Summary: Hearing Screening

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This summary report contains key information from 47 Country Reports.

The full reports can be found here: https://www.euscreen.org/hearing-screening-country-reports

Disclaimer: This is a summary report representing the responses from screenings expert working within hearing care services of the country or region reported. This report is the product of professional research conducted for the EUSCREEN study and does not represent conclusions made by the authors. It is not meant to represent the position or opinions of the EUSCREEN study or its Partners. Efforts were made to cross-check the information supplied; however, not all information supplied is fully verified by the authors.

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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	The proportion of all those invited for screening that are tested and receive a result, • Invited for screening includes all those that are offered the screening test. • Tested and receive a result could be a "pass" or "fail". Attendance rate provides information on the willingness of families to participate in screening.
Attendance rate in first year of life	See definition of **Attendance rate.** The calculation cut-off is after one year of life.
Compliance with referral (percentage)	The percentage of those who are referred from screening to a diagnostic assessment that actually attend the first diagnostic assessment. Percentage of compliance provides information on the willingness of families to attend the diagnostic assessment after referral from screening.
Coverage	The proportion of those eligible for screening that are tested and receive a result within a specific time. • Eligible for screening includes those within the population that are covered under the screening or health care program. • Tested and receive a result could be a "pass" or "refer to diagnostic assessment". • Specific time can be defined, such as 1 month after birth, 3 months after birth, etc. Coverage provides information on the overall effectiveness and timeliness of a complete screening programme. 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.
Coverage in first year of life	See definition of **Coverage.** The specific time is pre-defined as within the first year of life. 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.

False negatives	The percentage of infants/children with a hearing loss (defined by the target condition) that receive a result of "pass" 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	The percentage of infants/children with normal hearing that receive a result of "fail" from the final screening test. 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%.
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	A hearing impairment that is *not* due to a temporary or transient condition such as middle ear fluid. Permanent hearing loss can be either sensorineural or permanent conductive.
Positive predictive value	The percentage of infants/children referred from screening who have a confirmed hearing loss, as described by your protocol or guideline and indicated in the **Target Condition** (see definition). 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%.
Preschool or (pre)school children	All children between 3-6 years of age.
Preschool or (pre)school screening	Screening that takes place during the time children are between 3-6 years of age. This refers to *any* hearing screening during this age. The location of the screening is irrelevant to the definition.

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

1. Albania

***Hearing screening representative for Albania**: Genc Burazeri, Deputy Director, Institute of Public Health.*

1.1. Background

In Albania, universal childhood hearing screening is not currently implemented. Childhood hearing screening programmes have been project-based to date. The following report contains information with regards to the current and previous status of hearing screening in the entire country of Albania.

1.1.1. General

Albania has a total area of 28 748 km^2 and a population of 2 876 591 as of 2017 (Albanian Institute of Statistics (INSTAT), 2018). In Albania, each birth is registered through the Ministry of Health Civil Registration Office. The number of births in Albania was 31 733 from in 2016 (Albanian Institute of Statistics (INSTAT), 2018).

The World Bank income classification categorizes Albania as an upper-middle income country (The World Bank, 2018). The gross domestic product (GDP) is €3443 per capita as of 2014 (Albanian Institute of Statistics (INSTAT), 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Albania in 2015 was 266 USD or €229 per capita (World Health Organization, 2018).

Data acquired from the 2016 United Nations Demographic Yearbook indicate an infant mortality rate of 7.9 per 1000 for the country of Albania in 2013 (United Nations Statistics Division, 2016) and 8.7 per 1000 live births in 2014 according to the Albanian Institute of Statistics (2018).

1.1.2. Neonatal hearing screening

In Albania, neonatal hearing screening is only available as part of the maternity package within the few private hospitals. It is not available universally. An attempt at implementation occurred first in 2004; however, it was never implemented across the entire country. Currently, a neonatal hearing screening implementation project is underway through EUSCREEN.

The screening that has been performed on well babies has been funded by parents (private hospitals) and charity (project-based); screening for at-risk infants has been funded by parents and the state. Screening is not embedded into the general Preventive Child Health Care screening system nor is it obligatory for parents.

1.1.3. Preschool hearing screening

There is no preschool hearing screening in Albania.

1.2. Guidelines & Quality Control

There are no guidelines or protocols for hearing screening in Albania. Screening protocols have been developed for each independent project implemented in Albania.

Quality assurance on hearing screening is not performed and there have been no annual reports on hearing screening in Albania. Studies have been performed on hearing screening in Albania and data are collected after each project is completed (Beqiri & Nika, 2015; Hatzopoulos, Qirjazi, & Martini, 2007; Qirjazi, 2005; Sallavaci, 2016).

1.3. Process: Screening, Diagnosis, Intervention

1.3.1. Neonatal hearing screening

The average length of stay in the maternity ward after delivery is estimated to be 3 days. According to the National Health Report (2014), over 99% of births in Albania take place in the hospital. It is estimated that only 0.1% of births take place at home.

There is no neonatal hearing screening protocol that indicates the targeted maximum age of screening or target condition for screening. There is no general invitation for neonatal hearing screening for well or at-risk infants.

The target conditions indicated for previous neonatal screening protocols are hearing losses of > 35 dB HL for well babies and > 40 dB HL for at-risk babies. These target conditions were decided during the hearing screening project from 2004 to 2008 and were based on a literature review.

1.3.2. Neonatal diagnostic assessment

There is no protocol that indicates details of the diagnostic assessment. A diagnostic audiological evaluation should be completed by 3-6 months according to the protocol the project from 2004 to 2008 and is based on the JCIH position statement (Joint Committee on Infant Hearing, 2007).

1.3.3. Preschool hearing screening

In a study conducted on hearing loss prevalence among preschool-aged children in Albania, the target condition was a bilateral hearing loss of > 20 dB HL (Sallavaci, 2016).

1.3.4. Intervention approach

In Albania, treatment options available include grommets, hearing aids, and cochlear implants. Children are fitted with hearing aids from 2-5 years of age, and children are fitted with cochlear implants when they are available in Albania.

Cochlear implants have been fitted in Albania when money is available (i.e. when some money was donated to the government for this purpose). When available, these funds are used to fit both adults and children, including both failed CI users and new candidates. Until now 11 children have been fitted over 9 years. In 2018 the government allocated funds for approximately 9 CIs; however, these CIs are yet to be fitted.

The hearing aid fitting criteria for children in Albania is a bilateral moderate to severe hearing loss.

1.4. Protocols

In Albania, the ongoing implementation is part of the EUSCREEN Horizon 2020 EU project. During a previous project, a protocol was established to perform neonatal hearing screening in parts of Albania from 2004-2005 (Qirjazi, 2005; Hatzopoulos, Qirjazi, & Martini, 2007). The following information reflects the former screening protocols and results from this former project. It does not reflect the current hearing screening situation in Albania.

Note: sections 1.4 and 1.5 reflect the former screening protocol in place from 2004-2005 and does not reflect the current hearing screening situation in Albania.

Hearing screening protocols are described for neonatal hearing screening (well-baby 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.

1.4.1. Neonatal hearing screening (well)

The neonatal hearing screening protocol implemented in 2004-2005 in Albania is described below. The protocol was a 2-step OAE protocol. The first OAE was performed in the maternity hospital within the first 3 days after delivery and an OAE rescreen occurred in the ENT clinic within 1 month after the initial OAE. If the second OAE did not pass, infants were referred for a diagnostic ABR.

Table 1: Former screening process for well babies in Albania (Qirjazi, 2005; Hatzopoulos, Qirjazi, & Martini, 2007).

