested that quietness may be vital for patients, particularly if they are seriously ill, quite apart from the special need of all patients to have adequate and uninterrupted sleep. Also stressed was the effect of noise on activities which particularly include interference with communication and interruption of diagnoses.

The DHSS is currently conducting research into the acceptable aircraft noise levels in the hospital environment and these findings are not yet available. Meanwhile it has been suggested that use of the NNI concept, whilst not constituting a basis for setting standards for hospitals, is the most acceptable alternative in the present state of knowledge.

It seems therefore as though there are two requirements for resolving these problems:-

I. CRITERIA FOR ACCEPTABLE NOISE ENVIRONMENTS WITHIN HOSPITALS

1) Basic criterion and number of aircraft movements

Many methods exist for the assessment of aircraft noise nuisance (N.N.I., C.N.R., N.E.etc). However the added complexities of such measures as PNL, TPNL and EPNL when incorporated with this type of rating are not considered to be either sufficiently validated or justified for use in hospitals, particularly when task interference is considered.

Certain criteria already exist which recommend levels of noise acceptable in hospitals (for example, Beranek (1960), Kosten and Van Os (1961) and Furrer (1964)) although these are more concerned with continuous noise rather than intermittent short duration, time-varying noise. These levels vary between 35 and 40dBA. Subject to consideration being taken of the special requirements of staff and patients, then the dBA measure has a simplicity to be commended. There is nevertheless a need for an adjustment of the dBA criteria to suit the number of aircraft flyovers in a given period. Using similar arguments to Robinson (1969) and assuming a 30 second average overflight duration, corrections can be derived (Table 1) based on the BS 4142. It is felt that corrections for night time operations are more applicable to the hospital environment and these should apply over the 24 hour period.

No. of Aircraft Movements in an 8 hour period	100 & above	50–99	25–49	10–24	1–9
Recommended correction in dBA	0	1	2	3	5

Table 1. Additional tolerances to the dBA noise levels during each aircraft flyover.

Levels of acceptability - FOR STAFF

(a) Speech Interference.

There is little doubt that interference with communication between a doctor and his patient forms a major source of complaint against aircraft noise. This is important not only during conversation (especially in the case of psychiatric patients) but also during clinical examination. In addition social surveys of aircraft noise nuisance in the community indicate that speech interference plays a major part in annoyance.

The predictors of speech intelligibility are: the Articulation Index (AI), computed from equally intelligible spectral bands as a function of speech to noise ratios (0 is complete interference and no interference is 1): and the Speech Interference Level (SIL), defined as the average of the noise levels (in dB) in the three contiguous octave bands centred on 500,1000 & 2000 Hz. Levels can be specified which would be acceptable in the hospital environment (ie low level conversation at 4-5 feet distances) and these are an ambient AI of 0.60 (ie sentence intelligibility greater than 95%), or a SIL of about 37dB. The AI measure is considered to be the more satisfactory index and this can be allowed to degrade to a value of 0.40 during an aircraft flyover.

Gordon et al (1970) have proposed that the dBA scale can also be used as a satisfactory alternative to the AI. Thus, an ambient level of 45 dBA, equivalent to an AI of 0.60, will be acceptable, rising to 50 dBA during an aircraft flyover, for numbers of 100 or more in the 8 hour period.

(b) Interference with diagnoses.

Another major source of staff complaints concerns interference with the use of stethoscopes where heart murmurs of predominantly low frequency (below 300Hz) are of great importance in the diagnosis of heart disease and are readily masked by extraneous noises.

Only one study appears to have examined the effect of background noise on the impairment of auscultatory examination (Groom and Charleston,1956). These authors state that a reduction of hospital noise levels to 35 dBA affords a very real improvement in auscultatory proficiency,although the attainment of 35 dBA in out-patients' clinics and wards is probably impractical in the presence of considerable internal as well as external noise sources. Since the A-weighting network assigns less importance to frequencies below 500 Hz, these will not be correctly assessed by a single reading in dBA. Using data given by Groom and Charleston, it is tentatively suggested that for diagnostic rooms, a suitable criterion would be 35 dBA or less, provided that the overall SPL does not exceed 50 dB. More details of the frequency content of heart murmurs and the intensity in each band are required before a more exact criterion can be derived.

(c) Operations.

The data available for maximum allowable ambient noise levels in operating theatres are extremely limited and it is felt that recommended levels of less than 35 dBA are unnecessarily strict. In practice it does not appear that noise is a problem in operating theatres,although we feel that they should be kept as quiet as possible bearing in mind the special function of such rooms, and suggest a basic level of 40 dBA during an aircraft flyover.

Levels of acceptability - FOR PATIENTS

(a) Noise levels compatible with undisturbed sleep.

