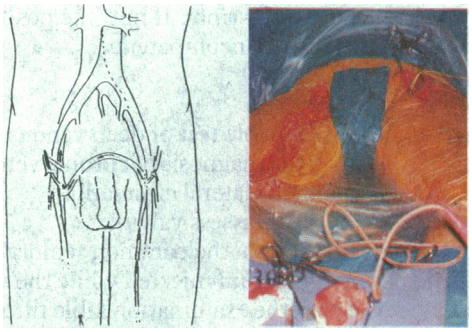
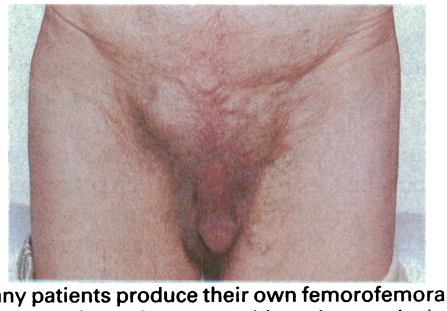


Diagram and operative photograph showing a Palma crossover vein bypass operation using the long saphenous vein from the normal leg (illustrating a left iliac vein occlusion).



Many patients produce their own femorofemoral collaterals (note the suprapubic varicose veins). Operation in such patients is unnecessary.

There are no reliable and safe methods for repairing incompetent valves in deep veins. Research continues, however, and includes assessment of transplanting vein valves from the axillary vein into the upper popliteal segment. This has relieved symptoms in some patients, and calf pump function has been improved. Additional attempts have been made to repair femoral vein valves. This may have a place in patients with congenital valve aplasia, but so far there has been no long term follow up in patients who have undergone repair of valves after thrombosis in limbs. The support of incompetent valves with external slings has also been tried, with encouraging initial results.

Longstanding venous occlusion may be treated by bypass. The contralateral normal long saphenous vein is dissected out and anastomosed to the femoral vein on the occluded side. The iliac occlusion is bypassed and encouraging results have been obtained. The adjunctive use of a temporary arteriovenous fistula increases flow, and this maintains patency. Bypass of an occluded superficial femoral vein (using long saphenous vein) does not give equally good results.

Synthetic materials are rarely used in the venous system except as simple patches, but externally reinforced polytetrafluoroethylene is the material of choice for replacement of the iliac veins and the inferior vena cava.

We acknowledge with thanks the assistance of the audiovisual department, St Mary's Hospital, London, in the preparation of the illustrations.

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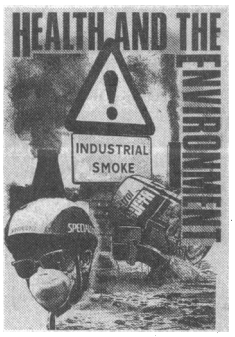
The ABC of Vascular Diseases has been edited by Mr John H N Wolfe.

Health and the Environment



Noise: breaking the silence

Fiona Godlee

Last year over 100 000 complaints about noise were made to environmental health officers in England and Wales. Every year the number of complaints increases. Noise is an environmental pollutant, another product of the technological age. At high levels and over prolonged periods it damages hearing. But how dangerous is it to health?

Noise induced hearing loss

According to the United States National Institutes of Health, more than 10 million Americans have had their hearing damaged by noise, and more than 20 million are regularly exposed to levels of noise that could cause hearing loss.[1] Noise at work is the major cause of hearing loss in adults in the industrialised world.[2] In Britain the Health and Safety Executive estimates that 1·7 million people have deafness due to occupational exposure to noise. Between 1983 and 1990 almost 10 000 people in Britain qualified for disablement benefit because of noise induced hearing loss sustained at work (R H McCaig, personal communication).

A dose-response relation between noise and hearing loss was established in 1970,[3] and from experimental data Professor Douglas Robinson of the Institute of Sound and Vibration Research in Southampton has estimated the risks from noise under different circumstances.[4,5]

It is generally accepted that noise levels below 80 dB(A) do not present a risk to hearing. A noise level of 90 dB(A), on the other hand, experienced every working day for 40 years, carries a 51% chance of a 30 dB(A) hearing loss. Although this represents only a moderate degree of impairment, it would, says Dr Ross Coles of the Institute for Hearing Research in Nottingham, lead to considerable difficulty in following a conversation in a pub or party where there is competing background noise. At occupational noise levels of 85 dB(A) the risk of developing a 30 dB(A) loss falls to 35%. The Health and Safety Executive estimates that in Britain 2·4 million workers are exposed to levels of more than 80 dB(A).