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	<24-72 hours	2/5 freq at 6 dB SNR & 70% reproducibility	EchoLab-Plus	Yes	Maternity hospital
OAE2	1 month			Yes	ENT clinic

1.4.2. Neonatal hearing screening (at-risk)

The neonatal hearing screening protocol implemented in 2004-2005 for NICU or at-risk infants in Albania was the same as the protocol for well babies (Table 1). For NICU babies the repetitions of the tests while the baby was still in the maternity hospitals were allowed.

1.4.3. Preschool hearing screening

Not applicable. Currently, there is no preschool hearing screening in Albania. In previous projects and research studies, preschool hearing screening used pure-tone audiometry (Sallavaci, 2016); however, the protocol varied depending on the study. No universal programme was ever established.

1.5. Professionals

Note: sections 1.4 and 1.5 reflect the former screening protocol in place from 2004-2005 and do not reflect the current hearing screening situation in Albania.

1.5.1. Neonatal hearing screening (well)

Midwives performed hearing screening during the 2004-2005 implementation of hearing screening (Qirjazi, 2005; Hatzopoulos, Qirjazi, & Martini, 2007). No theoretical training was offered during the project. The use of devices, the test results, delivery of information to parents, etc. was only practically taught by the project coordinator.

1.5.2. Neonatal hearing screening (at-risk)

Midwives also performed hearing screening for at-risk infants during the 2004-2005 implementation of hearing screening.

1.5.3. Preschool hearing screening

Not applicable. Currently, there is no preschool hearing screening in Albania. In previous research studies and projects, technicians would have performed screening.

2. Austria

Hearing screening representative for Austria: *Daniel Holzinger, Konvenhospital Barmherzige Brüder Linz, Institute of Neurology of Sensese and Language & University Graz, Department of Linguistics.*

2.1. Background

In Austria, hearing screening is organized locally, regionally and nationally. Neonatal hearing screening is implemented across the entire country, and provided in almost all hospitals. A national guidance document has been published by the Austrian ENT society, though screening is not established in federal law. Neonatal hearing screening protocols and data collection are regionally centered. Preschool hearing screening is organized locally, with each local social welfare authority organizing its own programme.

The following report contains information with regards to hearing screening for the Region of Upper Austria.

2.1.1. General

The country of Austria has a total area of 83 879 km^2 and a population of 8 739 806 as of 2016 (Statistics Austria, 2018). Upper Austria has an area of 11 982 km^2 and a population of 1 472 422 in 2017. In Austria, each birth is registered. The number of live births in Austria was 81 722 in 2014 and 87 633 in 2017. In Upper Austria, the number of live births was 15 394 in 2017 (Statistics Austria, 2018).

The World Bank income classification categorizes Austria as a high-income country (The World Bank, 2018). The gross domestic product (GDP) was €37 400 per capita in 2015 (Statistics Austria, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Austria in 2015 was 4 536 USD or €3 960 per capita (World Health Organization, 2018).

Infant mortality rate in the country of Austria was 3.0 and 3.1 per 1000 in 2014 and 2015, respectively (United Nations Statistics Division, 2016; Statistics Austria, 2018).

2.1.2. Neonatal hearing screening

In Austria, 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 for well and at-risk babies started in 1995 and was fully implemented in 1998 when a national ENT declaration was published, though screening was not a mandatory service. Neonatal hearing screening is funded by hospitals, and since 2003 has been embedded in the Preventive Child Health Care screening system as part of the Mother-Child Passport (Federal Ministry of Labor, Social Affairs, Health and Consumer Protection, 2018).

Neonatal hearing screening is organized by the hospitals, though most hospitals do not publish official protocols. While there is a national guidance document available (Audiology Association & Austrian ENT Society, 2017), regions across Austria follow their own protocol for screening well and at-risk infants. There is a protocol for screening for the region of Upper Austria.

2.1.3. Preschool hearing screening

In Austria, preschool hearing screening is not universally performed and not implemented across the country. In some areas, teachers may screen children's hearing and in other areas a speech-language pathologist may perform hearing screening in schools. Regions in Austria that do perform screening may screen differently, and there is no set protocol used throughout Austria.

The regions that are known to perform preschool hearing screening are Upper Austria and Tyrol. Preschool hearing screening in Upper Austria was fully implemented across the region in 2017 and is funded by the region. It is not part of the Preventive Child Health Care Programme, though it is linked to the universal speech-development screening that is also performed in kindergartens at this age. Prior to the implementation of universal preschool hearing screening in 2017, only a whisper test was administered (Holzinger, Heitz, & Kraxberger, 2017). Pure-tone screening is now available in every kindergarten across Upper Austria.

2.2. Guidelines & Quality Control

The neonatal hearing screening programme is decided on by the Ministry of Health in Vienna, in that hearing screening (where available) is offered as part of the Mother-Child Passport, even despite the fact that neonatal hearing screening may not be offered in all hospitals in Austria (Federal Ministry of Labor, Social Affairs, Health and Consumer Protection, 2018). Neonatal hearing screening was implemented in the Mother-Child Passport in 2003.

Though not established in law, national guidelines for neonatal hearing screening exist in Austria, published by the Austrian ENT society, with an original declaration published in 1998. The guidelines were recently updated in 2017, with recommendations added for bilateral screening and the use of aABR among children in the NICU (Audiology Association & Austrian ENT Society, 2017).

The protocols themselves are established regionally or locally, though some hospitals do not have official protocols. In Upper Austria, the regional health council is responsible for control of childhood hearing screening and provides funding for revisions. A multidisciplinary commission led by the health council decides on these revisions. In 2016/2017, the region of Upper Austria implemented a tracking programme for neonatal hearing screening, and in 2017 Upper Austria implemented universal screening of preschool children.

Quality assurance of hearing screening programmes is not imposed by the federal government, and data are not collected on a national level. Any data collection performed is done so on a local level by individual institutions or on a regional level, such as in Upper Austria. Data collection in Upper Austria is imposed by the regional government, and data collection occurs via a simple documentation tracking system that does not permit tracking of individual children. Data are collected annually, but because the tracking system started in 2017, official annual reports are not yet available.

There is data collection ongoing in Upper Austria regarding the neonatal hearing screening programme; however, there have not been any studies performed on the effectiveness of hearing screening in Upper Austria. Concerning the whole country of Austria, some studies have been found concerning the effectiveness of neonatal hearing screening (Weichbold, Nekahm-Heis, & Welzl-Müller, 2005; Weichbold, Nekahm-Heis, & Welzl-Mueller, 2006).

2.3. Process: Screening, Diagnosis, Intervention

2.3.1. Neonatal hearing screening

In Austria, infants are screened in the hospital maternity ward, in the NICU in cases of risk. According to the Birth Registry report, 98.4% of infants are born in hospitals each year and 1.3% are born at home (Teil des Instituts für Integrierte Versorgung der Tirol Kliniken GmbH, 2018). The average length of stay in the maternity hospital after birth is 3 days or 4 days in cases of a cesarean section. Families are invited to participate in screening directly in person at the hospital or in the NICU by the staff in the maternity hospital (nurses, speech therapists, NICU staff). Parents are asked to provide written content to having their baby's hearing screened.

The target condition for screening both well- and at-risk infants is a bilateral or unilateral hearing loss of >25-30 dB HL. Screening should be completed by 1 month of age for both well and at-risk infants.

Infants that undergo a different screening protocol from well, healthy babies (i.e., considered "at-risk"), are those who are admitted to the NICU. Data are unavailable on the childhood/infant prevalence of CMV infections or meningitis in Upper Austria.

2.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral should be completed by 3 months of age. Tests perform for confirmation of hearing loss include a clinical-ABR and ASSR.

2.3.3. Preschool hearing screening

In Upper Austria, preschool screening takes place in the kindergartens by a speech therapist. Children are invited to participate in screening via a letter.

The target condition for preschool hearing screening is a unilateral or bilateral hearing loss of >25 dB HL.

2.3.4. Intervention approach

In Austria, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Children are fitted with hearing aids from < 6 months of age and with cochlear implants from 1-2 years of age.

