



Summary: Hearing Screening

Slovakia

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1. Glossary of Terms: Hearing Screening

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| Abnormal test result | A test result where a normal “pass” response could not be detected under good conditions. The result on screening equipment may indicate “no response,” “fail,” or “refer.” |
| Attendance rate | <p>The proportion of all those <u>invited for screening</u> that are <u>tested and receive a result</u>,</p> <ul style="list-style-type: none"> • <u>Invited for screening</u> includes all those that are offered the screening test. • <u>Tested and receive a result</u> could be a “pass” or “fail”. <p>Attendance rate provides information on the willingness of families to participate in screening.</p> |
| Attendance rate in first year of life | <p>See definition of Attendance rate.</p> <p>The calculation cut-off is after <u>one year of life</u>.</p> |
| Compliance with referral (percentage) | <p>The percentage of those who are <u>referred from screening</u> to a diagnostic assessment that actually <u>attend</u> the first diagnostic assessment.</p> <p>Percentage of compliance provides information on the willingness of families to attend the diagnostic assessment after referral from screening.</p> |
| Coverage | <p>The proportion of those <u>eligible for screening</u> that are <u>tested and receive a result</u> within a <u>specific time</u>.</p> <ul style="list-style-type: none"> • <u>Eligible for screening</u> includes those within the population that are covered under the screening or health care program. • <u>Tested and receive a result</u> could be a “pass” or “refer to diagnostic assessment”. • <u>Specific time</u> can be defined, such as 1 month after birth, 3 months after birth, etc. <p>Coverage provides information on the overall effectiveness and timeliness of a complete screening programme.</p> <p>Factors such as being offered screening, willingness to participate, missed screening, ability to complete the screen, and ability to document the screening results will influence the coverage.</p> |
| Coverage in first year of life | <p>See definition of Coverage.</p> <p>The <u>specific time</u> is pre-defined as within the first year of life.</p> <p>In other words, the coverage is the proportion of those eligible for screening that complete the screening sequence to a final result within the first year of life.</p> |
| False negatives | The percentage of <u>infants/children with a hearing loss</u> (defined by the target condition) that <u>receive a result of “pass”</u> during screening. |



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| | Example: If 100 infants with hearing loss are screened, and 1 infant passes the screening, the percentage of false negatives is 1%. |
| False positives | <p>The percentage of <u>infants/children with normal hearing</u> that <u>receive a result of “fail”</u> from the final screening test.</p> <p>Example: If 100 infants with normal hearing are screened, and 3 infants fail the screening and are referred for diagnostic assessment, the percentage of false positives is 3%.</p> |
| Guidelines | Recommendations or instructions provided by an authoritative body on the practice of screening in the country or region. |
| Hearing screening professional | A person qualified to perform hearing screening, according to the practice in your country or region. |
| Inconclusive test result | A test result where a normal “pass” response could not be detected due to poor test conditions. |
| Invited for screening | Offered screening. |
| Outcome of hearing screening | An indication of the effectiveness or performance of screening, such as a measurement of coverage rate, referral rate, number of infants detected, etc. |
| Permanent hearing loss | <p>A hearing impairment that is <i>not</i> due to a temporary or transient condition such as middle ear fluid.</p> <p>Permanent hearing loss can be either sensorineural or permanent conductive.</p> |
| Positive predictive value | <p>The percentage of infants/children referred from screening who have a confirmed <u>hearing loss</u>, as described by your protocol or guideline and indicated in the Target Condition (see definition).</p> <p>For example, if 100 babies are referred from screening for diagnostic assessment and 90 have normal hearing while 10 have a confirmed hearing loss, the positive predictive value would be 10%.</p> |
| Preschool or (pre)school children | All children between 3-6 years of age. |
| Preschool or (pre)school screening | <p>Screening that takes place during the time children are between 3-6 years of age.</p> <p>This refers to <i>any</i> hearing screening during this age. The location of the screening is irrelevant to the definition.</p> |



