

State University of Medicine and Pharmacy

“Nicolae Testemitanu”

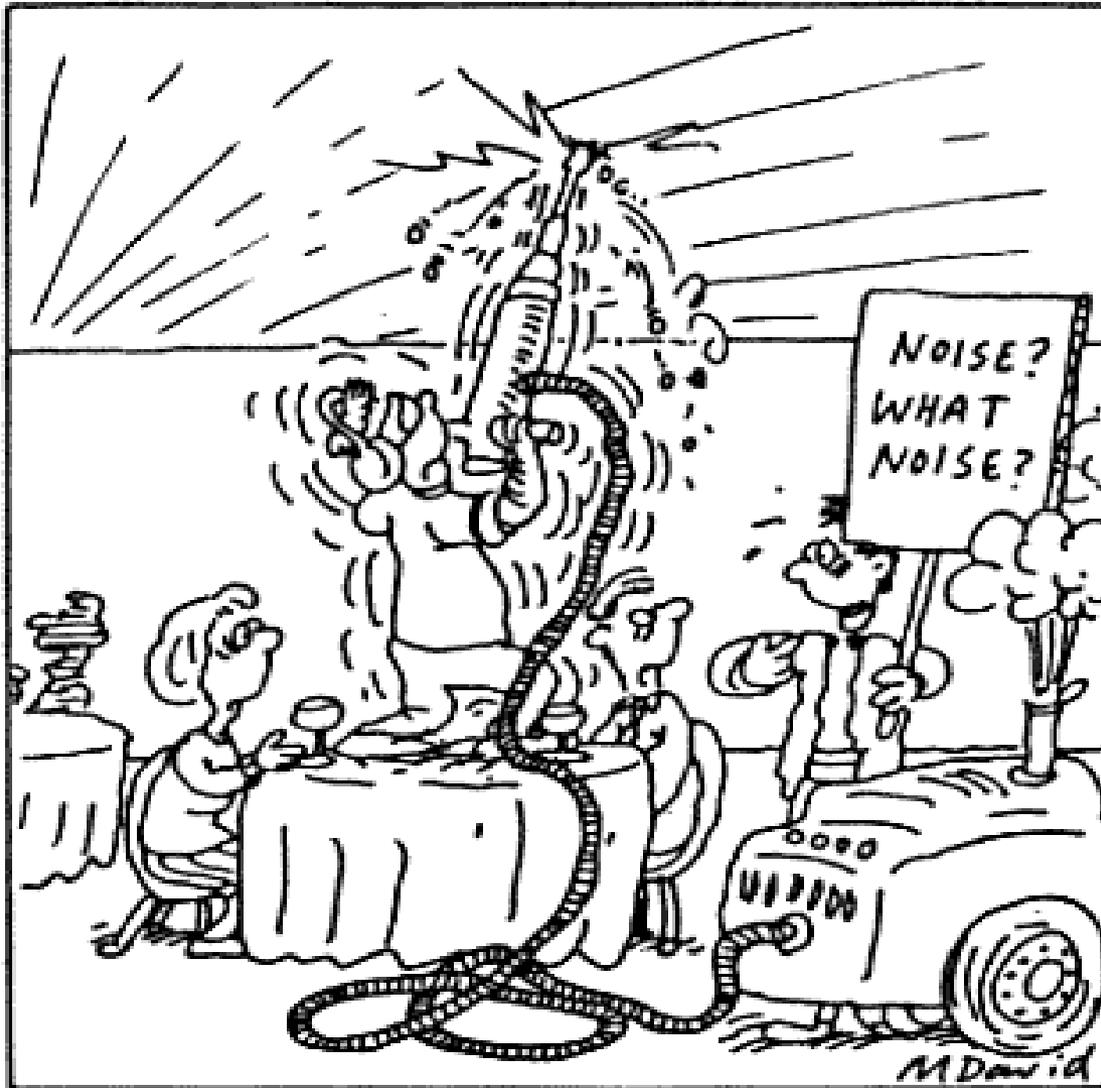
Department of Internal Medicine

**Occupational diseases induced
by physical factors.**

**Vibration, noise and non-ionizing
radiation.**

Doina Barba, MD, PhD

associate professor



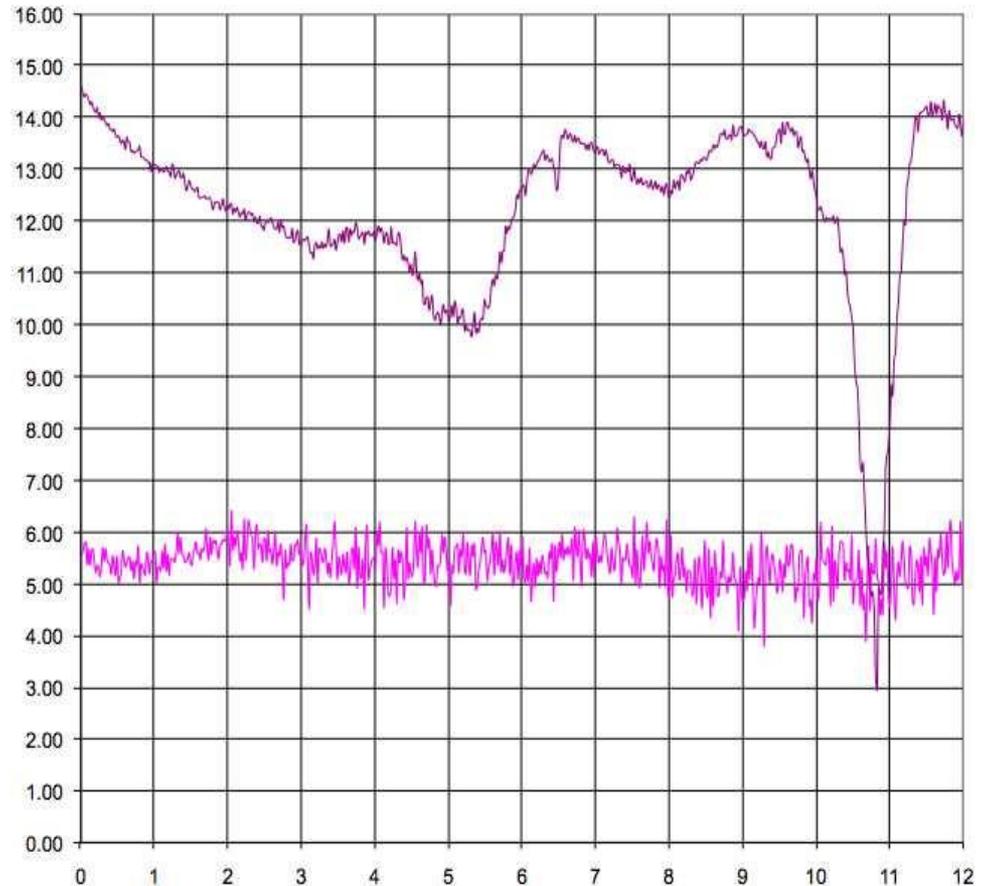
Noise

- **Noise** – any sound, especially loud or harsh or undesired.
- The most important effect of noise on men is hearing loss occurring as a consequence of exposure to loud sounds.



Noise

- Sound is the perception by the listener of the fluctuations in air pressure produced by a vibrating source.
- The loudness and character of the sound will depend on the magnitude of the pressure fluctuations and their frequency. The unit used is the decibel (dB) which is one tenth of a “bel”.



Noise

- The number of fluctuations (cycles per second) of the sound pressure wave, constitutes its frequency. The unit of measurement is the hertz (Hz), 1 hertz = being one cycle per second.
- The frequency of any sound will depend on the physical characteristic of the originating source. In an otologically normal young adult, the ear can perceive sounds in a frequency range from about 25 Hz to about 20.000Hz (20kHz).
- The human ear is most sensitive in the range 500 Hz to 4 kHz , which corresponds to the speech frequency.

Noise

- Repeated prolonged exposure to loud noise, particularly in the frequency range of 2-6 kHz causes first temporary and later permanent hearing loss owing to damage to the organ of Corti, with destruction of hair cells and eventually the auditory neurons.