Fitting criteria for hearing aids in Austria is a hearing loss of at least 30 dB HL. Hearing aids may be fit on children with unilateral hearing loss a severity of less than 85 dB HL.

2.4. 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

2.4.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies in Upper Austria is summarized in Table 1, whereby a 2-step OAE - OAE protocol is in effect. The first OAE is performed in the maternity hospital after birth when possible. The protocol in Upper Austria recommends that both screening and rescreening (when applicable) occurs before discharge. In 8% of births discharge occurs less 1 day after delivery or earlier (Teil des Instituts für Integrierte Versorgung der Tirol Kliniken GmbH, 2018), and families are instead invited to return to the maternity hospital for screening or rescreening. In some rare cases, rescreening may occur with an aABR instead of an OAE. If the infant does not pass the second OAE (or aABR), a referral to the ENT department for a diagnostic assessment is made.

Table 2: Screening process for well babies in Upper Austria.

Test	Age*	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	24-72 hours	Various	Various	Yes	Maternity ward
OAE2 / aABR	Before discharge	35-40 dB nHL (not defined in protocol)		Yes	Maternity ward

*There is no standardization as to the age at which screening is performed. The ages noted here are recommended by the protocol for Upper Austria.

2.4.2. Neonatal hearing screening (at-risk)

There are no guidelines specified for NICU infants as stipulated by the protocol specific to Upper Austria; however, recommendations defined by the Austrian ENT society would also be recommended in Upper Austria. That is, that all NICU infants are screened with aABR in place of OAE testing (Audiology Association & Austrian ENT Society, 2017).

2.4.3. Preschool hearing screening

In Upper Austria, hearing screening is performed in kindergartens at 4 1/2 years of age. Pure-tone audiometry screening (with headphones) is performed. If one or more thresholds are worse than 25 dB HL a referral is made to an ENT for a diagnostic assessment.

Table 3: Process for preschool hearing screening in Upper Austria

Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone screening	4.5 years	25 dB HL	Yes	Kindergarten schools

2.5. Professionals

2.5.1. Neonatal hearing screening (well)

Screening for well-babies is performed by nurses or speech-language therapists, depending on the hospital.

There is no specific training programme for screening professionals. An introduction to screening is integrated into the 3-year education of speech therapists. Otherwise, screening staff are trained on the job. Upper Austria has started workshops for screening staff; however, there is no obligatory training update or monitoring of screening professionals.

2.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by nurses or speech-language therapists. See 7.1 for details.

2.5.3. Preschool hearing screening

Preschool screening is performed by speech-language therapists.

3. Belgium (Flanders)

Hearing screening representative for Belgium (Flanders): *Luc Stappaerts, Kind en Gezin.*

3.1. Background

In Belgium, hearing screening is performed nationally and organized regionally. The following report contains information with regards to childhood hearing screening in the Flanders region and Brussels capital region in the country of Belgium.

3.1.1. General

The Flanders region of Belgium has a total area of 13 683 km^2 with a population of 7 341 546 in 2010 (Belgian Federal Public Services, 2019). In Belgium, it is regulation that each birth be registered in a national database. The number of births in Flanders and Brussels capital region was 88 691 infants in 2010 (Belgian Federal Government, 2017). Data from Statistics Flanders report 64 501 births in the Flanders region in 2017 (Statistics Flanders, 2018).

The World Bank income classification categorizes Belgium as a high-income country (World Health Organization, 2015). The gross domestic product (GDP) per capita for all of Belgium was €37 857.25 in 2014 (Trading Economics, 2017) and for Flanders region, GDP per capita was an estimated €36 700 in 2018 (Statistics Flanders, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Belgium in 2015 was 4228 USD or €3618 per capita (World Health Organization, 2018).

Data acquired from the 2016 United Nations Demographic Yearbook indicate an infant mortality rate of 3.3 per 1000 for the country of Belgium in 2015 (United Nations Statistics Division, 2016).

3.1.2. Neonatal hearing screening

In Flanders, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening, though participation is not obligatory for parents.

Neonatal hearing screening is funded by the Flemish government and embedded in the Preventive Child Health Care screening system. Neonatal hearing screening is organized by the programme Kind en Gezin for the Flemish Region.

Hearing screening for well babies was started by Kind en Gezin in 1997 and was fully implemented across Flanders in 1998. Prior to then, NICU screening had already been implemented autonomously by hospitals. When Kind en Gezin began the universal screening programme, some NICUs turned over screening responsibility to Kind en Gezin while others continued their NICU-screening programme independently. Hospitals that screen NICU infants independently report their screening coverage monthly to Kind en Gezin, and Kind en Gezin then screens any infants that missed screening prior to discharge.

3.1.3. Preschool hearing screening

Preschool and school entry hearing screening currently exists in Flanders. Preschool/school entry hearing screening is funded by the state. Preschool and school entry hearing screening is not embedded in Preventive Child Health Care, but instead it is organized by Centrum

Leerlingenbegeleiding translated to the Student Guidance Center. This organization employs doctors, nurses, social workers, etc., and provides schools with medical supervision.

Preschool hearing screening existed universally in Flanders up to the 2016-2017 school year. Thereafter, hearing screening guidelines changed in that screening is only provided to preschool-age children (age 3) with risk factors for hearing loss. Screening is later universally provided to all children during their first year of primary school (5-6 years), fifth year of primary school, and third year of secondary school.

3.2. Guidelines & Quality Control

National guidelines for childhood hearing screening are available from the Flemish Scientific Association for Youth Health Care, including both neonatal and preschool screening and include the protocols for performing hearing screening (Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg, 2015; Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg, 2017; Van Hoeck, 2015; Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg, 2016).

The content of the neonatal hearing screening programme was decided on by a scientific board on neonatal hearing screening, in collaboration with the departments Geïntegreerd gezinsbeleid and Medical cel within Kind en Gezin. The content of the preschool/school hearing screening programme was also decided on by a group of experts, a scientific advisory board, and a resonance group with the Student Guidance Center. Implementation of the guideline was performed after approval by a board of trustees within the Flemish Scientific Association for Youth Health Care (Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg, 2016).

The neonatal screening programme has been changed since implementation. Specifically, guidelines were adjusted in 2004 so that a non-pass result at rescreening would indicate cause for referral for audiological assessment. In 2006 and again in 2013, the programme updated its protocol to accommodate a change in screening device. The neonatal hearing screening programme is regularly reviewed during the annual meeting of the Scientific Board on Newborn Hearing Screening.

If changes are to take place, the following procedure is put in place: first, a notification will exist in the agenda of the Scientific Board meeting, at which time an open discussion will commence. Second, a taskforce will be implemented to investigate the change, and conclusions with proposed suggestions will be made to the Scientific and Administration Board of Kind en Gezin. Third, an implementation group will be assigned under guidance from the Scientific and Administration Board of Kind en Gezin, which will prepare the implementation process. Finally, after implementation, review and quality assessment will be performed by the Scientific and Administration Board of Kind en Gezin. This entire process is funded by the working budget of Kind en Gezin.

Because hearing screening is organized by Kind en Gezin, quality assurance of the neonatal hearing screening programme is an internal process. Specifically, information is collected about neonatal hearing screening through the infant's medical record collected by a nurse. Kind en Gezin works in close collaboration with 22 centers of excellence on diagnosis and rehabilitation.

Annual reports on neonatal hearing screening results are not available. However, some data on the performance of neonatal hearing screening are available and made public on the Kind en Gezin

website (Kind en Gezin, 2018). A report was previously published with data from 2009 to 2011 (Van Kerschaver & Stappaerts, 2012).