The level of acceptable noise is extremely difficult to determine, mainly because there are differing opinions as to what constitutes undisturbed sleep. Whether for example, it is change in the sleeping EEG pattern and autonomic nervous system, or behavioural awakening. Behavioural awakening from sleep seems to be a preferable criterion of sleep disturbance when attempting to relate its effect on health. Again, the levels of noise at which behavioural awakening is likely to occur are difficult to assess since there are several variables apart from the intensity of the stimulus which can determine whether or not awakening will occur. For example, information content of stimulus, duration of stimulus, sleep stages, differences in awakening threshold, adaptation etc.

Literature on this topic is sparse and the results vary according to experimental conditions. For example, a review of sleep research shows that inter-individual differences in behavioural awakening thresholds are marked even with subjects of the same age and sex. As yet there is no agreed noise level which is generally known to be compatible with undisturbed sleep, so that any figure given must be regarded as tentative. However, these investigations indicate that an ambient level of 40 dBA (indoors), rising to 50 dBA during an aircraft flyover, and including intermittency and duration corrections given in Table 1, should be compatible with undisturbed sleep for most patients.

(b) Effects on health and rates of recovery.

As Noise-Final Report (1963) points out "people's well-being is diminished by noise, so in this sense of the term there is no doubt that noise affects health". It was also stated that "interference with sleep is least to be tolerated because prolonged loss of sleep is known to be injurious to health". At present, the most obvious means of assessing the effects of noise on health is interference with sleep and this has already been dealt with.

Rice and Lilley (1969) have reviewed the literature on the effects of noise, and in particular the sonic boom, on health. They find that there is insufficient data on which to base opinions concerning hazards to health. Of particular relevance however was the conclusion drawn by Jansen (1968) who states that until someone proves that the changes in physiological state due to noise are negligible, we must consider noise to have a possible detrimental influence on human health.

Discussion of Patient and Staff requirements.

It appears that staff are more affected by aircraft noise than patients, and there are probably several factors which determine this difference, the principle ones being

(a) most staff are subjected to aircraft noise in hospitals for longer periods than most patients, although not for 24 hrs per day,

(b) when occupied with exacting tasks, annoyance and interference due to noise are less tolerable,

(c) most patients tend to live in areas near their hospitals and so are accustomed to the presence of aircraft noise, and in fact, may find hospitals quieter than their homes,

(d) finally, patients tend not to complain about conditions when being treated in hospitals.

In view of the staff reactions, greater priority must be placed on staff requirements than has hitherto been the case.

The professional (staff) opinion that patients' health is affected by aircraft noise may be biased by its effect upon their own activities. However, most felt that the detrimental effect was produced through sleep or rest interference and that this would greatly affect acutely nervous patients. Thus patient requirements should be focussed on noise levels compatible with undisturbed sleep and rest. The main staff requirements are that noise levels do not interfere with consultations or with stethoscope use.

Summary of Recommendations.

Unless otherwise stated the corrections in Table 1 should be made to the following noise levels:

(a) An ambient noise level of 40dBA for general wards, with a maximum level during an aircraft flyover of 50dBA.

(b) In consulting rooms an ambient noise level of 45dBA should be satisfactory. (This is equivalent to an articulation index of 0.60 for a speaker-listener separation of 4-5 feet). Again maximum levels during aircraft flyovers should not exceed 50dBA.

(c) 35dBA should never be exceeded in diagnostic or examination rooms, together with the restriction of the overall SPL to 50dB. It is felt that this level can be achieved if special rooms for this purpose are constructed. There is no allowance in these rooms for increased levels during aircraft flyovers.

(d) 40dBA should not be exceeded during an aircraft flyover in operating theatres.

II. PERMISSIBLE AIRCRAFT NOISE LEVELS OUTSIDE HOSPITALS

Limitations in the stated criteria.

A real problem arises when the sound attenuating properties of buildings is considered. The attenuation of a structure is frequency dependent, so transmission through the structure will alter the spectrum shape. Whilst the use of the A-scale will give a guide to the approximate levels of attenuation it is emphasised that such criteria must be re-interpreted in terms of octave or third-octave band analyses.

Siting and design of hospitals.

It is reasonable that hospitals should be sited in the quietest possible environment. However, whilst this may be possible for some new hospitals, it is often impossible to prevent some noise nuisance in existing hospitals.

The effective attenuation through the hospital structure will depend upon the details of the design, including size and type of window, size and treatment of room. It is possible to categorise the typical noise reductions that can occur in some situations. For a hospital building with single glazed, openable windows (non-air conditioned), typical noise reductions will be 10dBA with windows open and 17dBA with windows closed. For a hospital with sealed double glazed windows it is reasonable to expect that the noise reduction afforded by the structure will be 25dBA (or greater depending upon the care taken in design. It must be pointed out that the value of double glazed windows is being questioned (Marsh 1970), and particularly where low frequency attenuation of time and spectrally varying signals is required, single glazing of appropriate thickness and mounting appears to have definite advantages.

The permissible outside noise levels can be converted to the equivalent PNL, and the maximum acceptable level on this basis, for an existing hospital with single glazed windows, is of the order of 75-80PNdB.

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