



Summary: Hearing Screening Cyprus

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1. Glossary of Terms: Hearing Screening

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.



	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>



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 Cyprus, hearing screening is organized nationally, with the exception of the region of Cyprus occupied by Turkey.

The following report contains information with regards to hearing screening in the entire country of Cyprus, with the exception of the region occupied by Turkey.

3.1. General

Cyprus has a total area of 9251 km² and 5896 km² is under control of the Republic of Cyprus (i.e., excluding the region occupied by Turkey). Cyprus has a total population of 1.1 million including all of Cyprus and 864 200 in the Republic of Cyprus as of 2017 (Republic of Cyprus, Ministry of Finance, Statistical Service, 2018).

In Cyprus, all births are registered. The physician who delivers the baby fills out a form which is then sent to the Competent District Administration Office. From there, the birth is registered and a birth certificate is issued. There were 9229 live births registered in 2017 in the Republic of Cyprus (Republic of Cyprus, Ministry of Finance, Statistical Service, 2018).

The World Bank income classification categorizes Cyprus as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2016 was €21 396 per capita in Cyprus (Republic of Cyprus, Ministry of Finance, Statistical Service, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Cyprus in 2015 was 1634 USD or €1439 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 2.5 and 2.6 per 1000 is reported for Cyprus in 2015 and 2016 (Republic of Cyprus, Ministry of Finance, Statistical Service, 2018). The United Nations Statistics Division does not provide infant mortality rates due to the relatively low number of births and deaths each year in Cyprus (United Nations Statistics Division, 2016).

3.2. Neonatal hearing screening

In Cyprus, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening, though screening is not obligatory for parents. The universal program for well and at-risk babies was first implemented in 2004 expanding to universally covering well babies in 2005. Neonatal hearing screening is not part of the Preventive Child Health Care screening system, as there is no such system in Cyprus. The programme for well babies is funded through charity within the Centre for Preventive Paediatrics, while the programme for at-risk babies is state funded.

The neonatal hearing screening program for well babies is implemented by the Centre for Preventive Paediatrics, with one screening team per each of the 5 districts and a central administration hub.

3.3. Preschool hearing screening

In Cyprus, there is no preschool hearing screening.



4. Guidelines & Quality Control

The neonatal hearing screening guidelines exist via the Centre for Preventive Paediatrics (CPP) for well babies. Infants with risk factors are handled on a case-by-case basis (i.e., with both OAE and aABR). A protocol for NICU infants also exists but is handled separately and not part of the Centre for Preventive Paediatrics.

The content of the well-baby screening guidelines was developed by the Centre for Preventive Paediatrics together with audiologists and ENT developed the content in the guidelines for well babies.

Since its initiation in 2004-2005, the guidelines have not been revised. The protocol is revised ad hoc and infrequently. If required in the future, stakeholders would agree on the revisions, which would be decided on by the Center for Preventive Paediatrics. Currently, there is no funding allocated for guideline revision.

Quality monitoring of the neonatal hearing screening programme is performed. Data from well babies are collected by CPP (except approx. 8% mentioned before).

Annual statistics and review of data are performed within the CPP team and results are presented in relevant scientific meetings. Research apart from auditing has also been done on the neonatal hearing screening in Cyprus.

5. Process: Screening, Diagnosis, Intervention

5.1. Neonatal hearing screening

In Cyprus, it is estimated that there are 6 general hospitals. It is estimated that over 90% of children are born in a hospital or maternity clinic where the average length of stay is 3 days for normal deliveries. A very low proportion of births are estimated to take place at home. There is one NICU unit in Cyprus and it is located in a maternity hospital. Neonates at risk for hearing loss (i.e., NICU admissions) account for approx. 8-10% of total births.

Well-baby screening occurs in one of the five district offices of the Hearing Screening Team. There is one district office in each major city in Cyprus. The Centre for Preventative Paediatrics (CPP) contact parents directly or via their paediatrician and invite children to neonatal screening through an information leaflet. In contrast, parents of at-risk infants are contacted directly in person in the hospital, and infants are screened in the hospital in the NICU.

