



Using a personal audio device in a noisy environment increases the risk of noise-induced hearing loss.
MOROCCO

PHOTO: ADRIEN DELFORGE/UNSPLASH

Preventing hearing loss



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What do we mean by prevention?

Many organisations subdivide preventive measures into primary, secondary and tertiary prevention:

- **Primary prevention** refers to measures aimed at intervention before adverse health effects occur. Examples of primary prevention aimed at hearing loss would include immunisation programmes, reduction of harmful noise exposure and safe use of ototoxic medications.
- **Secondary prevention** measures aim to prevent disability by prompt detection and treatment, such as neonatal hearing screening programmes leading to early amplification, or treatment of chronic otitis media.
- **Tertiary prevention** measures aim to minimise the effects of existing disability by active rehabilitation, for example by fitting hearing aids or providing special education to minimise restrictions to communication.

In addition to these three categories, the notion of 'primordial prevention' is used to refer to actions aiming to prevent the occurrence of risk factors for a disease.

More recently, in 2021, the World Health Organization (WHO)'s *World Report on Hearing* placed prevention within the wider framework of a hearing capacity that evolves throughout the life course.¹ Each individual has their own baseline hearing capacity at birth, which evolves throughout their life in response to their exposure both to **causative factors** that

lead to hearing loss (genetic, biological, behavioural) and to **protective and preventive factors** that help preserve their hearing capacity. These two types of factors are illustrated in Table 1 on page 2 and in the box on page 3. The *World Report on Hearing* highlights that effective preventive actions against hearing loss can be implemented throughout the life course, whether they are public health measures supported by health workers or lifestyle changes made by individuals.

Why should we spend money and resources to prevent hearing loss?

At present about half a billion people worldwide have hearing loss to such a degree that it has a negative influence on their daily life experience. With global population growth and improved life expectancy, the number of people with disabling hearing loss is estimated to rise to 509 million by 2030 and to over 700 million by 2050.² Although hearing loss is a massive global issue, it often seems as if measures to prevent hearing loss are not given the recognition that they deserve. This is an era when there are conflicting demands on healthcare resources, and 90% of those with moderate and profound hearing loss live in low- and middle-income countries (LMICs) where health needs are greater and resources scarcer.

However, there are in fact many reasons why we should expend money and resources on preventing hearing loss:

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TABLE 1 CAUSATIVE FACTORS THAT LEAD TO HEARING LOSS ACROSS THE LIFE COURSEⁱ

Prenatal period <ul style="list-style-type: none"> Genetic factors Intrauterine infections (toxoplasmosis, rubella, cytomegalovirus, Herpes simplex 1 and 2, HIV, syphilis, Zika, lymphocytic choriomeningitis virus) 	Perinatal period <ul style="list-style-type: none"> Hypoxia or birth asphyxia Low birth weight Hyperbilirubinemia Other perinatal morbidities (cytomegalovirus, meningitis) and their management (ototoxic medication)
Childhood and adolescence <ul style="list-style-type: none"> Otitis media Meningitis, measles, mumps and other infections 	Adulthood and older age <ul style="list-style-type: none"> Chronic diseases Otosclerosis Smoking Age-related sensorineural degeneration
Factors that can occur at any age <ul style="list-style-type: none"> Impacted ear wax Trauma to the ear or head Loud sounds Ototoxic medicines Work-related ototoxic chemicals Nutritional deficiencies (e.g. deficiencies in vitamin A, zinc, or iron) Viral infections (HIV, Herpes simplex 1 and 2, Ebola, Lassa, West Nile virus) Other ear conditions (such as Meniere's disease, vestibular schwannoma, and autoimmune diseases) Non-modifiable risk factors (such as syndromes or genetic mutations associated with hearing loss) 	

ⁱ This table is extracted from Table 1.1 in: World Health Organization. *World Report on Hearing*. Geneva: WHO, 2021. 14–17.

A large proportion of hearing loss is preventable

Many causes of hearing loss are avoidable (see Table 1 on this page) and a large proportion of existing hearing loss can be prevented. Indeed, for children under the age of 15, WHO estimates that about 60% of hearing loss is preventable.³ In adults, the most common causes of hearing loss – exposure to loud noise or ototoxic chemicals – are preventable.

Preventing hearing loss is very cost-effective

There is good evidence that strategies to prevent hearing loss are very cost-effective.⁴

At an individual level, the burden of hearing loss is expressed in many ways, including potential difficulties with communication, stigmatisation, reduced employment opportunities and social isolation. When the costs over a lifetime at both individual and societal levels are taken into account, the financial benefits of preventing hearing loss and its effects are massive: the impact of unaddressed hearing loss on health, education and productivity

is estimated to cost over 980 billion US dollars annually worldwide.⁵

In addition, many initiatives to improve population health often prevent hearing loss in parallel. For example, mass immunisation programmes contribute to preventing hearing loss although this is not their primary aim (see page 4 of this issue): it is estimated that over 19% of childhood hearing loss could be prevented through immunisation against rubella and meningitis alone.⁶

There are many ways to contribute to the prevention of hearing loss

WHO's *World Report on Hearing* lists the following as 'effective strategies for reducing hearing loss':⁷

- Immunisation
- Good maternal and childcare practices
- Genetic counselling
- Occupational hearing conservation programmes for noise and chemical exposure
- Safe listening strategies for the reduction of exposure to loud sounds in recreational settings



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- Rational use of medicines to prevent ototoxic hearing loss
- Identification and management of common ear conditions.

These strategies span an unusually broad area of intervention and most of them are not expensive. This is because preventable hearing loss can occur throughout our lifespan and is caused by a number of avoidable causes. It follows that the scope for effective preventive action is particularly wide.