Deafness caused by noise at work is not a twentieth century phenomenon. It was reported among metal workers more than 250 years ago and recognised in

Measuring noise

Noise is measured in decibels (dB). The commonly used A scale (dB(A)) incorporates a weighting to take account of the ear's varying responses to different frequencies—humans are less sensitive to low frequency sounds than to high ones. Noise is measured on a logarithmic scale. This means that a noise of 100 dB(A) has 10 times as much sound energy as one of 90 dB(A). Subjectively, an increase of 10 dB(A) makes the sound twice as loud.

THE EFFECT OF BACKGROUND NOISE

With background noise at 50 dB(A) two people standing 6 m apart could engage in normal conversation. With 85 dB(A) of background noise and taking into account the fact that the voice automatically rises to compensate, a reliable face to face conversation would be possible only at a distance of less than half a metre.

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soldiers during the Napoleonic wars.[6,7] At the end of the last century it was common enough in the railway industry to be given its own name: boilermakers' deafness.[8] What is a twentieth century phenomenon, however, is the largely self inflicted damage to hearing caused by noisy social and leisure activities such as discos and personal stereos.

Disco danger

Discos are the main source of leisure noise and the most potentially damaging to hearing.[9] A report by Dr Adrian Davis and his colleagues at the Institute of Hearing Research in Nottingham estimates noise levels of about 97 dB(A) at discos, which about 6 million people attend for four hours a week for about seven years.[10] By comparison with occupational exposure the risks are small because of the shorter periods of exposure. But the effects of noise on hearing are cumulative, and people who have noisy jobs tend to have noisy pastimes. In one study 10-20% of people attending discos had noisy jobs.[9] The suggestion that other factors such as tobacco and alcohol increase the risk of hearing loss from noise remains controversial.[11] Finding suitable control subjects is difficult in a society where noisy leisure pursuits tend to be associated with smoking and drinking.

Personal stereo systems are also causing concern. An estimated 5 million people use them in Britain.[10] The National Deaf Children's Society measured the maximum sound output from a selection of machines playing tapes of Mahler's *Second Symphony*.[12] All exceeded 90 dB(A) and some exceeded 100 dB(A). The headsets do not cut out background noise so when listening in noisy conditions—for example while travelling on the underground—there is a cumulative effect. This is made worse by the need to turn the volume up to compete with the background noise. In another study by Davis *et al* the sound level selected by 24 subjects was, on average, 74 dB(A) if the music was for background listening, 83 dB(A) if it was the main item of interest, and 85 dB(A) if it was rock or pop music.[10]

Davis *et al* conclude that exposure to noise during leisure activities can be equivalent to occupational exposure of 80 dB(A) over a working life time. For those in noisy jobs, already subjected to levels of 80 dB(A) or more, leisure noise can effectively double the risk of developing hearing loss. The Royal National Institute for the Deaf has been active in publicising the possible dangers of high output personal stereo systems, especially for young children. It is calling for warnings to be printed on the packaging of personal stereos.

After a few hours of exposure to loud noise—in a disco, for example—the ears seem to acclimatise and the noise level seems to fall. This is because noise damages the hair cells in the cochlea. Put succinctly by Professor Chris Rice, director of the Institute of Sound and Vibration Research in Southampton, "You don't become accustomed to noise, you become deaf to it."

The deafness produced by intermittent exposure to loud noise is reversible, but repeated insult can cause permanent damage. Loss of hearing due to noise begins in the high frequencies. The earliest sign is a dip in the audiometry trace at about 4000 Hz. With continued exposure the deficit spreads in both directions to higher and lower frequencies.