Well babies and at-risk babies are screened with different protocols. It is estimated that the reason for a different protocol for at-risk babies is because of the higher prevalence of hearing loss. There are also regional differences in hearing screening protocols. Specifically, it is estimated that 8% of well babies are screened with a protocol that differs from the rest of the country. Specifically, one hospital has decided to use its own protocol for its maternity ward. There are no regional differences in the protocol for at-risk infants across regions as there is only one NICU. However, the team responsible for testing NICU infants is separate from the well-infant programme.

At-risk babies are defined as those admitted to the NICU unit. There is no minimum duration of time that infants are in the NICU. No other risk factors are considered within the neonatal screening program in Cyprus.

The prevalence of CMV infections or meningitis is not known.

Well-baby screening should be completed before 10 weeks of age though the target is 1 month. Data are unavailable for the recommended maximum age for screening infants at-risk.

The target condition for screening (both well babies and at-risk babies) is a bilateral or unilateral hearing loss of 35 dB HL or greater.

5.2. Neonatal diagnostic assessment

The diagnostic assessment test performed is a clinical ABR using all stimuli and tympanometry.

The diagnostic assessment of well babies should be performed before 12 weeks of age. Data are unavailable on the age at which the diagnostic assessment of at-risk infants should be performed.

5.3. Preschool hearing screening

Not applicable.

5.4. Intervention approach

In Cyprus, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids or cochlear implants at 6-12 months of age.



The hearing aid fitting criterion is a unilateral or bilateral hearing loss of more than 35 dB HL.



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 screening process for well babies is indicated in Table 1. A 3-step OAE-OAE-aABR protocol is in place. All screening occurs at the district office after discharge from the maternity hospital.

Table 1: Screening process for well babies in Cyprus.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	10 days	6 dB SNR at 5 freqs (1-4 kHz)	EZ Screen protocol ILO	Yes	District office
OAE2	6-10 days after OAE1	6 dB SNR at 5 freqs (1-4 kHz)	EZ Screen protocol ILO	Yes	District office
aABR	12 weeks max	35 dB nHL		Yes	District office

6.2. Neonatal hearing screening (at-risk)

Information is not available regarding the protocol for NICU infants, as this is controlled by a separate team.

6.3. Preschool hearing screening

Not applicable.



7. Professionals

7.1. Neonatal hearing screening (well)

Screening for well babies is performed by designated screeners. These professionals undergo a 6 week-training course. This training is regularly updated, monitored, or revalidated, but it is not accredited or certified. The professions that could be trained to screen are science and social science graduates.

7.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants in NICUs is performed by audiologists.

7.3. Preschool hearing screening

Not applicable.



8. Results: Neonatal Hearing Screening

8.1. Coverage and attendance rates

The coverage of neonatal hearing screening for well babies is estimated to be over 90%. The coverage of at-risk infants for a diagnostic test is all babies admitted to the NICU. The coverage for all babies (well and at-risk) is estimated to be over 90%; however, this figure is approximate.

8.2. Referral rates

Referral rates for the 3-step OAE-OAE-AABR screening for well babies are indicated in Table 2.

Table 2: Referral rates for well babies in Cyprus (Centre for Preventive Paediatrics, 2017).

Test	Referral Rate
OAE1	4%
OAE2 / aABR	15%

Referral rates assume 100% attendance. Rates reflect the number of infants referred out of the number of infants screened at each step. From the CPP, the referral rate for OAE2 and aABR steps are combined.

The total percentage of well babies who are referred from the 3-step screening process to diagnostic evaluation is 0.6% (Centre for Preventive Paediatrics, 2017).

8.3. Diagnostic assessment attendance

Among the referred well babies, it is estimated that >90% of infants received the diagnostic assessment. Lost to follow-up rates were 0% after referral for well babies.

For at-risk babies, data are unavailable because the team for NICU hearing screening is not part of the programme.

8.4. Prevalence / Diagnosis

The prevalence rates of permanent hearing loss among neonates in Cyprus has been estimated and presented in Table 3. However, these values are not accurate because they only reflect around 85% of infants born in Cyprus. NICU infants are not screened or monitored by the CPP, nor are some well babies screened in the maternity wards. Therefore, only incidence of well babies tested at the CPP can be provided.

Table 3: Incidence of permanent hearing loss among neonates in Cyprus (per 1000 in 2017; Centre for Preventive Paediatrics, 2017).