The variety of measures to prevent hearing loss is shown in Table 2 using the six levels for strategy development described in Larry Cohen's 'Spectrum of prevention', which is a useful framework for developing a comprehensive approach to prevention.⁸

Health personnel who are not specialised in EHC can play a key role in preventing hearing loss

Particularly in LMICs, there are insufficient numbers of personnel trained in ear and hearing care (EHC). However, when it comes to preventing hearing loss, much can be done by personnel who are not specialised in EHC. In fact, in WHO's list of seven effective strategies for reducing hearing loss, only two – 'identification and management of

WHAT INDIVIDUALS CAN DO TO MAINTAIN THEIR HEARING CAPACITY THROUGHOUT THEIR LIVESⁱⁱ

The most relevant protective and preventive actions that can be undertaken by individuals across the life course are:

- Maternal nutrition
- Maternal hygiene
- Breastfeeding
- Good ear hygiene
- Avoidance of tobacco
- Good nutrition across the lifespan
- Protection against head or ear injury (e.g. helmets)
- Healthy lifestyle
- Immunisation
- Avoidance of loud sounds

ⁱⁱThis box is extracted from Table 1.2 in: World Health Organization. World Report on Hearing. Geneva: WHO, 2021. 30–32.

common ear conditions' and 'occupational hearing conservation programmes' – need to be carried out by personnel with at least some training in EHC.

Generic healthcare providers are often, through no fault of their own, poorly educated in hearing loss and ear disease. This issue of *Community Ear and Hearing Health* aims to show the many ways in which they can help prevent hearing loss and help usher in a time when preventive measures effectively reduce the huge burden of disease caused by hearing loss.

TABLE 2 THE SPECTRUM OF PREVENTION: A FRAMEWORK FOR A COMPREHENSIVE APPROACH TO PREVENTIONⁱⁱⁱ

Levels of prevention	Examples relating to the prevention of hearing loss ^{iv}
1. Strengthening individual knowledge and skills <i>Enhancing individual capacity</i>	<ul style="list-style-type: none"> • Personal awareness of the harmful effects of excessive noise from personal audio devices such as smartphones and noisy entertainment venues • Awareness of the importance of hearing in maximising opportunities for education and employment
2. Promoting community education <i>Reaching groups with information and resources</i>	<ul style="list-style-type: none"> • Awareness programmes for promoting ear and hearing care within the community (e.g. importance of basic ear care and positive effects of good nutrition⁹ and hygiene) • Awareness programmes alerting people to the harmful effects of loud noise
3. Educating providers <i>Informing providers who influence others</i>	<ul style="list-style-type: none"> • Training of primary care health workers and physicians in the relevance of ear diseases and the need for early intervention • Educating healthcare workers on the potential dangers of misuse of ototoxic medicines • Educating maternal and child health providers on the importance of good antenatal care in preventing hearing loss
4. Fostering coalitions and networks <i>Convening groups and individuals for greater impact</i>	<ul style="list-style-type: none"> • Encouraging the formation of support groups (local, regional and national) for people with hearing loss and their families
5. Changing organisational practices <i>Adopting regulations and shaping norms</i>	<ul style="list-style-type: none"> • Implementation of early intervention programmes such as neonatal and school hearing screening, leading to prompt diagnosis and rehabilitation • Optimisation of educational provision within a local context so that children with hearing loss are not neglected • Encourage noisy industries to have workplace hearing screening programmes
6. Influencing policy and legislation <i>Developing strategies to change laws and policies</i>	<ul style="list-style-type: none"> • Formal and legally enforced limits to occupational noise exposure • Limiting environmental noise, which has been recognised as having harmful effects on the overall burden of disease¹⁰ • National immunisation programmes • National drug regulatory mechanisms to restrict the sale and use of ototoxic medicines

ⁱⁱⁱThis is based on the framework presented in: Cohen L and Swift S. The spectrum of prevention: developing a comprehensive approach to injury prevention.⁸

^{iv}It is important to appreciate that some preventative measures fall into more than one level.

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Preventing hearing loss with vaccination



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Many avoidable causes of hearing loss, particularly in low- and middle-income countries (LMICs), are infectious diseases that can be prevented by existing vaccines. This is why the 2017 World Health Assembly Resolution on the prevention of deafness and hearing loss¹ urges Member States 'to ensure the highest possible vaccination coverage against rubella, measles, mumps and meningitis'. The greatest progress to date in preventing severe to profound sensorineural hearing loss can be attributed to the measles and rubella vaccines, and the bacterial meningitis vaccines (targeting *Haemophilus influenza* type b, pneumococcal and meningococcal disease).²

Many of these vaccines are included in the World Health Organization (WHO)'s Expanded Programme on Immunisation (EPI). Immunisation programmes are now routinely reaching over 80% of children under one year of age and, since 2000, the Global Alliance for Vaccination and Immunisation (GAVI) has contributed to a steady increase in vaccine coverage in poorer countries.

Vaccine-preventable diseases causing hearing loss

Rubella: Rubella is usually a mild viral disease affecting susceptible children and young adults worldwide. Rubella infection in early pregnancy may result in miscarriage, foetal death or serious congenital defects (including severe or profound sensorineural hearing loss), known as congenital rubella syndrome (CRS).³ Large-scale rubella vaccination during the last decade has drastically reduced or practically eliminated rubella and CRS in many high-income countries and in some LMICs. Countries should consider starting rubella vaccination only if they can achieve a coverage level of 80% or greater.

Tuberculosis (TB): Sensorineural hearing loss is estimated to occur in 10–30% of tuberculous meningitis survivors. It may also occur following treatment with streptomycin, an ototoxic antibiotic (not now used in first-line TB treatment). The BCG vaccine, which protects against TB, was first used in 1921. BCG vaccination of infants should be done at or soon after birth.