Four main effects on hearing from noise exposure

- Temporary hearing loss
- Permanent hearing loss
- Tinnitus
- Recruitment

Recruitment

- **Recruitment** is a distortion of the perception of sound which occurs in individuals with severe noise-induced hearing loss.
- It is a response by the damaged cochlea in which sounds well above the threshold of hearing are suddenly heard by the deaf individual at normal or greater than normal loudness.

Non-auditory effects of noise

- Rise to difficulties due to interference with the perception of speech. When employees regularly work in loud noise levels, in the long term there will be some adaptation, such as subconscious raising of the voice and lip reading.
- Annoyance
- Reduced efficiency
- Fatigue
- Effect on mental health
- A physiological effects have been attributed to noise- such as sleep interference
- Cardiovascular function- high blood pressure
- Gastrointestinal tract – peptic ulcer
- Excess noise affect the development and reading skills of children.

NOISE THERMOMETER



140 DECIBELS
Immediate danger to hearing
Gunshot, Jet engine at take-off



120 DECIBELS
Risk of hearing damage in 7.5 minutes
Rock concert, Sandblasting

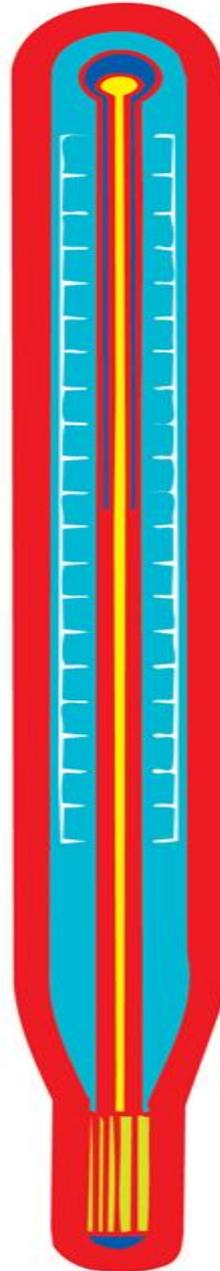


110 DECIBELS
Risk of hearing damage in 30 minutes
Snowmobile from driver's seat



100 DECIBELS
Risk of hearing damage in 2 hours
Chainsaw, Stereo headphones

90 DECIBELS
Risk of hearing damage in 8 hours
Lawn mower, Truck traffic



125 DECIBELS
Pain threshold
Air raid siren, Firecracker



115 DECIBELS
Risk of hearing damage in 15 minutes
Baby's cry, Stadium football game



105 DECIBELS
Risk of hearing damage in 1 hour
Jackhammer, Helicopter



95 DECIBELS
Risk of hearing damage in 4 hours
Motorcycle, Power Saw



85 DECIBELS
Beginning of OSHA regulations

30 DECIBELS
Faint sound
Whisper



IS IT TRUE THAT NOTHING
CAN BE DONE ABOUT
NOISE, JOHN?

YOU WILL HAVE TO SPEAK
UP. JOHN HAS BEEN
WORKING HERE A LONG
TIME.