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| Prevalence | The number or percentage of individuals with a specific disease or condition. Prevalence can either be expressed as a percentage, proportion, or as the value per 1000 individuals within the same demographic. |
| Programme | An organized system for screening, which could be based nationally, regionally or locally. |
| Protocol | Documented procedure or sequence for screening, which could include which tests are performed, when tests are performed, procedures for passing and referring, and so forth. |
| Quality assurance | A method for checking and ensuring that screening is functioning adequately and meeting set goals and benchmarks. |
| Referral criteria | A pre-determined cut-off boundary for when an infant/child should be re-tested or seen for a diagnostic assessment. For example, referral criteria may be “no response” at 35 dB nHL. |
| Risk babies / Babies at-risk | All infants that are considered to be at-risk or have risk-factors for hearing loss according to the screening programme. Two common risk factors are admission to the neonatal-intensive care unit (NICU) or born prematurely. However, other risk factors for hearing loss may also be indicated in the screening programme. |
| Sensitivity | The percentage of infants/children with hearing loss that are identified via the screening program. For example, if 100 babies with hearing loss are tested, and 98 of these babies are referred for diagnostic assessment while 2 pass the screening, the sensitivity is 98%. |
| Specificity | The percentage of infants/children with normal hearing that pass the screening. For example, if 100 babies with normal hearing are tested, and 10 of these babies are referred for diagnostic assessment and 90 pass the screening, the specificity is 90%. |
| Target condition | The hearing loss condition you are aiming to detect via your screening programme. This includes: <ul style="list-style-type: none"> • The <u>laterality of the condition</u>, whether the program aims to detect both unilateral and bilateral hearing loss or just bilateral hearing loss. • The <u>severity of the condition</u>, whether the program aims to detect hearing loss ≥ 30 dB HL, ≥ 35 dB HL, ≥ 40 dB HL or ≥ 45 dB HL |
| Well, healthy babies | Infants who are <i>not</i> admitted into the NICU or born prematurely. Well, healthy babies may or may not have additional risk factors for hearing loss, according to the procedures indicated in the specific screening programme. |



2. Abbreviations

ABR – auditory brainstem response

aABR – automatic auditory brainstem response

ANSD – auditory neuropathy spectrum disorder

ASSR – auditory steady-state response

CI – cochlear implant

CMV – cytomegalovirus

dB HL – decibel hearing level

dB nHL – decibel normalized hearing level

dB SNR – decibel signal-to-noise ratio

DPOAE – distortion product otoacoustic emissions

HA – hearing aid

NICU – neonatal intensive care unit

OAE – otoacoustic emissions

TEOAE – transient-evoked otoacoustic emissions



3. Background

In Slovakia, hearing screening is performed nationally and organized both nationally and locally. The following report contains information with regards to childhood hearing screening in the entire country of Slovakia.

3.1. General

Slovakia has a total area of 49 035 km² with a population of 5 443 120 in December of 2017.

In Slovakia, all births are registered. The number of live births in Slovakia in 2017 was 57 969.

The World Bank income classification categorizes Slovakia as a high country (The World Bank, 2018). The gross domestic product (GDP) in 2018 was €16 560 per capita in Slovakia.

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Slovakia in 2015 was 1101 USD or €998 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 5.1 per 1000 is reported for Slovakia in 2015 according to the United Nations Statistics Division (United Nations Statistics Division, 2016).

3.2. Neonatal hearing screening

In Slovakia, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening, though participation is not obligatory for parents. Hearing screening started in Slovakia in 2006 and available across the country by 2009. Screening may not be provided in some local areas if there are issues with equipment.

Neonatal hearing screening is funded through the state health insurance and is embedded in the Preventive Child Health Care screening system. Neonatal hearing screening is organized by the Pediatric ENT Department of Medical Faculty and NICD in Bratislava; they are currently working on better organisation of screening within the country.

National guidelines are available as is a screening protocol used across the country (Ministerstva zdravotníctva Slovenskej republiky, 2006). There are no differences in the screening protocols across the country.

3.3. Preschool hearing screening

There is no preschool hearing screening programme in Slovakia.