Measles: Measles virus infection manifests as fever, rash, conjunctivitis, and bronchitis, with about 1% of infected children developing severe complications such as encephalitis in LMICs. It may lead to high mortality, especially in young children. The hearing loss due to measles is sensorineural and is usually in both ears. It may be moderate or profound. Measles vaccine is given either alone, or in a measles-rubella (MR), measles-mumps-rubella (MMR), or measles-mumps-rubella-varicella (MMRV) combination.

Mumps: Mumps virus infection causes fever, rash, parotitis and orchitis and is occasionally complicated by aseptic meningitis. Mumps likely causes sensorineural hearing loss through labyrinthitis which is often unilateral (80%).

Meningococcal meningitis: Meningitis, particularly meningococcal meningitis, is a recognised cause of severe and profound deafness as well as other neurological sequelae.⁴ Meningococcal meningitis is largely vaccine-



DAVID MARKPITABAY

Vaccination against certain diseases helps prevent hearing loss

preventable and several vaccines are available for protection from the most common serogroups causing disease.

Pneumococcal disease and otitis media:

Pneumococcal disease affects a large proportion of all populations. Clinical manifestations of infection include sepsis, bacteraemia, meningitis, pneumonia, bronchitis, sinusitis, otitis media, arthritis, and osteomyelitis. The association with hearing loss is most likely to occur through meningitis and otitis media. Out of over 90 serotypes, only a small minority cause most disease. There are two available pneumococcal conjugate vaccines (PCV) that target either 10 or 13 of the most prevalent serotypes. WHO recommends their inclusion in childhood immunisation programmes worldwide.⁵

Haemophilus influenza type b (Hib): Manifestations of infection with Hib include sepsis, bacteraemia, meningitis, epiglottitis, pneumonia, cellulitis, arthritis, and osteomyelitis. The association with hearing loss is most likely to occur through meningitis and associated inflammation of the cochlea. Hib meningitis is complicated by sensorineural hearing loss in around 3–8% of affected children. WHO recommends the inclusion of Hib vaccines in all routine infant immunisation programmes.⁶

Future developments

Malaria: Malaria is a life-threatening disease, particularly amongst infants and children in Africa, and its complications, especially cerebral malaria, may cause hearing loss in survivors. Malaria treatment drugs such as quinine and chloroquine are ototoxic and may also cause hearing loss.

There is currently no commercially available malaria vaccine, but over 20 vaccine constructs are currently being evaluated in clinical trials or are in advanced preclinical development⁷ and it was recently announced from early vaccine trials that the R21/Matrix-M was the first malaria vaccine in children aged 5–17 months to reach the 75% efficacy target set by WHO.⁸

Otitis media: Worldwide, the majority of mild and moderate conductive hearing loss is associated with otitis media, which is to some extent a vaccine-preventable disease. The development, in the future, of otitis media vaccines that protect against common respiratory pathogens could greatly reduce the frequency of mild and moderate hearing loss in young children.²

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Preventing hearing loss in primary healthcare



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The World Health Organization (WHO) estimates that half of all causes of hearing loss can be prevented through public health measures.¹ There are no specific figures available about what proportion of those public health interventions can be channelled through, or carried out, at Primary Health Care (PHC) level. However, the authors of this article firmly believe that the prevention of hearing loss at this level of care can and should have the greatest impact:

- Small children and mature adults are the most frequent users of PHC services,² and not just in low- and middle-income countries (LMICs). WHO estimates at 60% the proportion of causes of hearing loss which are preventable in children under 15 years of age across the world (up to 75% in LMICs).¹
- Since the beginning of recorded history, young children have outnumbered their elders, but this demographic trend has now changed. The number of people aged 65 or older is projected to grow from an estimated 524 million in 2010 to nearly 1.5 billion in 2050, with most of the increase in developing countries.³ Although most of the hearing loss acquired by people in this age group may not be completely avoided, awareness about other causes of hearing loss and early detection by PHC workers will prevent complications and reduce the severity of age-related hearing loss (presbycusis). This will improve the quality of life of mature adults.
- Primary healthcare workers (PHWs) are the first line of healthcare. This is particularly relevant in LMIC settings where paediatric and geriatric services are not readily accessible.
- In many settings in LMICs, PHWs are often the only health workforce available, and PHC is the only level of care available in every country.
- PHWs who are not specialised in Ear and Hearing Care (EHC) can play an important role in preventing hearing loss.

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Measures and interventions for the prevention of hearing loss are multifactorial and multilevel initiatives that involve all levels of healthcare, but this article focusses only on preventive measures which are within the scope of community and PHC levels. It describes the different situations in which PHWs can contribute to preventing hearing loss throughout the lifespan: firstly, in young children, when prevention is particularly important; secondly, when patients of any age seek advice about problems related to ear or hearing, or have complaints that carry a risk of hearing loss.

Note: Vaccination programmes are another way in which PHWs can help to prevent hearing loss. This is covered in the article on page 4 of this issue.



Community health worker advocating for ear health. NEPAL

Pre- and postnatal consultations

Family planning, genetic counselling, prenatal and postnatal care are usually included in a country's primary healthcare. These give PHWs the opportunity to help prevent hearing loss.

1 Family planning and genetic counselling

Family planning: This can help patients avoid undesired adolescent pregnancies. Adolescent pregnancies can be associated with prematurity and low birth weight,⁴ which are high risk factors for congenital hearing loss.⁵

Genetic counselling: This can be used to identify consanguinity between prospective parents and to explore the existence or suspicion of hereditary hearing loss among their relatives. These are recognised risk factors for being born with congenital hearing loss. Genetic counselling does not necessarily imply or require the existence of specialist services such as karyotyping, which are expensive and not always available. A brief interview with the parents-to-be may be sufficient.