Occupations particularly under risk for hearing loss

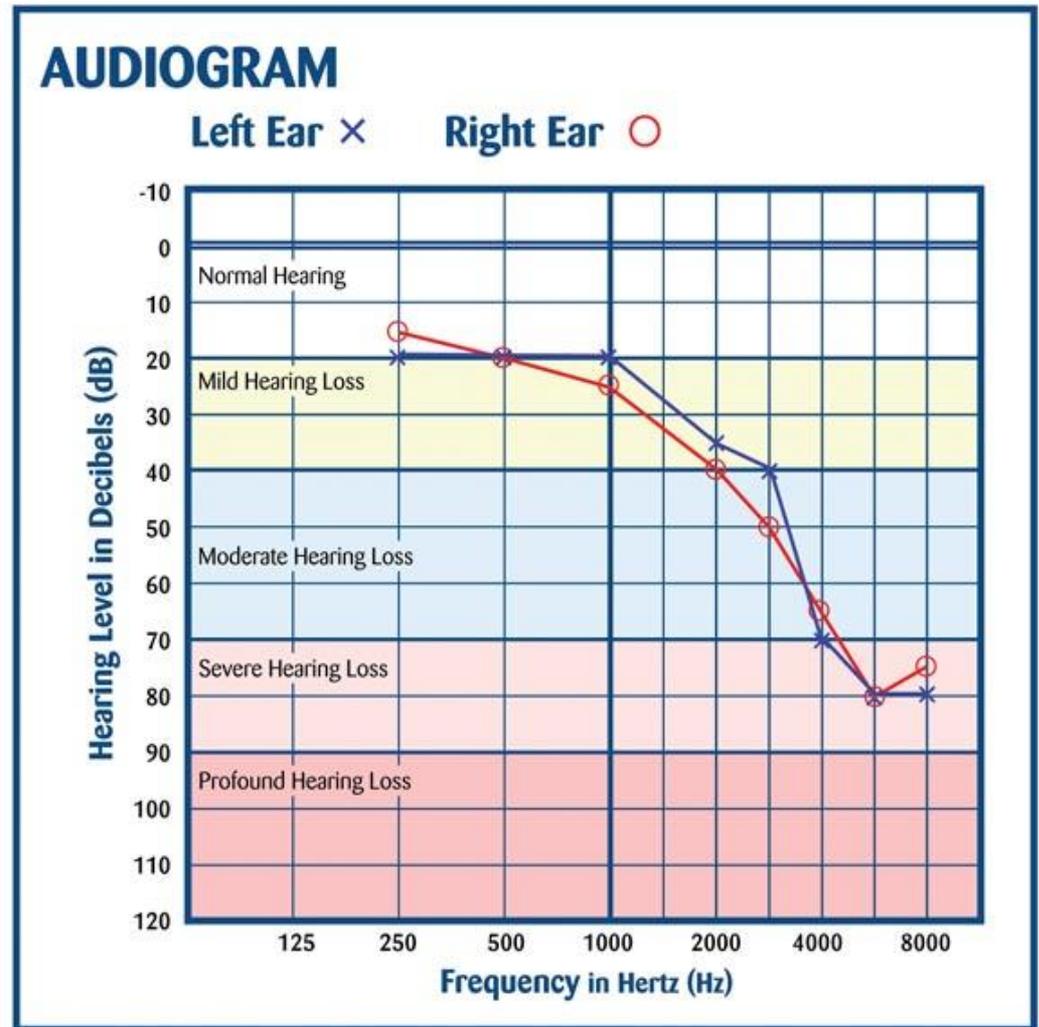
- firefighters
- police officers
- factory workers
- farmers
- construction workers
- military personnel
- heavy industry workers
- musicians
- entertainment industry professionals

Dangerous recreational activities

- video arcades
- fire crackers
- discos
- music concerts
- shooting a gun
- movie theatres
- sporting events
- motor boards
- motorcycles
- snowmobiles

Diagnosis

- Audiometry
- Tympanometry
- Evoked response audiometry.



* An example presbycusis (sloping high-frequency hearing loss) synonymous with the ageing process.

Tympanometry

- Tympanometry measures the mobility of the eardrum and is used to identify possible middle-ear dysfunction. It is helpful in detecting fluid in the middle ear, negative middle ear pressure, and disruption of the ossicles, tympanic membrane perforation, and otosclerosis.
- To perform this test, a soft probe is placed into the ear canal and a small amount of pressure is applied. The instrument then measures movement of the tympanic membrane (eardrum) in response to the pressure changes.

Tympanometry



Evoked response audiometry(ERA)

- ERA audiometry refers to an evoked potential generated by a brief click or tone pip transmitted from an acoustic transducer in the form of an insert earphone or headphone.
- The elicited waveform response is measured by surface electrodes typically placed at the vertex of the scalp and ear lobes.
- The amplitude (microvoltage) of the signal is averaged and charted against the time (millisecond), much like an EEG. The waveform peaks are labeled I-VII. These waveforms normally occur within a 10-millisecond time period after a click stimulus presented at high intensities (70-90 dB normal hearing level [nHL]).