There have been studies published on the hearing screening programme in Flanders including studies measuring the effectiveness of neonatal hearing screening (Van Kerschaver, Boudewyns, Stappaerts, Wuyts, & Van de Heyning, 2007; Verhaert, Willems, Van Kerschaver, & Desloovere, 2008; Hardonk, et al., 2011; Van Kerschaver, Boudewns, Declau, Van de Heyning, & Wuyts, 2012; Stappaerts & Hoppenbrouwers, 2018).

3.3. Process: Screening, Diagnosis, Intervention

3.3.1. Neonatal hearing screening

Well-babies are screened by Kind en Gezin in welfare baby clinics, at home, in district houses, or in Houses for the Child. There is currently one maternity ward where well babies are screened in the hospital by audiologists. For NICU infants, some hospitals perform screening in the hospital NICU while other hospitals discharge NICU infants and they are then screened by Kind en Gezin at home, in district houses, or in welfare baby clinics.

The percentage of infants born in a maternity hospital in Flanders is 83.8% and 0.8% are delivered at home. The remaining percentage is unknown. It is roughly estimated that the length of stay in the hospital after delivery is, on average, 3 nights (4 days) for first-time mothers and 2 nights for non-first-time mothers.

Parents/caregivers of well and at-risk babies are invited to participate in neonatal hearing screening via a house call by nurses of Kind en Gezin or by phone for parents that are difficult to contact. Asylum seekers are contacted in their asylum centre. Parents who drop into the welfare baby clinics with a baby who has not previously been screened are invited for hearing screening.

Hearing screening for well babies should be completed by 4-6 weeks though the programme aims to screen within 21 days after birth. Hearing screening for at-risk babies screening should be completed as soon as possible according to protocol. Exclusion criteria from neonatal screening is 4 months for a well-baby and 6 months for a NICU baby. At this age, if screening has not been performed, they are automatically referred for follow-up testing.

All babies with risk factors included on the JCIH list are regarded by Kind en Gezin as ‘at risk’ and are followed-up more closely by the screening protocol. A nurse who is responsible for the trajectory of the child keeps a closer eye on the development these infants. Approximately 3% of neonates make up this group of infants considered “at-risk.”

Data are not available regarding the prevalence of CMV or meningitis in Flanders.

The target condition for screening for well and at-risk babies is a unilateral or bilateral hearing loss of 40 dB HL or worse.

3.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral should be completed by 3 months.

3.3.3. Preschool hearing screening

Preschool hearing screening is not embedded in the Preventive Child Health Care screening system but is part of the Centres for Student Guidance and takes place in the Centres for Student Guidance.

The target condition for preschool hearing screening (selective screening) is a hearing loss of 35 dB HL or worse at 1000 and 4000 Hz. The target condition for school-entry screening (universal screening) is a hearing loss of 35 dB HL or worse at 1000 and 4000 Hz (Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg, 2016).

All children in the first year of primary school (age 5-6) are invited to screening by Centres for Student Guidance and screening is performed in the schools by nurses from the Centres for Student Guidance (Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg, 2016). Screening also occurs in the fifth year of primary school and third year of secondary school.

3.3.4. Intervention approach

In Flanders, treatment options available include grommets, hearing aids, bone conductive devices, cochlear implants, and brainstem implants.

Data are not available regarding the minimum age for fitting infants with hearing aids or cochlear implants. Data are not available at Kind en Gezin regarding the minimum criteria for fitting hearing aids.

3.4. 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

3.4.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies is summarized in Table 1, whereby a 2-step aABR - aABR protocol is in effect.

The aABRs are performed in welfare baby clinics, at home, in district houses, or in Houses for the Child, with the exception of one hospital performing screening in the maternity ward. If the infant does not pass the first aABR test, rescreening occurs within 48 hours. One exception is if the infant is suffering from a severe cold, in which re-screening will take place after one week.

Table 4: Process for neonatal hearing screening for well, healthy infants in Flanders.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
aABR1	<1 month	35 dB nHL	MAICO 11MB Classic	Yes	Welfare baby clinics, home, district houses, Houses for the Child
aABR2	48 hrs after first test	35 dB nHL	MAICO 11MB Classic	Yes	

3.4.2. Neonatal hearing screening (at-risk)

The screening protocol for at-risk (NICU) infants is the same as for well infants. Details are described in Table 2. However, there are some differences in care and follow-up in that infants with JCIH risk factors are carefully monitored by Kind en Gezin and followed closely by their pediatric nurse.

The organizational situation is complex for NICU infants, as some hospitals take responsibility for screening NICU infants, while for other hospitals Kind en Gezin screens infants before or after discharge. A hospitalized infant will be screened immediately after discharge or in the hospital ward, depending on the condition of the child and length of expected stay.

Some infants are referred to a diagnostic assessment after initial screening, thus skipping the rescreening. These infants are those with a presence of family history (at parent's request) or with a craniofacial abnormality.

Table 5: Process for neonatal hearing screening for at-risk infants in Flanders

Test	Age	Referral criteria	Unilateral Referrals?	Location
aABR1	>31 weeks gestational age	35 dB nHL	Yes	NICU
aABR2	48 hrs after first test	35 dB nHL	Yes	NICU / Welfare baby clinics, home, district houses, Houses for the Child

3.4.3. Preschool hearing screening

Preschool-age screening is selectively performed on children with risk factors for hearing loss or those who were not screened as a newborn. Universal hearing screening is then performed in schools at 5-6 years of age using a short version of pure-tone audiometry screening. At a later age (age 10-11 and 14-15), children are screened again using the SPIN (speech in noise) test (Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg, 2016).

Table 6: Process for preschool hearing screening in Flanders.

Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone audiometry (selective)	3-4	35 dB HL (1 & 4 kHz)	Yes	Preschool

Table 7: Process for school-entry hearing screening in Flanders.

Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone audiometry (universal)	5-6	30 dB HL (1 & 4 kHz)	Yes	School

3.5. Professionals

3.5.1. Neonatal hearing screening (well)

Neonatal hearing screening is performed by nurses employed by Kind en Gezin as well as audiologists in some maternity wards.

Training consists of an e-learning module (2 hours) and on-site training by an experienced nurse-colleague or training coordinator within Kind en Gezin (4 hours). This training is not certified, as it is provided internally and immediately after employment by Kind en Gezin; however, the training quality itself is internally monitored by the Kind en Gezin team.

There is an annual update for the trainers, and the e-learning module is updated when changes are made to the screening programme. Updates are then made to nurses via the regional senior expert and intranet information. The performance of nurses is monitored via tracing of unscreened infants, late screened infants, or infants that were not referred properly. Infants that do not attend follow-up assessments following referrals are tracked, along with infants that are improperly referred. Infants that are diagnosed with hearing loss having received a pass are registered and investigated. NICU graduates that missed screening are closely monitored to ensure high coverage.

3.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk (NICU) infants is also performed by nurses in Kind en Gezin, or independently by nurses or audiologists in the hospitals.

3.5.3. Preschool hearing screening

Screening for preschool-age children is performed by nurses from the Centres for Student Guidance.

4. Belgium (Wallonia-Brussels Federation)

Hearing screening representative for Belgium (WBF): *Bénédicte Vos, School of Public Health - Université libre de Bruxelles/Centre d'Epidémiologie Périnatale.*

4.1. Background

In Belgium, hearing screening is organized regionally, with regions Wallonia-Brussels Federation, Flanders, and the German-speaking community each organizing and running a separate program.

This report contains information corresponding to hearing screening the Wallonia-Brussels Federation (WBF) region of Belgium.

4.1.1. General

The WBF region of Belgium has a total area of around 17 000 km^2 (Fédération Wallonie-Bruxelles, 2016) with a population of 4 571 072 in 2015 (Fédération Wallonie-Bruxelles, 2016). In Belgium, it is regulation that each birth be registered in a national database. The number of births in WBF was 57 500 infants in 2015 (Fédération Wallonie-Bruxelles, 2016).