2 Prenatal care and maternal health

Prenatal care is already embedded into PHC services, as a means to control the progress of normal pregnancies. It can be helpful to detect conditions (treatable or not) which could affect the hearing or ear development of the unborn baby.

The following infections should be identified or suspected prenatally by PHWs:

- Syphilis
- Toxoplasmosis
- Rubella
- Cytomegalovirus (CMV)
- Herpes.

PHWs can identify these conditions before the baby is born, treat them when feasible, and diagnose any complications as soon as possible after birth. Early treatment of these conditions, when available, can avoid or reduce the occurrence of hearing loss.

3 Postnatal care

Globally, in 2019, 81% of births were assisted by skilled health professionals, which generally includes a general doctor, nurse or midwife;⁶ however, the proportion of births that take place in health facilities

Continues overleaf ➤

varies considerably across the world, from 99% in Western Europe to only 57% in sub-Saharan Africa, which also varies between urban areas (78%) and rural areas (48%).⁶ Although these figures highlight the urgent need to improve maternal and perinatal health coverage, they also indicate the relevance and key role that PHWs could potentially have in the prevention and early identification of hearing loss:

Early detection of hearing loss: In health facilities, newborn early detection programmes can be implemented, taking advantage of the hours or days during which the baby remains in a controlled health setting before being sent home. Outside these facilities, at PHC level, there are hearing screening techniques, some of them inexpensive, which can be carried out by PHWs. These include physiological (objective) measures, high-risk registers, family questionnaires and assessments of behavioural response. However, for hearing screening activities at PHC level to be sustainable, there needs to be an established screening programme. This programme should be multidisciplinary and include objective screening and diagnosis.⁷

Knowledge of high-risk factors: High-risk factors associated with hearing loss in babies and young children should be known and recognised by all PHWs. These are:⁵

- Family history of permanent childhood hearing loss
- Neonatal care involving any of the following:
 - intensive care of more than 5 days
 - assisted ventilation
 - exposure to ototoxic medications, such as certain antibiotics (gentamicin, tobramycin, amikacin, streptomycin, etc.), loop diuretics (furosemide), cancer treatment (chemotherapy), etc.
 - hyperbilirubinemia (jaundice) that requires exchange transfusion
- In-utero infections that could have damaged the baby's hearing (see above).
- Craniofacial anomalies close to, or involving, the ear.
- Postnatal infections associated with hearing loss, including confirmed bacterial and viral meningitis.
- Certain syndromes are associated with hearing loss. PHWs should keep this in mind when presented with combinations of unusual physical findings (e.g. differently coloured eyes, a white forelock, low vision, etc.) associated with hearing loss.

When faced with a baby or young child presenting those risk factors, PHWs should refer them to specialist EHC services as soon as possible, for diagnosis confirmation and appropriate management.

Advice on hearing conservation: PHWs can also provide advice to help preserve babies' hearing, such as the promotion of breastfeeding, immunisation, and good habits for ear and hearing health.⁸

Preventing hearing loss: when a patient seeks help for hearing problems

This is the simplest situation in which a PHW can help prevent hearing loss. They can:

- Check the patient's impression that their hearing has diminished and/or validate caregivers' concerns regarding a child's hearing, speech, language or developmental delay.⁹
- Explain to the patient or caregiver that early actions can help prevent hearing loss, or reverse it, or prevent it from becoming more severe; early intervention can also contribute to re/habilitate persons with hearing disability and improve their quality of life.



Training session in primary ear and hearing care. NIGERIA

Beware that, for some patients, the main presenting symptom is tinnitus (noises in the ear). Tinnitus is frequently associated with hearing loss, therefore the first thing to do is to check the person's hearing. However, PHWs should keep in mind that tinnitus may also have many other different causes which need to be explored by an ear, nose and throat (ENT) doctor when possible.

Preventing hearing loss: when a patient seeks help for ear problems

The following ear conditions require hearing evaluation (including bone conduction whenever possible) after the patient has undergone medical and/or surgical treatment, whether that treatment takes place at PHC or specialist care level:¹⁰

- Impacted ear wax
- Foreign bodies in the ear
- Otitis externa (inflammation of the outer ear)
- Ear trauma (either self-inflicted with cotton-buds, hairpins, etc., or other types)
- Recurrent Acute Otitis Media or AOM (more frequently found in children)
- Otitis Media with Effusion (OME) which does not disappear after three months of follow-up (this is the most frequent cause of hearing loss in children)
- Chronic Suppurative Otitis Media (CSOM)
- Dry tympanic membrane perforation which persists after six months of follow-up
- Tympanic membrane retraction or pockets (all types)
- Presence or suspicion of cholesteatoma (all cases need to be referred to an ENT department)
- Children who have had complications from middle ear disease (retro-auricular fistula, mastoiditis, facial palsy, meningitis, brain abscess, etc.).

Preventing hearing loss: when a patient seeks care for unrelated symptoms

In some cases, patients will consult primary healthcare services for symptoms that may seem to have no direct link to ears or hearing, but they are actually at risk of hearing loss. Even if hearing loss may not seem an immediate priority at the time of consultation, due to the severity of the main complaint, it is important to take action on avoidable causes in order to prevent hearing loss.

PHWs should keep in mind the risk of hearing loss when patients consult for the following reasons:

- Dizziness or vertigo
- Head trauma, especially a basal skull/temporal bone fracture requiring hospitalisation
- Meningitis
- Measles
- Mumps
- Autoimmune conditions
- Cancer (neoplasia) treatment (chemotherapy, radiotherapy, etc.)
- Conditions which require the use of ototoxic drugs (see article on page 8)
- Chronic health conditions: HIV-AIDS, tuberculosis, diabetes, hypertension, vascular diseases, tobacco, neurodegenerative disorders, etc.