Evoked response audiometry(ERA)



Prevention: Ear plugs



Hearing aids

- Hearing aids are technical hearing devices that are usually placed inside of the ear to help people with hearing problems.
- They use a microphone in the electrical device to take in all sound from the surrounding area, then a speaker amplifies the sound inside of the ear.
- The volume levels can be changed, depending on how loud or quiet the location is, which determines with how loud the sound is amplified into your ear

Hearing aids

Behind-the-ear

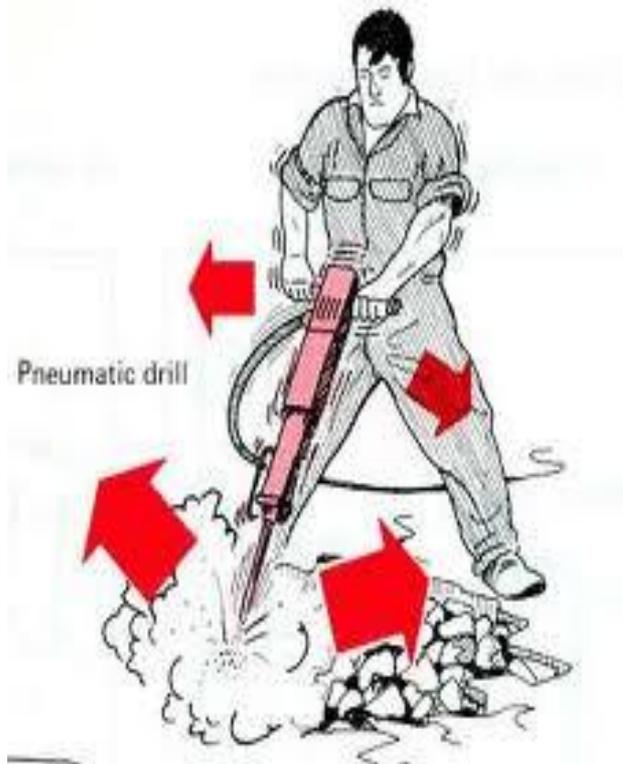


In-the-canal



In-the-ear





Vibration

Definition

- **Vibration** can be defined as the mechanical oscillation of a surface around its reference joint. It is measured in terms of
- Frequency (cycles per second (c.p.s.) or Hertz (Hz)).
- The most damaging frequencies are between 25 and 250 Hz
- Magnitude (m/s)
- Direction

Occupations particularly under risk

- ***Whole body vibration*** is most likely to affect
- drivers of tractors,
- fork-lift trucks,
- mobile cranes,
- helicopters.

Occupations particularly under risk

Hand arm vibration exposure occur in factory workers involved in

- fettling
- chipping
- grinding
- riveting
- swaging
- using drop hammers and hand-held pneumatic hammers, drills, and chisels
- forestry, agricultural and woodworkers using chain saws,
- miners drilling rock surfaces, construction, and root workers, using drills and compactors
- shoe manufacturers using polishing and rotator tools.

Clinical effects

Whole body vibration

- headache,
- motion sickness,
- sleep and visual disturbance,
- urinary and abdominal complaints,
- low back pain.

Hand transmitted vibration

- secondary Raynaud's phenomenon
- numbness
- reduced temperature
- pain
- inability to distinguish and hold small objects
- difficulty with manipulating the steering wheel of a car or buttoning up clothes

Musculoskeletal effects

- muscle weakness
- exostoses and cysts in the carpal bones
- carpal tunnel syndrome
- Osteoarthritis
- Dupuitren's contracture

Physical examination

- Callosities on the hands
- loss of touch
- pinprick or temperature sensation in the affected digits
- muscle weakness
- Phalen's sign – tingling sensation in the fingers following flexion of the wrists.
- Tinel's sign – sharp tingling along the path of the median nerve on tapping the wrist over the site of the carpal tunnel.

Raynaud phenomenon



Clinical and special tests

- Compression of the nail bed of affected digits for 10 sec. May show delayed (> 5 sec.) return of the digital circulation (**Lewis-Prusik test**).
- **Finger plethysmography** allows measurement of changer in finger systolic pressure and finger vascular circulation following local cooling.
- **Digital blood pressure measurement** using a Doppler device may demonstrate a fall in pressure after attempt to provoke digital pallor.
- **Sensory aesthesiometry** may detect early loss of tactile perception.
- **Vibrometer** for evaluating thresholds of perception of vibration.