The World Bank income classification categorizes Belgium as a high-income country (World Health Organization, 2015). The gross domestic product (GDP) was €395 262 million in Belgium as a country and estimated to be €156 091 million for WBF in 2013. With a population of 4 526 142 in 2013 (Fédération Wallonie-Bruxelles, 2016), this equates to an estimated €34 486 per capita for the region.

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Belgium in 2015 was 4228 USD or €3618 per capita (World Health Organization, 2018).

Data from the WHO indicates a child mortality rate (under age 5) in Belgium of 4 per 1000 in 2013 (World Health Organization, 2015), and data from the Euro-Peristat Perinatal Health Report indicates infant mortality rates (at or after 22 weeks to one-year of age) in 2010 as 4.8 and 3.1 per 1000 births in Brussels and Wallonia, respectively (Alexander, et al., 2010). Data acquired from the 2016 United Nations Demographic Yearbook indicates an infant mortality rate of 3.3 per 1000 for the country of Belgium in 2015 (United Nations Statistics Division, 2016).

4.1.2. Neonatal hearing screening

In WBF, neonatal hearing screening is conducted universally, with all well babies within the region having access to hearing screening, though screening is not obligatory for parents. The universal program was implemented and officially launched in November 2006 as part of the Preventive Child Health Care screening system, and it is funded through the province/region as well as by the parents. The same protocol is used throughout the region for well babies.

Infants with risk factors for hearing impairment are referred directly to a diagnostic evaluation.

4.1.3. Preschool hearing screening

There is no preschool hearing screening in the WBF.

4.2. Guidelines & Quality Control

A regional guideline and protocol exist for neonatal hearing screening in the Wallonia-Brussels Federation of Belgium (Communauté française de Belgique, 2015).

The content of the neonatal hearing screening guidelines was developed by a group of experts. ENT physicians, pediatricians, public health individuals in coordination with the coordinating agency of the neonatal hearing screening program decided on the content.

Since its initiation in 2007, the guidelines on hearing screening have not been revised. The document has only had administrative updates since its publication. If required in the future, a group of experts would be responsible for decisions on revisions.

The role of quality monitoring is assumed by the neonatal hearing screening coordinating agency. Data are collected on the screening process, such as date of test and results of screening. Currently, depending on the hospital, data is either sent electronically (50% of hospitals) or by paper (50%). In the future, all screening data will be transferred electronically.

Annual reports of neonatal hearing screening results in WBF are available online (www.depistagenenatal.be). Furthermore, the effectiveness of neonatal hearing screening WBF was investigated as part of a PhD thesis (Vos, 2016).

4.3. Process: Screening, Diagnosis, Intervention

4.3.1. Neonatal hearing screening

In WBF, well-baby screening occurs in the maternity unit at hospitals. There is a total of 45 hospitals with maternity wards in the WBF. Participation in the WBF neonatal screening programme is voluntary. Two maternity hospitals do not participate in the programme, and instead organize their own screening protocol.

Approximately 99.2 to 99.5% of children are born in a hospital or maternity clinic, and approximately 0.4 to 0.5% of births occur at home. The average stay in the maternity hospital after birth is 2-3 days as of a new reform in 2016/2017 (Van Leeux, Leroy, Englert, & Zhang, 2017; Leroy, Van Leeuw, Englert, & Zhang, 2017).

All babies that are screened are done so using the well-baby protocol. As indicated, babies at-risk are not screened but referred directly for diagnostic assessment. Well-baby screening should ideally be completed before the infant is discharged from the hospital. If hearing screening cannot be completed by discharge, an appointment is booked before 15 days of age; however, in some cases where this is not possible, a 4-week maximum benchmark age is tolerated by protocol (Communauté française de Belgique, 2015).

The target condition for screening is not specified in the protocol for well babies, nor is the target condition for at-risk babies.

At-risk babies are defined as those with a family history of hereditary hearing loss, consanguinity to the first degree, in utero infections including CMV, toxoplasmosis, herpes, rubella, and syphilis), drug or alcohol poisoning during pregnancy, an APGAR score of 0-6 at 5 minutes or gestational age <

weeks and/or low birth weight (<1500g), NICU stay ≥ 5 days, newborn ototoxic medication, exchange transfusion, assisted ventilation, head or neck abnormalities, syndrome including hearing loss, neurological diseases or endocrine diseases. These may include babies in both the well-baby and NICU units (Communauté française de Belgique, 2015).

In 2015, a total of 787 infants were born prematurely (< 37 weeks) in WBF (Van Leeux, Leroy, Englert, & Zhang, 2017; Leroy, Van Leeuw, Englert, & Zhang, 2017). The prevalence of CMV infection is unknown. This information is not collected and registered; on the other hand, risk factor data are collected. CMV has been reported as a risk factor in 213 out of 506 000 neonates (Vos, Lavenne, Oumourgh, & Levêque, 2017).

The prevalence of meningitis is not collected, but instead all neurological diseases combined are reported in the neonatal hearing screening program.

Neonates with at least one risk factor for hearing loss account for 9% of total births, including both well infants and infants admitted the NICU (Vos, Lavenne, Oumourgh, & Levêque, 2017).

4.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests vary across the WBF. While it is recommended that at least an ABR is performed, other diagnostic tests performed may include otoscopy, OAEs, and impedance measurements.

The diagnostic assessment of well-babies should be performed within 15 days from hearing screening referral (Communauté française de Belgique, 2015). Recall letters are sent by the coordinating agency in cases where infants are lost to follow up after referral or infants who were not screened, or by the hospitals for the 3rd recall or in cases where data transmission is performed via paper.

All at-risk babies are referred directly for a diagnostic assessment during their stay in the hospital / maternity ward. The diagnostic test may be performed while the infant is in the hospital or via a scheduled appointment. Medical professionals may phone the parents or send a letter with the scheduled day and time of consultation. The test takes place in the hospital in the NICU or the ENT clinic. This diagnostic test should be completed by 2-8 weeks after birth or by 1-month of age, corrected. (Communauté française de Belgique, 2015).

4.3.3. Preschool hearing screening

Not applicable.

4.3.4. Intervention approach

In WBF, treatment options available include grommets, hearing aids, bone conductive devices, cochlear implants, and more. The age at which children are fitted with hearing aids or cochlear implants are not reported, as this depends on individual trajectory of care and age at which hearing loss is diagnosed (Vos, Senterre, Boutsen, Lagasse, & Levêque, 2018).

Fitting guidelines for hearing aids are not published in guidelines, but international recommendations are followed. WBF criteria for hearing aid fitting depend on the child's hearing loss, personal situation, other disabilities, etc.

4.4. 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

4.4.1. Neonatal hearing screening (well)

The screening process for well babies is indicated in Table 1. In WBF, a two-step OAE protocol is performed when necessary before discharge. Infants that fail the second OAE at discharge are referred for a diagnostic assessment (Communauté française de Belgique, 2015).

Table 8: Screening process for well babies in Belgium (WBF).

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	24-72 hours	8x peaks of alternating-signs	Accuscreen*	Yes	Maternity hospital
OAE2	+1 day after OAE1 (before discharge)			Yes	Maternity hospital

*While the Accuscreen device by Madsen is widely used across WBF, some hospitals use the EchoScreen by Natus, which has a bimodial statistical algorithm, or Echocheck by Otodynamics.

4.4.2. Neonatal hearing screening (at-risk)

All infants considered at risk are referred directly for audiological diagnostic assessment.

4.4.3. Preschool hearing screening

Not applicable.

4.5. Professionals

4.5.1. Neonatal hearing screening (well)

Screening is performed by midwives or nurses. Sometimes screening is performed by audiologists, speech therapists, or assistant nurses. There is no formal training for screening staff or accreditation required.

A non-mandatory half- to full-day session is held once every 3-5 years to discuss elements of hearing screening, including the programme, operation, results, risk factors, etc; however, this session is not intended for training on the use and operation of screening equipment (Communauté française de Belgique, 2015).