Awareness and screening activities: preventing hearing loss throughout the lifespan

PHWs can raise awareness of risk factors for hearing loss and, when possible, can also screen for hearing loss and help prevent further damage. As some avoidable causes of hearing loss are more prevalent at specific ages (see Figure 1), the focus of activities will vary depending on the age group targeted:

Children

- Promote vaccination and good habits for healthy ears.
- Raise awareness of the important link between sound stimulation and the acquisition of language and communication skills in babies and young children. Early detection and intervention result in better communication skills.
- Explain the impact that even a temporary hearing loss will have on a child's academic achievements and behaviour at school.
- Promote early intervention to facilitate communication for children with permanent hearing loss, as well as additional help in the classroom in their later years, irrespectively of the degree and type of hearing loss.

Teenagers

- Promote healthy habits related to noise exposure, in particular recreational noise, to avoid hearing loss.¹¹
- Contribute to early suspicion and diagnosis of hearing loss, in order to promote behavioural changes for hearing conservation before communication is affected.

Adults

- Raise awareness of occupational hearing loss and promote behavioural change as well as enforcement of local legislation on the matter.
- Advocate for policy-makers and employers to contribute towards personal protection for workers and safer working environments.¹²

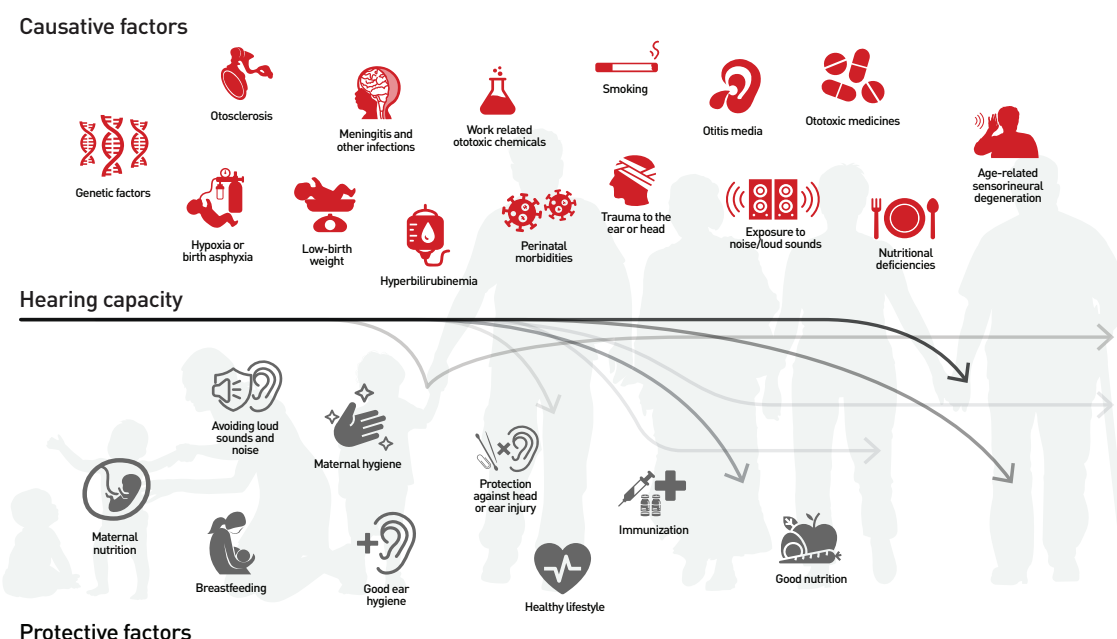
Mature adults

Specific to mature adults is the condition presbycusis, or hearing loss related to ageing. One out of every three persons over 65 years of age has a disabling hearing loss,¹ and many more have mild or unilateral hearing loss in this age group. Although presbycusis cannot be prevented, PHWs can help promote early diagnosis and raise awareness about the use of hearing devices.¹³ This will greatly improve patients' quality of life and help prevent social isolation as well as mental health problems linked with unaddressed hearing loss.¹⁴

Conclusion

Very often, when designing and implementing a programme for EHC at national or sub-national level, the first cadres of health workers taken into consideration are the specialist professionals (ENT specialists, audiologists, etc.). However, primary healthcare, as the only level of care available in every country, is the entry point and a core component of any successful EHC programme established within national health systems and services. As can be seen in this article, primary healthcare workers can, and should, play an essential role in awareness raising, in the prevention of ear diseases and in early intervention for the re/habilitation of hearing loss. This will contribute towards a more inclusive society for all.

FIGURE 1 HEARING ACROSS THE LIFE COURSE*



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Preventing ototoxicity and its effects



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TREATING DISCHARGING EARS: BEWARE OF OTOTOXICITY

Topical aminoglycosides are still often used as a first-line treatment of chronic suppurative otitis media (CSOM), although they carry a risk of ototoxicity, especially with longer-term or repeated use.

It has been suggested that, when possible, topical quinolones be used, as they do not carry the same risk.¹¹

When topical aminoglycosides are the only available choice to treat CSOM, ENT-UK has issued the following guidelines for safer use:¹²

- Only use a topical aminoglycoside in the presence of obvious infection when suitable non-ototoxic antibiotics could not be used.
- Do not use for longer than 2 weeks.
- If possible or practical, baseline audiometry should be performed before treatment (at least bone conduction thresholds).
- The justification for using topical aminoglycosides should be explained to the patient.