	Bilateral		Unilateral	
	≥ 40 dB HL	≥ 80 dB HL	≥ 40 dB HL	≥ 80 dB HL
Prevalence rate per 1000 (Center for Preventive Pediatrics)	0.53	0.63	0.38	0.19*

*It is estimated that 50% the children with unilateral hearing loss have a hearing loss of 80 dB or worse.

Information on the distribution of neonatal hearing loss according to severity and laterality has been calculated based on 102 cases of infants with hearing loss (Centre for Preventive Paediatrics, 2017). These data are presented in Table 4.



Table 4: Distribution of hearing loss (%) based on degree and laterality among infants diagnosed with permanent hearing loss after neonatal hearing screening (Centre for Preventive Paediatrics, 2017).

	Bilateral		Unilateral	
	≥ 40 dB HL	≥ 80 dB HL	≥ 40 dB HL	≥ 80 dB HL
Distribution of infants (%) with permanent hearing loss	29%	42%	29%	52%

Data regarding hearing loss diagnosed among babies who were not screened via neonatal hearing screening are not available.

8.5. Treatment success

The number of children fitted with hearing aids per year in Cyprus after neonatal hearing screening is not available. The number of children fitted with cochlear implants in Cyprus after neonatal hearing screening is not available.

8.6. Screening evaluation

The percentage of false negatives is unavailable but is expected to be very low. The percentage of false positives is estimated to be 0.4%.

The positive predictive value of a refer result in one or two ears in well babies is estimated to be about 30%.

The sensitivity of neonatal hearing screening in well babies is estimated to be 99% and the specificity of neonatal hearing screening is estimated to be 96%.

Sensitivity and specificity information on neonatal hearing screening for infants at-risk is not available.



9. Results: Preschool Hearing Screening

9.1. Coverage rates

Not applicable

9.2. Screening attendance and referral rates

Not applicable

9.3. Diagnostic assessment attendance

Not applicable

9.4. Prevalence / Diagnosis

Not applicable

9.5. Screening evaluation

Not applicable



10. Costs: Neonatal Hearing Screening

Hearing screening available in Cyprus is free of charge for parents. There is no financial reward when parents attend hearing screening, and there is no penalty for those who do not attend hearing screening.

There has not been a cost effectiveness analysis completed in Cyprus.

10.1. Screening costs

The total screening annual costs for well-baby neonatal hearing screening in Cyprus is €283 631. The total screening cost per baby is €38, including diagnostic services.

Screening costs for at-risk babies are not available.

10.2. Equipment costs

(Information extracted to protect commercially sensitive data)

The maintenance costs are €1500 per year for both OAE and aABR, and the disposable costs are €1000 per year. aABR equipment is scheduled to be replaced every 10 years and OAE equipment every 15 years.

10.3. Staff costs

In Cyprus, the CPP employs 6 screeners, one audiologist, and one coordinator.

The yearly salary for a hearing screening professional (not audiologist) is €16 000 to €20 000 or €12 to €18 per hour. As indicated previously, hearing screeners are trained via a 6-week training course which is estimated to cost about €500 per person.

10.4. Diagnostic costs

The cost for a diagnostic assessment is €120 per baby tested. This is incorporated into the costs for screening.

10.5. Amplification costs

In Cyprus, children may not be fitted with hearing aids or cochlear implants if deaf parents refuse amplification.

The costs for the first year of hearing aid intervention, including device and consultation/rehabilitation costs, is €2730, which is renewable every four years.

For cochlear implantation, the initial cost of the implant is estimated at €25 000 and the cost of the processor is estimated at €5000, which is renewable every five years.

10.6. Social costs

In Cyprus, hearing impaired students may attend regular primary school with help from special support and instruction personnel or a special school for deaf children, of which there is one in Cyprus. There are no data available for the number of children attending this school or the costs per child to attend this school.



The cost for a normal hearing child to attend regular primary school is not available, and the cost for special support in regular primary school for hearing-impaired students is not available.



11. Costs: Preschool Hearing Screening

11.1. Screening costs

Not applicable.

11.2. Equipment costs

Not applicable.

11.3. Staff costs

Not applicable.

12. References

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