Damage to the hair cells in the cochlea causes tinnitus, which may precede any awareness of hearing loss. The severity of the tinnitus is a good indicator of the severity of the hearing loss. Tinnitus can occur for a few minutes after exposure to loud noise—the ringing in the ears on leaving a disco, for example—or spontaneously and for longer periods. Ten per cent of adults in the United Kingdom experience spontaneous tinnitus lasting for more than five minutes.[13]

Figure 1 shows some typical noise levels. Some people seem to be more susceptible than others to the effects of noise on hearing; men are more susceptible than women, for example, although this may be a statistical quirk due to the small number of women exposed to high levels of occupational noise.[14] Brown eyed people are less susceptible than people with blue eyes, possibly because melanin on the cochlea protects it from auditory insults.[15]

Whether or not hearing loss is an inevitable consequence of aging is also controversial. Members of the primitive Mabaan tribe in Sudan are not exposed to loud noise, having no drums, let alone guns or road traffic, to contend with. Mabaan men in their 70s were found to have hearing similar to 30 year old American men who had worked in a noise free environment.[16] According to Dr Davis, however, the validity of this comparison is questionable. Professor Robinson believes that hearing loss declines naturally with age. His risk tables include one for the effects of "no noise," which predicts that one in four men in Britain will develop hearing loss of 28 dB(A) or more by the age of 60 without having been exposed to excessive noise levels.[5]

People are often reluctant to acknowledge that they are going deaf and are therefore unlikely to seek help until the problem is well advanced.[17] Problems with communication may be misinterpreted as friction with other people or a change in personality. Doctors need to be aware that noise induced hearing loss is common and preventable.

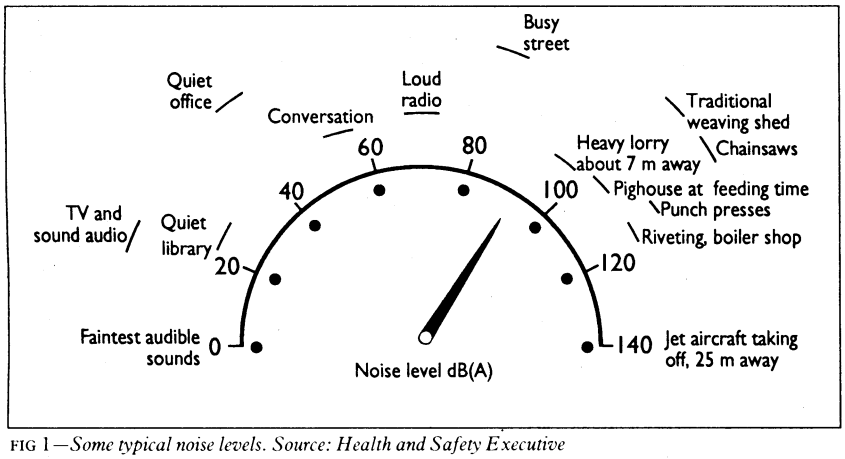

FIG 1—*Some typical noise levels. Source: Health and Safety Executive*

Prevention

Preventing hearing loss from occupational noise is one of the jobs of the Health and Safety Executive. The 1989 Noise at Work Regulations specify two action levels above which employers have an absolute duty to reduce noise by as much as is practicable.[18] At the lower level, 85 dB(A), employers must inform employees of the dangers and explain preventive measures. Ear protectors must be provided but are worn at the employee's discretion. At levels of 90 dB(A) or more employers must ensure that ear protection is worn. Ear protectors, however, have their limitations. Their efficacy tends to be over estimated,[14] and they may interfere with communication and prevent workers from hearing warning signals.

The provision of audiometric screening in the work place is recommended but not mandatory. This, says Professor Rice, is a weakness in the law. At present employees who are worried about their hearing are advised to go to their general practitioner. Since most general practitioners do not have audiometric equipment, patients are referred on to the NHS or

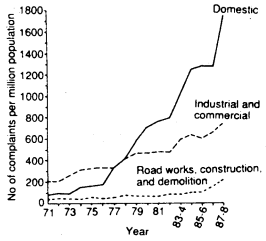

FIG 2—*Noise complaints received by environmental health officers, 1971-88. Source: Environmental Health Reports, Institution of Environmental Health Officers*[20]

to private audiologists. "On the principle that the polluter should pay," says Professor Rice, "this service should be provided by the employer." In making the provision of audiometry services in the workplace voluntary, the Health and Safety Executive has, he thinks, caved in under pressure from industry.