4.5.2. Neonatal hearing screening (at-risk)

Screening is not performed. Audiologists or specialized nurses perform the diagnostic test bilaterally. As a legal requirement, the test results must be analyzed by an ENT or neurophysiologist.

4.5.3. Preschool hearing screening

Not applicable.

5. Bosnia and Herzegovina (Tuzla canton)

***Hearing screening representative for Bosnia and Herzegovina**: Fuad Brkić, Head of ENT Dept. University Clinical Center Tuzla.*

5.1. Background

In Bosnia and Herzegovina, hearing screening is organized and implemented regionally.

The following report contains information with regards to hearing screening in the Tuzla Canton of Bosnia.

5.1.1. General

Bosnia and Herzegovina comprises two autonomous regions: The Federation of Bosnia and Herzegovina and the Republika Srpska (Serb Republic), plus a third region, the Brčko District. The Federation of Bosnia and Herzegovina is made up of 10 cantons, or member states, each with its own Ministry of Health, Law of Health and maternity wards. Tuzla Canton is the most populous of the 10 cantons in the country with 10 maternity wards.

Tuzla Canton has a total area of 2 664 km^2 (Vlada Tuzlanskog kantona, 2018) and a population of 477 278 as of the 2013 census (Agency for Statistics of Bosnia and Herzegovina, 2013) In Tuzla Canton, each birth is registered. In 2016, the number of live births was 30 183 in all of Bosnia and Herzegovina and 3727 in Tuzla Canton (Agency for Statistics of Bosnia and Herzegovina, 2018).

The World Bank income classification categorizes Bosnia and Herzegovina as an upper-middle income country. It was classified as a lower-middle-income country prior to 2010 (The World Bank, 2018). The gross domestic product (GDP) is €4 571 per capita as of 2017 (Agency for Statistics of Bosnia and Herzegovina, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Bosnia and Herzegovina in 2015 was 431 USD or €378 per capita (World Health Organization, 2018).

Data acquired from the 2016 United Nations Demographic Yearbook indicate an infant mortality rate of 4.8 per 1000 for the country of Bosnia and Herzegovina in 2014 (United Nations Statistics Division, 2016).

5.1.2. Neonatal hearing screening

Only some cantons in Bosnia and Herzegovina have implemented neonatal hearing screening, such as Tuzla canton, Sarajevo, and Livno. Universal hearing screening is not carried out across the entire country.

In Tuzla Canton, neonatal hearing screening is conducted universally, with all babies in the region having access to hearing screening, though screening is not obligatory for parents. The hearing screening programme for at-risk babies was first implemented in 2001, and for well, healthy babies it was implemented in 2009. As indicated, it is not yet implemented across the entire country. Neonatal hearing screening is not embedded in the Preventive Child Health Care screening system. Screening is funded through health insurance and through the municipalities.

Across Tuzla Canton, there are differences in the location and timing of screening. Specifically, out of the three hospitals in Tuzla Canton, one hospital (General Hospital Gračanica) performs OAE screening in the maternity ward. In the two other hospitals, screening is not performed in the maternity ward, but parents are instead invited to hearing screening at the Audiology department.

5.1.3. Preschool hearing screening

In Tuzla Canton, preschool hearing screening is not performed.

5.2. Guidelines & Quality Control

Guidelines and a protocol for hearing screening do not exist in Tuzla Canton. There are no official protocols or guidelines. The Joint Committee of Infant Hearing (2007) document is used as guidance.

The content of hearing screening programme was decided on by ENT specialists. The content of the programme has not changed since hearing screening implementation; however, changes have been made due to device failure. Specifically, in 2009, all hospitals performed neonatal hearing screening in the maternity ward. However, in two of three hospitals, device failure has caused the location of screening to move from the maternity ward to the Audiology department in Tuzla. Since then, parents are provided written information about neonatal hearing screening in the delivery ward, inviting them to the Audiology department to have their newborn's hearing screened free of charge.

Quality assurance of hearing screening programmes is not imposed by the government, nor is it performed in Tuzla Canton; however, data on the number of newborns screened are collected, sent monthly to the Audiology department in the ENT clinic at the University Clinical Center Tuzla. Data are also available from the Audiology department, as newborns born in two of three hospitals are screened directly in the Audiology department.

Reports are available for screening Tuzla Canton, including data collected from April 2009 to December 2010 and from December 2010 to March 2017. From these data, studies have been performed on neonatal hearing screening and its effectiveness in Tuzla Canton. Studies have also been performed on hearing screening in other parts of Bosnia and Herzegovina (Pirić, 2018; Sarajlić, 2013; Hrncic, 2018; Vranjes, et al., 2012).

5.3. Process: Screening, Diagnosis, Intervention

5.3.1. Neonatal hearing screening

Well-babies and at-risk babies are mostly screened in the Audiology department in Tuzla. Infants born in one hospital in Tuzla Canton are screened in the maternity hospital, where the maximum length of stay is estimated to be 2 days. It is roughly estimated that 1-2% of births take place at home. Families of well infants are typically invited to participate in neonatal screening via a letter. Families of at-risk infants are invited to participate directly in person in the hospital

Neonatal hearing screening for well babies should be completed before 6 months of age, and by 6-12 months of age for at-risk infants.

The target condition for screening well babies is a bilateral or unilateral hearing loss of greater than 30 dB HL, and the target condition for screening at-risk babies is a bilateral or unilateral hearing loss of greater than 25 dB HL.

In Tuzla Canton, at-risk infants are defined based on the list created by the Joint Committee on Infant Hearing (2007); however, there is no difference in protocol between well and at-risk infant. Data are unavailable regarding how many infants meet the listed risk-factor criteria (Joint Committee on Infant Hearing, 2007).

The prevalence of CMV infections and meningitis among neonates is not known.

5.3.2. Neonatal diagnostic assessment

The diagnostic assessment test performed after neonatal hearing screening referral is a clinical ABR. Well infants should have their diagnostic assessment completed by 6 months of age, and at-risk infants should have their diagnostic assessment completed by 80 weeks, corrected.

5.3.3. Preschool hearing screening

Not applicable.

5.3.4. Intervention approach

In Tuzla Canton, treatment options available include grommets, hearing aids, and cochlear implants. Infants are fitted with hearing aids or cochlear implants from 6-12 months of age or older.

The hearing aid fitting criteria in Tuzla Canton is a hearing loss > 40% according to the Fowler-Sabine scale (a frequency-weighting algorithm to estimate hearing handicap).

5.4. 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

5.4.1. Neonatal hearing screening (well)

There are two to three steps to the newborn hearing screening protocol for well babies in Tuzla Canton. Tables 1 and 2 describe the different protocols used in Tuzla Canton. In one hospital, initial OAE screening is performed in the maternity ward. A possible third step is sometimes performed at the age of 4 months. In the other two hospitals, screening devices are not available in the maternity

wards. Instead, parents are invited for screening at the Audiology unit. For these infants, screening takes place around the age of 2 months. For infants that fail the first OAE, a rescreening occurs 1 to 2 months later.

Table 9: Screening process for well babies in Tuzla Canton (hospital 1).

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location
OAE1	24-72 hours	Not indicated	Not indicated	Yes	Maternity ward
OAE2	1-2 months	Not indicated	Not indicated	Yes	Audiology dept.
*OAE3**	*4 months*	*Not indicated*	*Not indicated*	Yes	*Audiology dept.*

*Infants are *sometimes* invited back for a third OAE at 4 months of age before being referred for a clinical ABR.

Table 10: Screening process for well babies in Tuzla Canton (hospitals 2 & 3).

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location
OAE1	2 months	Not indicated	Not indicated	Yes	Audiology dept
OAE2	3-4 months	Not indicated	Not indicated	Yes	Audiology dept.