The term ototoxicity is used to refer to temporary or permanent damage to the audiovestibular system as a result of medicines or chemicals. The ototoxic substances may target:

- The vestibular system, which is important for balance
- The cochlea, which is the organ of hearing
- The auditory pathways, which convey signals from these structures to the auditory cortex/vestibular cortex
- A combination of these.

Although studies from many countries have shown that ototoxicity is not a major cause of hearing loss or balance problems, it is important as it is potentially preventable. It is more prevalent in low- and middle-income countries (LMICs) due to a lack of understanding amongst health workers and insufficient resources to identify improper use of medicines and chemicals. Health workers may not have come across ototoxicity in their training. Laboratories in hospitals may lack the facilities to monitor the blood levels of ototoxic drugs and industrial use of ototoxic chemicals may not be recognised as a cause for concern by those responsible for the care of the workers exposed.

Causes of ototoxicity

Ototoxic substances can be medicines or environmental agents. A list of the more common ones can be seen in Table 1.

Medicines

Ototoxic medicines could be administered by oral, intramuscular, intravenous routes and also given topically (e.g. eardrops when there is an eardrum perforation).

The most frequently used ototoxic medications are antibiotics (e.g. aminoglycosides such as gentamicin in Neonatal Intensive Care Units) and cytotoxic drugs (e.g. platinum-based chemotherapy regimes for specific cancers). Antimalarials such as quinine and its derivatives are still being used in certain countries and can occasionally be ototoxic.¹

Factors which influence the effects of ototoxic medication are listed below:

- **Dosage:** ototoxic antibiotics such as gentamicin are often life-saving and can be used safely as long as the dosage is not too high. Blood levels would need to be monitored to ensure this.
- **Duration of treatment:** medication given at normal dose levels can be cumulative (e.g. aminoglycosides).²
- **Synergism:** combination medications can potentially be more ototoxic.³
- **Susceptibility:** some individuals may be genetically more likely to develop a hearing loss as a result of aminoglycoside medication. A change in one or more genes can render family members more likely to develop a sensorineural hearing loss. A hearing loss may have occurred later in life anyway, but the medication hastened its onset.⁴



It is important for health workers to be aware of ototoxicity. **IVORY COAST**

- **Coexisting medical conditions:** these can increase the risk of ototoxicity occurring, e.g. in chronic kidney disease as a result of impaired elimination of the drug.⁵ Where there is an ear perforation, eardrops, as a result of prolonged use or frequently repeated courses, could cause ototoxic damage in the affected ear as the amount reaching the inner ear is increased (see Box).
- **Past medical history:** pre-existing acoustic trauma⁶ and previous radiation for head and neck cancer⁷ can make it more likely that ototoxic medication given subsequently, even at normal dosage and usage, can result in damaging effects to the inner ear.

Environmental agents

Ototoxic environmental agents, such as organic solvents or industrial chemicals (see Table 1), can be inhaled or absorbed through the skin and damage sensory cells in the inner ear. Ototoxic solvents are used extensively in the paint, dry cleaning engineering, printing, plastic and rubber industries. Ototoxic chemicals include arsenic, which is used in weedkillers and the tanning industry.

The ototoxic effects of organic solvents or industrial chemicals can be enhanced in workers who are also exposed to loud noise.

Many countries have legislation which regulates exposure to these environmental agents as well as exposure to loud noise.

Preventative measures

It is preferable and possible to prevent ototoxicity. If it has occurred already, it is important to detect it early to prevent further damage and manage it effectively.

- Medical practitioners should avoid using ototoxic medication unless absolutely necessary, e.g. in treating neonates, especially where there is other, non-ototoxic, medication available.
- Health practitioners should be made aware of ototoxic substances (Table 1), of the risk factors for ototoxicity, as well as symptoms of ototoxicity and available methods of management (see next sections).
- In settings where there are no alternatives to ototoxic drug usage, there should be a personalised ototoxicity monitoring programme to allow for harm-minimisation and early detection.⁸

TABLE 1 MOST COMMON OTOTOXIC SUBSTANCES

Aminoglycoside antibiotics	Loop diuretics	Anti-malarials	Anti-cancer drugs	NSAIDs*	Environmental agents	Eardrops
Gentamicin Amikacin Tobramycin Neomycin Kanamycin Streptomycin	Furosemide Bumetamide Ethacrynic acid Bumetamide Torsemide	Quinine Chloroquine	Cisplatin Carboplatin	Salicylate Naproxen Ibuprofen	Toluene Xylene Ethylbenzene Trichloroethylene Benzene Arsenic	Aminoglycosides Boric acid (prolonged use)

*Non-steroidal anti-inflammatory drugs

Sodium thiosulfate is used in some hospitals to reduce ototoxicity from chemotherapy (cisplatin). Several other substances have been proposed in the prevention of ototoxicity on the basis of animal studies: these include glutathione, amifostine, N-acetylcysteine and steroid therapy.⁹ The use of these agents in humans awaits robust clinical trials.

Symptoms

Those affected by ototoxicity may notice:

- A hearing loss: this usually starts in the high frequencies and may not be noticed by the patient initially.⁸ The loss in the high frequencies results in difficulty discriminating speech, but the more normal low frequencies makes the hearing loss more difficult to detect.
- Hyperacusis: a greater sensitivity to loud sounds.
- Tinnitus: noises in the ear not caused by an external sound. It is usually the first sign of salicylate ototoxicity.
- Dizziness: a feeling of being off-balance.
- Vertigo: a sensation of your surroundings moving.