Management, treatment and prevention

- The action of choice is to eliminate or reduce the source of vibration.
- Specially designed gloves can keep the hand, for warm and reduce vibration transmission.
- Keeping the body and hands warm, especially in cold weather or when working with cold or pneumatic tools, and cessation of cigarette smoking.
- Vasodilatory drugs have been used to alleviate symptoms in severe cases. These drugs include calcium antagonists such as verapamil and nifedipine, angiotensin converting enzyme inhibitors, prostaglandins have also been tried.

Radiation

Radiation are either ionizing or non-ionizing.

Ionization involves the forcible ejection of an orbital electron from an atom of matter creating an ion. When this take place in a molecule of biological importance it may lead to biological damage.

Non – ionizing radiation may be capable of excitation , but cannot convey sufficient energy to the target molecules to produce this gross structural change.

non-ionizing

ionizing



extremely low frequency

radio

infrared

ultraviolet

microwave

x-ray

gamma rays

visible light

non-thermal

thermal

optical

broken bonds

induces low currents

induces high currents

excites electrons

damages DNA

???

heating

photochemical effects

static field
power line

AM radio

FM radio
TV

microwave oven

heat lamp

tanning booth

medical x-rays

Non – ionizing radiation



Potential biological effects

- The optical radiation portion, where electron excitation can occur (visible light, infrared light)
- The portion where the wavelength is smaller than the body, and heating via induced currents can occur (MW and higher-frequency RF)
- The portion where the wavelength is much larger than the body, and heating via induced currents seldom occurs (lower-frequency RF, power frequencies, static fields)

	Source	Wavelength	Frequency	Biological effects
<u>UVA</u>	<u>Black light</u> , sunlight	318– 400 nm	750–950 THz	Eye – <u>photochemical cataract</u> ; skin – erythema, inc. pigmentation
<u>Visible light</u>	<u>Lasers</u> , sunlight, <u>fire</u> , light bulbs	400– 780 nm	385–750 THz	Skin <u>photoaging</u> ; eye – photochemical & thermal retinal injury
<u>IR-A</u>	<u>Lasers</u> , remote controls	780 nm – 1.4 μm	215–385 THz	Eye – thermal retinal injury, thermal cataract; skin burn
<u>IR-B</u>	<u>Lasers</u>	1.4– 3 μm	100–215 THz	Eye – <u>corneal burn</u> , cataract; skin burn
<u>IR-C</u>	<u>Far-infrared laser</u>	3 μm – 1 mm	300 GHz – 100 THz	Eye – corneal burn, cataract; heating of body surface

Biological effects

<p><u>Microwave</u></p>	<p>PCS phones, some mobile/cell phones, microwave ovens, cordless phones, motion detectors, long-distance telecommunications, radar, <u>Wi-Fi</u></p>	<p>1 mm – 33 cm</p>	<p>1– 300 GHz</p>	<p>Heating of <u>body tissue</u></p>
<p><u>Radio-frequency radiation</u></p>	<p>Mobile/cell phones, television, FM, AM, shortwave, CB, cordless phones</p>	<p>33 cm – 3 km</p>	<p>100 kHz – 1 GHz</p>	<p>Heating of body tissue, raised body temperature</p>

Biological effects

Low-frequency RF	Power lines	>3 km	<100 kHz	Cumulation of charge on body surface; disturbance of nerve & muscle responses
Static field ^[3]	Strong magnets, MRI	Infinite	0 Hz	Magnetic – vertigo/nausea; electric – charge on body surface

Non-ionizing radiation detectors



Protection

ICNIRP mission is to screen and evaluate scientific knowledge and recent findings toward providing protection guidance. The commission produces reviews of the current scientific knowledge and guidelines summarizing its evaluation. ICNIRP provides its science-based advice free of charge.



Four major ways to reduce radiation exposure to workers or to population:

- Shielding. Use proper barriers to block or reduce ionizing radiation.
- Time. Spend less time in radiation fields.
- Distance. Increase distance between radioactive sources and workers or population.
- Amount. Reduce the quantity of radioactive material for a practice.

ALARP

- ALARP, is an acronym for an important principle in exposure to radiation and other occupational health risks and stands for "***As Low As Reasonably Practicable***".

Thank you for your attention!