4. Guidelines & Quality Control

There are national guidelines for hearing screening in Slovakia. Guidelines were developed by the Ministry of Health in 2006 (Ministerstva zdravotníctva Slovenskej republiky, 2006). The guideline has not been revised since its initial implementation. Preparation of a new guideline is of interest in Slovakia.

Quality assurance of hearing screening programmes is not imposed by the government; however, information is collected by the ENT clinic in Bratislava and stored in a database. Collection of data has been in place since 2015; however, it is difficult to collect all data due to inconsistent cooperation from hospitals. Data collection is performed via paper copies of screening results from individual children that is sent to the Paediatric ENT department in Bratislava. A national registry is in consideration; however, due to data collection issues, national data are not available.

Studies have not been performed on the hearing screening programme in Slovakia or its effectiveness. Annual reporting does not take place on a national level.



5. Process: Screening, Diagnosis, Intervention

5.1. Neonatal hearing screening

Well babies are screened in the hospital, and at-risk babies are screened in the hospital or child health clinic. The percentage of infants born in a maternity hospital in Slovakia is unknown, though it is very high. The percentage of home births are low. The average length of stay in the hospital after delivery is unknown, though roughly estimated to be around 3-4 days. Parents/caregivers of well and at-risk babies are invited to participate in neonatal hearing screening via a phone call or directly in person in the hospital.

Guidelines from the Ministry of Health indicates that screening should be completed by 1 month of age; however, hearing screening for well babies should be completed in the hospital before discharge. The diagnostic assessment for all infants should be completed by 6 months of age.

Infants at-risk are those with infectious causes (rubella, measles, mumps, cCMV, and meningitis), use of ototoxic medications, birth complications (hypoxemia, low birthweight, hyperbilirubinemia, and prematurity, genetic predisposition to hearing impairment. Data on the prevalence of CMV and meningitis are not available.

Data are unavailable regarding the target conditions for neonatal hearing screening.

5.2. Neonatal diagnostic assessment

The diagnostic assessment should be completed by 5-6 months of age.

5.3. Preschool hearing screening

Not applicable.

5.4. Intervention approach

In Slovakia, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Intervention should be provided by about 6 to 7 months of age. Infants are fitted with hearing aids from 6-12 months of age or older and with cochlear implants from 1-2 years of age or older.

Data are not available regarding the fitting criteria for hearing aids in Slovakia, as it varies depending on the type of hearing loss.



6. Protocols

Hearing screening protocols are described for neonatal hearing screening (well and at-risk) as well as for preschool hearing screening when applicable.

- The Test performed is the screening technique used
- The Age of the child is indicated in hours, days, months or years
- Referral criteria may be the lack of an OAE response at specified frequencies, a response-waveform repeatability constant, the absence of an aABR response at a specified intensity, or an absent behavioural response at a specified intensity. Referral criteria may be defined within a protocol or limited based on the device used.
- The Device is the screening device used.
- Unilateral Referrals indicates whether children are referred if only one ear fails screening.
- The Location is where the screening takes place

6.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies is described in Table 1. A 2-step OAE protocol is in effect, whereby the first OAE is performed in the maternity hospital on the 1st to 3rd day of life. If the infant fails the first test, rescreening at 1 month of age either at the maternity hospital or the ENT department. A subsequent fail at rescreening would warrant a referral to the ENT department for a diagnostic assessment.

Table 1: Process for neonatal hearing screening for well, healthy infants in Slovakia.

| Test | Age | Referral criteria | Device | Unilateral Referrals? | Location |
|------|-------------|-------------------|---------------|-----------------------|-------------------------------------|
| OAE1 | 24-72 hours | Not described | Not described | Yes | Maternity hospital |
| OAE2 | 1 month | | | Yes | Maternity hospital / ENT department |

6.2. Neonatal hearing screening (at-risk)

The screening process for at-risk infants is described in Table 2. In Slovakia, at-risk infants are screened with OAE and then referred to the ENT department for an aABR.