There may be a single symptom or several occurring simultaneously, and onset may be rapid or gradual. Severity may be very mild to total incapacitation resulting in profound effects on communication and daily functioning. The effect may be permanent and progressive or reversible resulting in a short duration of symptoms (e.g. reversible symptoms due to salicylate, from physiological effects on outer hair cells rather than permanent cell loss).¹⁰

Assessment of hearing, tinnitus and balance problems caused by ototoxicity

In a specialist department, the patient's history will be gathered, the ear and its related areas examined and hearing, tinnitus and balance assessed.

Hearing, including the main speech frequencies, is assessed in each ear separately using an audiometer. An audiometer can also be used to assess the nature and extent of tinnitus.

Balance problems can also be assessed clinically or by specialised equipment if available.

Management of ototoxicity

Initial symptoms could be temporary and improve once the medication is reduced or stopped.

Where there is permanent hearing loss, various options can be offered to optimise communication and improve quality of life (e.g. hearing aids, cochlear implants, assistive listening devices etc.) and advice can

be given to avoid further damage. It is essential to follow up these patients, as hearing loss could progress.

Tinnitus may require management with psychological support, tinnitus maskers (wearable electronic devices) and medication.

Vestibular problems (imbalance) can be helped by specific exercises.

How health workers can help identify ototoxicity

Ototoxicity is preventable and the earlier it is detected, the better the outcome. Non-specialist health workers can play an important role in early diagnosis. They can do the following:

- Maintain a high level of suspicion when seeing patients who have had potentially ototoxic medication.
- Be aware of the risk factors for ototoxicity.
- Understand that ototoxicity could occur rapidly or take months to appear, so continual vigilance is therefore needed.
- Be aware that early signs of hearing or vestibular dysfunction may not be noticed by patients, carers or professionals due to several reasons, including the severity of a patient's illness and the gradual deterioration of the function.

Symptoms and signs to enquire about when seeing a patient

- Do they have noises in their ears (tinnitus)?
- Have they noticed any unsteadiness/difficulties in maintaining balance?
- Have they noticed difficulties with hearing, including hearing when they are in a noisy place? (Noise can mask out some elements of a sound/speech signal.)
- Have others noticed that the patient has poor hearing?
- Do they sometimes find it difficult to decide where a sound is coming from?

Useful checks

- Health workers can use their voices to gauge whether a hearing loss is likely to be present to a moderate or severe degree.
- Check if whispered voice can be heard by the patient at a metre's distance from the ear without being able to lip-read, as this may be an indication that there could be a mild high-frequency hearing loss.
- Speak out of sight with the voice raised in steps until it is heard; this can indicate possible severity of the patient's hearing loss.

Any patient suspected of ototoxicity must be referred to a specialist department where the patient can be tested and treatment discussed.

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Enlisting the help of non-specialist personnel to prevent hearing loss

Non-specialist personnel (i.e. not trained in ear and hearing care or EHC), as well as community members, can be trained to contribute to the prevention of hearing loss. Indeed, this can help overcome several obstacles to the prevention of hearing loss, such as the lack of information on ear diseases and hearing loss,¹ the important gaps in the availability of EHC

personnel, particularly in low- and middle-income countries,² as well as the delays in identification and intervention caused by a lack of EHC services at primary and community levels.³

The following two case studies, along with the article on pages 5–7 of this issue, illustrate how task-sharing can contribute to the prevention of hearing loss.

CASE STUDY

Training non-specialists in Primary Ear and Hearing Care (PEHC) to help prevent hearing loss



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Primary EHC workshop participants learning to make a dry mop. INDIA

We have trained many different kinds of non-EHC specialists, not all of them health workers, but all able to contribute to the prevention of hearing loss. These include:

- Primary Health Care workers
- Other non-EHC health workers, e.g. paediatricians, physiotherapists, geriatricians, obstetricians, etc.
- Community workers
- Social workers
- Coordinators of Development projects
- Personnel from Organizations of Persons with Disabilities
- Policy-makers and community leaders
- Industry personnel and occupational health staff
- Members of the general community interested in EHC (professionals, parents, students, etc.).

We always use the World Health Organization's PEHC training resources (Basic, Intermediate and Advanced levels).⁴ The content of our workshops depends on the audience's background and their level of training, but attendees can be taught:

- To understand and know how to raise awareness about the impact of hearing disability for the individual, their family and society.
- Basic knowledge about the growing number of persons living with hearing loss and its main causes.
- To understand and promote daily habits and general measures to prevent hearing loss.
- How to identify common EHC conditions, the importance of early referral, and whom to refer patients to.
- How to diagnose and practically manage simple EHC conditions at Primary Health Care level.

Impact on the prevention of hearing loss

There are many signs that PEHC workshops have a positive impact, for example in Latin America, where

a total of 2,330 persons in 9 countries (Bolivia, Cuba, Dominican Republic, El Salvador, Guatemala, Mexico, Nicaragua, Paraguay and Peru) received training in PEHC between 2006 and 2015.

- In Bolivia, after 5 years of delivering training of trainers in PEHC, the number of persons in the community whom the CBM programme had to screen for EHC conditions started to decrease, due to the implementation of EHC screening activities within the local health system (8,598 in 2006 to 7,227 in 2011). The number of assistive consultations for EHC services, however, continued to increase (13,519 in 2006 to 18,335 in 2011).
- In the Trinidad-Beni project of Bolivia, the number of self-referred patients with EHC complaints increased yearly (4,921 in 2006 to 11,108 in 2011), as did the proportion of self-referred patients amongst the overall total composed of self-referred patients and those referred by EHC screening personnel (22% in 2006 to 43% in 2011).
- There is a growing demand for replication of the training in the region of the Americas. For example, in Guatemala, a total of 24 replica courses were delivered between 2013 and 2016, reaching a total of 606 participants.