5.4.2. Neonatal hearing screening (at-risk)

The sequence for screening infants at-risk is identical to the protocol for well, healthy infants. The only exception is that testing occurs when the health condition of the infant allows.

5.4.3. Preschool hearing screening

Not applicable.

5.5. Professionals

5.5.1. Neonatal hearing screening (well)

Screening for well babies in the neonatal ward is performed by nurses. Screening at the Audiology department is performed by a hearing rehabilitator. There is no specific training for hearing screeners in Tuzla Canton.

5.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by nurses or a hearing rehabilitator, as described in section 5.5.1.

5.5.3. Preschool hearing screening

Not applicable.

6. Bulgaria

Hearing screening representatives for Bulgaria: *Petar Rouev, ENT Dept., Trakia Hospital Stara Zagora.*

6.1. Background

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

6.1.1. General

Bulgaria has a total area of 110 994 km^2 with a population of 7 101 859 at the end of 2016 (National Statistical Institute, 2018).

In Bulgaria, all births are registered into public information. Birth information is regulated by a medical standard in Obstetrics and Gynecology. There were 63 955 births registered in 2017 (National Statistical Institute, 2018).

The World Bank income classification categorizes Bulgaria as an upper-middle-income country (The World Bank, 2018). The gross domestic product (GDP) in 2017 was €7,099 per capita in Bulgaria (National Statistical Institute, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Bulgaria in 2015 was 572 USD or €502 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 6.4 per 1000 is reported for Bulgaria in 2017 (National Statistical Institute, 2018). The United Nations Statistics Division also shows a higher mortality rate in Bulgaria in rural areas compared to urban areas. Infant mortality rates in 2015 were 10.9 and 5.2 for rural and urban areas, respectively (United Nations Statistics Division, 2016).

6.1.2. Neonatal hearing screening

In Bulgaria, neonatal hearing screening is conducted universally. All babies in the country should have access to hearing screening, though participation is not obligatory for parents.

Hearing screening for both well and at-risk babies started and was fully implemented in Bulgaria in 2015. Screening for well babies is funded through the council (Ministry of Health) and it is roughly estimated that funding for at-risk infants is funded through the province/region. Screening is not embedded in the Preventive Child Health Care screening system. Neonatal hearing screening is organized by the Ministry of Health in Bulgaria.

National guidelines are available as is a screening protocol used across the country. Although a national universal programme is in place in Bulgaria and all hospitals should follow the same protocol, there are some inconsistences regarding how accurately the hearing screening protocol is followed in some hospitals.

6.1.3. Preschool hearing screening

Preschool hearing screening is conducted universally in Bulgaria. Before school start, children's hearing should be tested. Screening is not embedded in the Preventive Child Health Care screening

system and is funded by parents or health insurance. It is unknown when preschool hearing screening started or was implemented across the country. It is typically organized by the child's physician and is performed in the clinic. Referrals are made to the ENT clinic when necessary.

6.2. Guidelines & Quality Control

There are national guidelines for hearing screening in Bulgaria.

The content of the general hearing screening programme was decided on by the Ministry of Health and has not been changed since implementation in 2015.

Quality assurance of hearing screening programmes is not imposed by the government; however, information is collected directly by the Ministry of Health. Each hospital provides screening information to the regional office of the Ministry. Data are unavailable on whether annual reports are produced.

It is unknown whether research has been done on hearing screening programmes in Bulgaria, but there has not been research performed on the effectiveness of screening in Bulgaria.

6.3. Process: Screening, Diagnosis, Intervention

6.3.1. Neonatal hearing screening

Well-babies and at-risk babies are screened in the hospital, NICU or private clinic. The percentage of infants born in a maternity hospital in Bulgaria is unknown though roughly estimated to be close to 100%, while home births are roughly estimated to be below 2-3%. The average length of stay in the maternity hospital after delivery is roughly estimated to be 3-5 days. Parents/caregivers of well and at-risk babies are invited to participate in neonatal hearing screening directly in person in the hospital.

Neonatal hearing screening for well babies should be completed before 3 months of age. For at-risk babies, screening should be completed before 3 months of gestational (corrected) age.

The definition of at-risk infants is listed according to the Joint Committee on Infant Hearing (2007).

Data on the prevalence of CMV and meningitis is not available in Bulgaria, but are roughly estimated to be very low (less than 0.5% and 1%, respectively).

The target condition for screening for both well at at-risk babies is a bilateral hearing loss of 40 dB HL or worse.

6.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral should include an ABR assessment and be completed by 3 months of age for well infants, and 3 months corrected age for at-risk infants.

6.3.3. Preschool hearing screening

Hearing screening is performed on children before they start school. They are invited to participate by their general practitioner, and screening is performed there in the health care clinic by the GP. Follow-up may be made to the ENT clinic if necessary.

The target condition for preschool hearing screening is a unilateral or bilateral hearing loss of 40 dB HL or worse.

6.3.4. Intervention approach

In Bulgaria, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants; however, not all children in Bulgaria are treated due to capacity problems and payment problems. Furthermore, children with deaf parents who refused cochlear implats for their children are not fitted with cochlear implants.

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. The fitting criteria in Bulgaria for a hearing aid is roughly estimated to be bilateral hearing loss of at least 40 dB HL.

6.4. 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

6.4.1. 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. If the infant fails the first test, rescreening occurs at 1 month of age. A subsequent fail at rescreening would warrant a referral to the ENT department for clinical/diagnostic ABR.

Table 11: Process for neonatal hearing screening for well, healthy infants in Bulgaria.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1*	24-72 hours	4 of 6 freq: >5dB SNR (TE); 3 of 4 freq: >6dB SNR (DP).	Various	Yes	Maternity hospital
OAE2	1 month	4 of 6 freq: >5dB SNR (TE); 3 of 4 freq: >6dB SNR (DP).	Various	Yes	Maternity hospital

* OAE1 may be performed 1-3 times before discharge.

6.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk infants is described in Table 2. A combined TEOAE+aABR screening is in effect whereby both OAE and aABR is performed before the infant is discharged from the NICU. Both aABR and TEOAE are required for all at-risk infants. Additionally, follow-up is performed on all at-risk infants at 6 months of age.

Table 12: Process for neonatal hearing screening for at-risk infants in Bulgaria.

Test	Age	Referral criteria	Unilateral Referrals?	Location
OAE+ aABR	24-72 hours	40 dB nHL	Yes	Maternity hospital / NICU

6.4.3. Preschool hearing screening

Hearing screening is performed in health care clinics at 7 years of age. The screening test is pure-tone audiometry.

Table 13: Process for preschool hearing screening in Bulgaria.

Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone audiometry	7 years	40 dB HL	Yes	Health Clinic

6.5. Professionals

6.5.1. Neonatal hearing screening (well)

Neonatal hearing screening is performed by a nurse, audiologist, midwife or paediatrician.

There is currently no specific training for hearing screening staff. The training currently provided is practical (on the job).

6.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by paediatricians.

6.5.3. Preschool hearing screening

Screening for preschool-age children may be performed by general practitioners, ENT physicians or audiologists. This is not clearly defined in Bulgaria.

7. China

Hearing screening representative for China: *Xiangyue Peng, Hunan Children's Hospital, ENT Dept.*

7.1. Background

In China, hearing screening is implemented regionally and organized both nationally and regionally. Specifically, the National Health Department designates where neonatal hearing screening should be implemented and guidelines for screening, and specifics such as tests, personnel and equipment is decided on at a regional or local level. The following report contains information with regards to childhood hearing screening across all of China.

7.1.1. General

The country of China has a total area of 9 597 000 km^2 and a population of around 1 395 380 000 as of December 2018. In China, each birth is registered. The number of live births in China was 15 230 000 in 2018 (National Bureau of Statistics of China, 2014).

