



## Report of Audiogram

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**A** 26-year-old man suffered from tinnitus, slight reduction in hearing ability and fullness in his left ear since two days before. Otoscopy revealed normal ear canal and tympanic membrane. He has worked in a utility section of a refinery company for five years and been exposed to steam out noise without wearing ear protection. The audiogram of patient is shown above.

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What's your diagnosis?

## Noise-Induced Sensorineural Hearing Loss

In the world today, noise is one of the major health problems in workers exposed to hearing harmful levels of noise in their work environment.<sup>1</sup> It is estimated that there are approximately nine million American workers with hearing loss caused by occupational exposure to noise. It is estimated that 50 million in the US and 600 million people worldwide are exposed to noise hazards occupationally.<sup>2</sup> In developing countries, the situation is usually more severe, since it is common for workers to be exposed to intense noise levels in their work places, besides low compliance with the measures used for collective and individual protection.<sup>3,4</sup>

Human ear, when exposed to sound loud enough to affect it, will show a loss of sensitivity to sound. Occupational hearing loss may be caused by explosive blasts, accidents or intense heat. Noise-induced hearing loss (NIHL) due to exposure to loud noise is the most common and most important type of occupational hearing loss.<sup>5</sup>

Noise is a waveform with a random change in amplitude. It is an unwanted sound that affects hearing in a variety of ways. Exposure to sound levels <70–80 dbA, even for a long time, does usually not cause any hearing loss. However, exposure to industrial noise levels >85–90 dbA for months or years may cause cochlear damage.

Broadband noise—the most common type of noise in industrial environment—mostly affects high frequencies ranging from 2–6 kHz (around 4 kHz). Therefore, NIHL is typically designated by the presence of a notch in this frequency range of

the audiogram<sup>6</sup> (Figure 1). Frequent audiometric evaluation of workers is the only way to actually determine whether occupational hearing loss is being prevented.<sup>7</sup>

With progression of the disease, the damage may extend to both the higher and lower tones. The lowest tones, however, are affected least and since speech reception is not altered seriously until the hearing loss is >40 db in the speech frequencies,<sup>8</sup> *i.e.*, 500–2000 Hz, substantial damage may occur before a person becomes aware of hearing loss.

### Changes in hearing due to noise

According to the World Health Organization, the excessive exposure to noise can cause other health problems, such as auditory stress under exposures of 55 dbA; physical reaction such as blood pressure raise, heart rhythm and muscle contractions; the increase in adrenaline production and other hormones; irritability; stress; insomnia and anxiety.<sup>9</sup>

People have different susceptibilities to noise-induced damage and hearing loss. It may cause temporary or permanent damage to the inner ear, although damage to the middle ear can also occur. NIHL has two phases: The first phase is called “temporary threshold shift” (TTS).<sup>4</sup> If after the noise has been eliminated, the hearing returned back to its previous level, the condition is called noise-induced TTS (NITTS). In NITTS no permanent damage has occurred.<sup>10</sup> The symptoms of NITTS may be relatively brief, lasting less than one hour or may extend up to several hours or days. The amount of NITTS developed and the duration of the recovery are related to the

duration and intensity of the noise. Nonetheless, if the hearing does not return back to its previous level, permanent damage has ensued, and thereby, the condition is termed “noise-induced permanent threshold shift” (NIPTS).<sup>11</sup>

Another type of hearing impairment is termed “acoustic trauma.” Acoustic trauma occurs following explosion and an extremely intense noise; the exposure may be brief. It causes direct damage to the hair cells of cochlea, but other structures of the auditory system such as eardrum or ossicular chain may also be damaged. Impulse noises and their effects on hearing are difficult to study because they can vary in many ways such as peak pressure change, repetition rate and the number of pulses during an exposure period.

The risk of NIPTS increases when one is exposed to a noise level above the minimum acceptable intensity (*i.e.*, 75–80 dbA).<sup>12</sup> Hearing loss develops with repeated daily exposure to noise. Long-term exposure triggers the formation of destructive molecules, the so called “free radicals,” which cause hair cell death.<sup>13</sup> The stereocilia are fused and can no longer transmit energy to the auditory nerve fibers. When hair cells are severely damaged, they will neither be recovered nor replaced by new cells—the patient develops permanent hearing loss.

During the first eight hours of working, lower level of noise produces smaller amount of NITTS. With increased exposure, the type and frequency of noise affect the extent of NITTS. For example, in low level TTS, the most affected pure tone frequencies are in the range of 2–6 kHz causing more hearing impairment.

Long-term studies have shown that there is a direct link between configuration of hearing loss and the duration of exposure.<sup>14</sup> If the exposure to noise exceeds

eight hours above the minimum intensity level (approximately 75–80 dbA) NITTS will occur. NIPTS will occur with repeated daily exposure to noise.

Persons who work in places where the noise level exceeds 85–90 dbA are required to have periodic hearing assessments so that cochlear impairment can be early detected. When hearing loss is diagnosed, it is better to transfer the worker to a less noisy area. However, if it is necessary for a person to continue working in a highly noisy area, he should use ear protectors. The available simple earplugs do not afford enough protection in industries with extremely high noise levels (*e.g.*, jet factories). In such factories, where the sound level may reach 140 dbA, persons should employ much stronger protection means and wear earplugs, muffs over the ear, and a large shield over the entire head.

## References

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Use of tiles in Islamic art. For an article on lead poisoning among traditional tile workers see page 29.