Challenges

- Balancing cost and wide impact: courses are much more effective when participants work in disadvantaged/remote communities, but travel and accommodation increase costs. One solution would be to de-centralise training.
- Difficulties in locating and communicating with some participants six months after training, which makes long-term follow-up more difficult.
- Lack of equipment necessary to put into practice what was learnt during the course. One solution would be to include basic EHC diagnostic equipment in the training package.
- Lack of official commitment to embed this training programme within the national curriculum for training Primary Health Care Workers and to equip healthcare centres with basic EHC instruments and materials.

Conclusion

It is worth investing time, effort, and resources into training non-specialists in Primary EHC. PEHC training is the most essential component of any sustainable EHC programme and an excellent tool to raise awareness and advocate for EHC as a key area of health systems and services.



DIEGO J SANTANA-HERNÁNDEZ

"The success of our programmes is largely attributable to the use of non-specialists from the communities we serve"



Tersia De Kock
Audiologist & Project Lead, hearX Group;
Director, hearX Foundation,
Cape Town, South Africa

An interview with Tersia De Kock

What are the reasons that made you decide to enlist the help of non-specialist personnel to prevent hearing loss?

- Due to the limited number of audiologists in South Africa, especially in the public health sector, we needed to enlist non-specialist personnel to aid in our newborn hearing as well as preschool hearing screening programmes to grow our coverage rates.
- We always recruit non-specialists from the specific community where we implement the prevention programme as they can speak the local language, have cultural sensitivity and can easily navigate themselves in the community.
- Cost-effectiveness is another reason: as hearing loss prevention aims to reach a large number of people (i.e. universal coverage of newborns or pre-schoolers), employing audiologists to fulfil this role would not be cost-effective. Using non-specialists thus decreases programme costs and enhances scalability.

Which non-specialist personnel did you train and what tasks did you want them to perform?

We trained lay persons from low-income communities; we have also trained nurses/nursing assistants in obstetric units and primary healthcare clinics for newborn screening.

We trained them to do the following tasks:

- Newborn hearing screening
- Preschool hearing screening
- Elderly hearing screening
- To facilitate our EARS Teacher Training Programme that equips teachers with the knowledge to play an active role in the identification of hearing difficulties in children
- To be able to conduct community awareness and prevention talks
- To visit/contact families (individually), when they do not attend appointments after we have identified a child with hearing loss.

Our training methods include:

- Workshop style (theoretical training)
- Role-play using scripts and step-by-step guides

- Practising new skills on one another in the training environment
- Observation of a professional performing the task and then doing it under supervision
- In-service training
- Regular refresher and feedback sessions.

Which challenges did you encounter during and after training and which solutions did you find helpful?

As programme manager, one is always concerned about programme quality remaining high despite the use of non-specialist staff. The mHealth (mobile health) equipment we now use has built-in quality indicators that allow us to track the accuracy with which screening tests are conducted. This has been helpful to know when intervention is necessary.

Training of non-specialists always needs to include hands-on 'in-service training'. We spend a lot of time with them in the field to make sure they feel competent with all possible scenarios that might pop up.

We have also learnt that regular 'refresher' sessions are good to implement – just to highlight key tasks or scripts that are important to maintain (as we all tend to fall into the trap of finding our own way of saying things or shortcuts). Often the refreshers also relate to administrative processes that are critical to the success of the programmes (or integral in tracking impact).

What happened afterwards? Did you notice a positive impact, e.g. on your work, on the community, on the prevention of hearing loss?

The success of our programmes is largely attributable to the use of non-specialists from the communities we serve (most of our work is with the Khayelitsha, Mitchell's Plain and Mbekweni communities in Cape Town). We would not be able to do any of the work we do without them. Besides the tasks we train them to do, non-specialists contribute their own helpful knowledge and skills, for example:

- When a family does not attend diagnostic or intervention appointments, the non-specialists often have much greater success in speaking to the family to explain the situation in lay terms and to address any cultural resistance etc.
- On a more practical note, they know where the different community sites are, know how to look out for safety aspects and can navigate home visits. In the communities where we work the address system is very poor and you often need to find the homes based on landmarks and by asking around.

It is incredible to see how the non-specialists truly become ear and hearing advocates in their communities. They are so invested and passionate about what they do. We feel very privileged to witness their transformation and to work alongside them towards greater awareness and prevention of hearing loss in our communities.



Training participant practising hearing screening on a schoolchild.

SOUTH AFRICA

During training, participants practise hearing screening on each other.

SOUTH AFRICA



TERSIA DE KOCK

Six effective strategies to prevent hearing loss*



DAVID MARK/PIXBAY

1

Vaccinate as recommended by global immunisation programmes



PIET VAN HASSELT

2

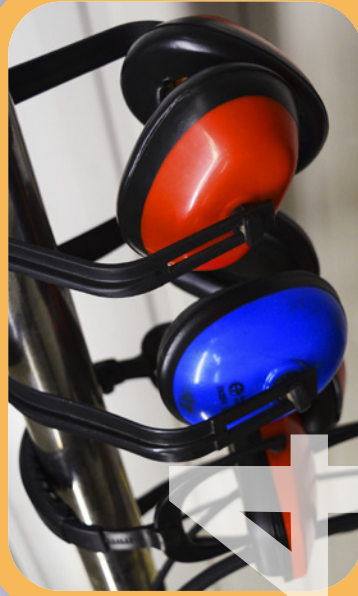
Ensure good antenatal maternal health and perinatal care



PIET VAN HASSELT

3

Identify and manage common ear conditions



MIMZY/PIXBAY

4

Limit exposure to noise and chemicals at work



HANNY NAIBAHO/UNSPLASH

5

Limit exposure to noise in recreational settings



FERDINAND AMA

6

Take care with ototoxic medicines (and avoid them when possible)