The Health and Safety Executive denies this charge. According to Dr R H McCaig, the current provision is in line with the 1986 European Community directive, which states that employees should be able to have their hearing checked by a doctor. It does not mention audiometry. The executive believes that it is better to encourage the provision of high standard audiometry on a voluntary basis than to force companies to provide it, in which case the standard may well fall.

Noise annoyance

The non-auditory effects of noise are more difficult to define. They have recently been reviewed for the Health and Safety Executive.[19] Noise annoyance consists of disturbance of normal activities such as speech and sleep. The number of complaints made by members of the public suggests that noise annoyance is on the increase (fig 2). In the past 20 years complaints about noise in Britain increased 20-fold (D Trippier, lecture to the Institution of Environmental Health Officers, September 1991). Last year local authorities in Britain received more than 100 000 serious complaints. According to a survey carried out in 1986-7 by the Building Research Establishment, noise from neighbours is the greatest source of complaints, annoying 14% of adults in England.[20] Two thirds of the noise nuisance from neighbours came from amplified music and dogs.

Reactions to environmental noise depend as much on the person as on the type and level of noise. Middle class people are more likely to be bothered by aircraft noise, for example.[21] Having some control over the level of noise, or even perceiving that you do, makes it easier to tolerate.[14]

Tolerance to noise varies enormously from person to person. A survey in London asked people whether they were annoyed by noise at home, out of doors, and at work.[22] For each setting respectively, 56%, 27%, and 20% said they were annoyed by the noise while 41%, 64%, and 70% noticed it but were not disturbed. The rest did not even notice it. At 45 dB(A) the average opinion was "no annoyance" but 10% of people were still highly annoyed.[22]

The British 1990 Environment Protection Act has made noise a statutory nuisance like smell or smoke. Local authorities now have a statutory duty to investigate every reasonable complaint. The act also introduced draconian penalties—£2000 fine or six months in prison—for people receiving noise abatement notices and failing to act on them. Commercial companies can now be fined up to £20 000. The problem, according to a spokesman for the Noise Abatement Society, is one of enforcement. The society believes that local authorities should provide a 24 hour complaints service since most noise nuisance occurs at night.

Traffic noise

Road traffic is a major contributor to perceived environmental noise, initiating 11% of complaints to local authorities.[20] In England and Wales in 1986, the Department of the Environment recorded 11 422 offences relating to noise from motor vehicles, 90% of which involved faulty silencers.[23] Current legislation to limit noise emissions for new motor vehicles—based on a 1984 European Community directive—puts a limit of 77 dB(A) on passenger cars and 84 dB(A) on the heaviest heavy goods vehicles. Existing vehicles are simply required not to produce "excessive" noise. There is at present no provision for noise checks as part of the Department of Transport test (MOT), although, according to Mr Andrew Brown of the department's vehicle standards and engineering division, this is being considered.

As with air pollution, tightening up on noise emissions from individual vehicles will have little effect on overall noise levels if the volume of traffic continues to grow. The United States Environmental Protection Agency is recommending that overall outdoor noise should be limited to an average of 55 dB(A) to prevent noise annoyance.[14]

Sleep disturbance

Interference with sleep is the commonest form of annoyance caused by noise. But measuring its extent and effects is fraught with difficulty. The artificial surroundings of the sleep laboratory inevitably alter subjects' reactions, while responses to questionnaires about noise and sleep tend to be highly subjective. Added to this is the problem that not all sleep disturbance is due to noise. According to a survey in Greater London, 20% of people suffer from sleep disturbance unrelated to noise.[24]

The type and timing of the noise is important. Intermittent noises or changes in noise level—as happens when an aeroplane passes overhead—are more disturbing than continuous noise of an equivalent energy level; and meaningful sounds, such as the cry of a child, are more likely to disturb sleep than neutral sounds. Sensitivity to sleep disruption due to noise is about 10 dB(A) lower in children than in adults, which means that children suffer less. The early hours of the morning are the worst time, especially for elderly people, because this is the time of lightest sleep.[14]