Table 2: Process for neonatal hearing screening for at-risk infants in Slovakia.

| Test | Age | Referral criteria | Unilateral Referrals? | Location |
|----------|---------|-------------------|-----------------------|---------------------------|
| OAE+aABR | 1 month | 35 dB nHL | Yes | Hospital / ENT department |

6.3. Preschool hearing screening

Not applicable.



7. Professionals

7.1. Neonatal hearing screening (well)

Initial neonatal hearing screening is performed by newborn nurses in the maternity hospitals. Rescreening is performed by newborn nurses if performed in the maternity hospital and audiologist nurses if performed in the ENT department.

Newborn nurses do not have any special training for performing hearing screening. They are only trained to perform the OAE by the manufacturer when the devices were purchased. Ongoing training is performed on-the-job. Audiologist nurses are nurses that have a specific 1-year audiological training.

7.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by doctors or audiologist nurses.

7.3. Preschool hearing screening

Not applicable.



8. Results: Neonatal Hearing Screening

8.1. Coverage and attendance rates

In Slovakia, national data on neonatal hearing screening is not yet available. Efforts are underway to develop a national registry system. Neonatal hearing screening should be available in all maternity hospitals, and all infants should be screened in theory; however, this may not be completely the case in practice. For example, screening does not cover home births. Parents must seek out hearing screening independently for these cases. Additionally, if equipment is malfunctioning, these infants may be missed.

Currently, no data are available on screening coverage or attendance.

8.2. Referral rates

Data are not available.

8.3. Diagnostic assessment attendance

Data are not available.

8.4. Prevalence / Diagnosis

Data are not available.

8.5. Treatment success

In Slovakia, it is unknown how many children per year are fitted with hearing aids or cochlear implants. It is roughly estimated that 50 children per year are implanted with cochlear implants.

8.6. Screening evaluation

Actual data on the sensitivity or specificity of neonatal hearing screening are not available, and neither are data on false positives, false negatives, or the positive predictive value.



9. Results: Preschool Hearing Screening

9.1. Coverage and attendance rates

Not applicable. There is no preschool hearing screening in Slovakia.

9.2. Referral rates

Not applicable.

9.3. Diagnostic assessment attendance

Not applicable.

9.4. Screening evaluation

Not applicable.



10. Costs: Neonatal Hearing Screening

Financing of neonatal hearing screening in Slovakia is covered by health insurance. Screening is free of charge for parents. There are three health insurance companies in Slovakia

A cost analysis of neonatal hearing screening in Slovakia has not been completed.

10.1. Screening costs

The total screening costs is unknown. The screening cost per well baby can be estimated from the reimbursement provided by the insurance companies. The reimbursement per child screened is €11.66, €11.12 and €9.90 per child per year.

10.2. Equipment costs

The cost an OAE screening device depends on the make and manufacturer. Data are unavailable, but a roughly estimated cost is €1000 per device. Maintenance costs are unknown. Devices are often replaced every 10 years. The cost for disposables is unknown.

10.3. Staff costs

There are 55 maternity hospitals and 6 ENT diagnostic departments. The average annual salary for a newborn nurse is €10 194, for an audiological nurse is €10 764, for a non-attested physician is €14 310 and for an attested physician is €26 418.

10.4. Diagnostic costs

The total cost of diagnostic confirmation is not indicated.

10.5. Amplification costs

In the Slovakia, not all children with hearing loss are treated. There are problems in Slovakia with regards to the number of phoniaticians, and therefore, many parents travel abroad to have their children fitted with hearing aids. There are no data with regards to the number of parents that refuse cochlear implants for their children.

Data are unavailable regarding the yearly intervention costs for hearing aid or cochlear implant treatment. The hearing aid device itself is around €500 and cochlear implants are €23 000, plus the cost of surgery is €1 800.

10.6. Social costs

There are approximately 80 schools in Slovakia for deaf and hard-of-hearing students. It is unknown how many children attend this school. In mainstream schools, extra support is provided to children with hearing impairment. All costs for mainstream or special education schools are unknown.



11. Costs: Preschool Hearing Screening

11.1. Screening costs

Not applicable.

11.2. Equipment costs

Not applicable.



12. References

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