Sleep disturbance can mean that the person takes longer to fall asleep, wakes repeatedly, or is aware of having slept badly the next morning. Peak noise levels of 60 dB(A)—for example, from passing traffic—or an ambient level of 50 dB(A) may greatly increase the time taken to fall asleep.[25] Noise may also cause changes of which the person is unaware, such as shifts from heavy to lighter sleep, reductions in rapid eye movement sleep, and increases in body movements during the night.[14,26]

The effects of a bad night's sleep include mood change, reduced cardiovascular performance, and poor performance at intellectual and mechanical tasks. A recent review of research into noise and sleep recom-

SALLY AND RICHARD GREENHILL

The early hours of the morning are the worst time for sleep disturbance

HONEY SALVADORI/NETWORK

Ear protectors have their limitations

mends that sound at night in sleeping quarters should not exceed 45 dB(A).[14]

Noise can have positive effects. It increases arousal and may improve concentration and performance of simple, repetitive tasks, especially when the person is sleepy or unmotivated.[27] But noise worsens performance of complex or intellectual tasks. Fewer accidents occur when noise levels are reduced[27]; and American school children whose classrooms looked out on to railway lines performed less well in reading tests than similar children in classrooms on the quiet side of the school.[14] Noise also adversely affects behaviour, increasing anxiety and reducing the incidence of helpful behaviour.[14] Levels of aggression are increased by loud noise, an effect which may persist outside the noisy environment. Steelworkers have more domestic disputes if they work in noisy areas.[14]

Noise and psychiatric problems

Studies have shown a consistent relation between sensitivity to noise and psychiatric illness.[28] But there is no evidence that noise actually causes psychiatric problems. High scores on the general health questionnaire—indicating psychiatric illness—were associated with degree of annoyance due to noise rather than with the degree of noise itself.[29] Dr Stephen Stansfield and his colleagues at the Institute of Psychiatry in London found that women who were highly sensitive to noise had significantly more psychiatric symptoms, higher scores for neuroticism, and greater reactivity to other stimuli such as air pollution than women who were less sensitive to noise.[30] In a study of people suffering from depression, sensitivity to noise fell when patients recovered.[31] Stansfield concludes that sensitivity to noise acts as a non-specific marker for increased vulnerability to other stresses in the environment.

Other effects of noise

The idea that noise might jeopardise physical health became the subject of controversy in the 1980s with the publication of data suggesting increased mortality related to noise near Los Angeles International Airport. Subsequent reports found the analysis to be faulty,[32] but other studies claim to have found links between noise and several diseases including stroke, cardiovascular disease, hypertension, and peptic ulceration.[33] Experimental studies have also shown that noise can produce changes in circulation and skin resistance.[34]

There are good theoretical reasons why noise might cause such effects. It triggers the so called fight or flight mechanisms in the body, causing cardiovascular and other autonomic changes. The relation between stress and illness is now well recognised, and stress is known to be exacerbated by feelings of lack of control, such as those caused by noise inflicted by others. But assessing whether a widespread and varied environmental factor like noise contributes to common diseases is difficult. There are problems with potential confounders—smoking, alcohol, diet, age, pre-existing illness, other environmental factors—and with finding unexposed control subjects. In addition, extrapolations from experimental data, whether on humans or animals, are not always valid. In a critical review of all published studies that examined the effects of noise on cardiovascular health, Shirley Thompson of the University of South Carolina concluded that the only consistent finding was a small increase in blood pressure.[35]

Interpreting the findings creates further controversy. What, for example, might be the long term implications of a temporary increase in blood pressure due to noise? This question is now being addressed by the Medical Research Council's Caerphilly and Speedwell Prospective Heart Disease Studies.[36] So far, according to Dr Peter Ellwood, director of the council's epidemiology unit in South Glamorgan, the findings relating to noise are inconclusive.

Conclusion

Noise damages hearing. Environmental noise probably contributes little to the overall risk of hearing loss, except where loud music is concerned. Low levels of noise in the environment can, however, damage health in the wider sense of wellbeing. Noise also contributes to the dehumanising effect of our increasingly urban society.

I am grateful to Dr Adrian Davis and Professor Chris Rice for their help in preparing this article.

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