The World Bank income classification categorizes China as an upper-middle-income country (The World Bank, 2018). The gross domestic product (GDP) was € 7 768 per capita in 2017 (National Bureau of Statistics of China, 2014).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in China in 2015 was 393 USD or €346 per capita (World Health Organization, 2018).

Infant mortality rate in the country of China was 1.4 per 1000 in 2015 (United Nations Statistics Division, 2016).

7.1.2. Neonatal hearing screening

In China, neonatal hearing screening is conducted universally, and participation is obligatory for parents. Hearing screening for well and at-risk babies started in 1996 and was fully implemented across the country in 2009.

In 2000, the Chinese government affirmed the significance and necessity of newborn hearing screening in the form of a law of the People's Republic of China on maternal and infant health care and began to carry out the work across the country (State Council of the People's Republic of China, 2001).

Prior to 2009, neonatal hearing screening was hospital-organized and each hospital decided on whether to implement neonatal hearing screening and how to run the programme. In 2009, the national government (Ministry of Health) implemented a scale-up neonatal hearing screening programme (Ministry of Health of the People's Republic of China, 2009; National Health Department, 2010). The goal of the scale-up programme was to gradually introduce universal neonatal hearing screening in hospitals across China.

Neonatal hearing screening is funded by regional hospitals and by parents. The cost is the same for all families, including for both well and at-risk babies, but it is not indicated. It is embedded in the Preventive Child Health Care screening system. Neonatal hearing screening is organized by the National Health Department, which designates the regions/hospitals that will perform screening.

National guidelines and screening protocol are available. Across China, the same protocol is followed for performing hearing screening; however, tests, screening professionals, and equipment are decided on by the hospitals.

7.1.3. Preschool hearing screening

There is no preschool hearing screening programme in China. Preschool hearing screening is not universally performed or organized. After neonatal hearing screening, follow-up is recommended, and screening may be done by a doctor in the hospital, but this practice is not embedded in the Preventive Child Health Care screening system. Any screening performed is funded by the parents.

7.2. Guidelines & Quality Control

There are national guidelines for hearing screening in China developed by the National Health Department of the People's Republic of China (2010).

The content of the general hearing screening programme was decided on by audiologists/ENT specialists and the public health organization (National Health Department), and there have not been any changes since the initial publication in 2009. The public health organization would make decisions on future revisions, if applicable.

Quality assurance of hearing screening programmes is not imposed by the government and information is only collected locally in hospitals performing screening. Annual reports are not available.

There has been research performed on hearing screening programmes in China (Huang, et al., 2012; Chen, et al., 2012; Tobe, et al., 2013; Chen, et al., 2017; Wenjin, et al., 2017), and articles published investigating the effectiveness of neonatal hearing screening in China (Tobe, et al., 2013; Chen, et al., 2017).

7.3. Process: Screening, Diagnosis, Intervention

7.3.1. Neonatal hearing screening

Newborn hearing screening is available in both urban and rural areas. Well and at-risk babies in urban areas are screened in the hospital or NICU. In rural areas, screening can be carried out in town health care centres or in regional medical institutions.

Parents/caregivers of well and at-risk babies are invited to participate directly in person in the hospital. Parents/caregivers of infants that are discharged from the hospital are invited to participate in screening via a telephone call. The hospital will phone the family and instruct them to perform hearing screening as soon as possible.

Neonatal hearing screening should be completed within 42 days after birth.

At-risk infants are defined as those with low birth weight (less than 1500 g), born premature (28 to 37 weeks gestation), low body weight due to malnutrition, NICU stay greater than 5 days, family history

of permanent childhood hearing impairment, intrauterine infection (CMV, rubella, herpes, syphilis, toxoplasmosis), craniofacial malformation (including ear canal malformation), hyperbilirubinemia, meningitis, neonatal asphyxia, respiratory distress, ECMO, mechanical ventilation for more than 48 hours, maternal use of ototoxic drugs or drug abuse, present or suspected syndrome involving hearing impairment. .

These infants are screened with the same protocol as well babies in the hospital; however, they are referred for the second step of screening regardless of the results of the initial screen.

The prevalence of meningitis and CMV in China are unknown. The prevalence rate of CMV is difficult to ascertain, as only approximately 40-60% of individuals with CMV show associated symptoms.

The target condition for screening for well and at-risk babies is a bilateral or unilateral hearing loss ≥ 25 dB HL

7.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral should be performed by 3 months of age according to the guidelines for all of China. Diagnosis and treatment institutions designated by the provincial health and family planning administrative department for further diagnosis within 3 months after birth.

7.3.3. Preschool hearing screening

As specified, there is no preschool hearing screening programme in China. Hearing testing around preschool age is performed in public hospitals, and children are invited to participate directly via a telephone call. Testing is performed by doctors.

The target condition for preschool hearing screening is not indicated.

The prevalence of chronic otitis media with effusion in China is 7.3 to 30.7% (Liu, et al., 2018).

7.3.4. Intervention approach

In China, treatment options available include hearing aids, bone conductive devices and cochlear implants. Infants are fitted with hearing aids from 6 months of age or older and with cochlear implants from 1-2 years of age or older.

The fitting criteria in China for a hearing aid is hearing loss of at least 60 dB HL. Children with a hearing loss from 25-60 dB HL are observed for habilitation potential, and children with a hearing impairment greater 60 dB HL are advised to wear hearing aids after 6 months of age.

7.4. 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

7.4.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies is described in Table 1. A 2-step OAE-aABR/ASSR protocol is in effect, whereby the first OAE is performed in the maternity hospital before the 3rd day of life. If the infant fails the first test, a secondary screening occurs within 42 days after birth. A subsequent fail would warrant a referral to the ENT department for a diagnostic assessment.

Table 14: Process for neonatal hearing screening for well, healthy infants in China.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE	48-72 hours	Not indicated	Not indicated	Yes	Maternity hospital
aABR/ASSR	42 days	35 dB nHL		Yes	

7.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk infants is the same as for well infants, with the exception that all infants considered “at-risk” are referred to step 2 screening at 42 days of age, regardless of the results of the OAE test in the hospital.

7.4.3. Preschool hearing screening

Not applicable.

7.5. Professionals

7.5.1. Neonatal hearing screening (well)

Neonatal hearing screening for well babies is performed in the maternity hospitals by nurses or audiologists. During step 2, audiologists and ENT physicians interpret the results of the aABR/ASSR and refer for further evaluation when warranted.

There is no specific training for hearing screening staff. Audiologists and ENT physicians have 3 years of background education.

7.5.2. Neonatal hearing screening (at-risk)

In addition to the professionals described in 5.1, screening for at-risk infants is may also be performed by neonatologists.

7.5.3. Preschool hearing screening

Not applicable. Hearing testing at preschool age is performed by doctors.

8. Croatia

Hearing screening representative for Croatia: *Marko Velepic, Clinic of Otorhinolaryngology Head and Neck Surgery, Clinical Medical Center University of Rijeka.*

8.1. Background

In Croatia, hearing screening is organized nationally.

The following report contains information with regards to hearing screening in the entire country of Croatia.

8.1.1. General

Croatia has a total area of 56 594 km^2 and a population of 4 284 889 as of 2011. In Croatia, each birth is registered. The number of births in Croatia was 39 939 in 2013 and 37 503 in 2015 (Croatian Bureau of Statistics, 2015).

The World Bank income classification categorizes Croatia as a high-income country. It was briefly classified as an upper-middle-income country in 2016 (The World Bank, 2018). The gross domestic product (GDP) is €10 586 per capita as of 2015 (Croatian Bureau of Statistics, 2018)

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Croatia in 2015 was 852 USD or €737 per capita (World Health Organization, 2018).

Data acquired from the 2016 United Nations Demographic Yearbook indicate an infant mortality rate of 4.1 per 1000 for the country of Croatia in 2015, a rate of 4.2 per 1000 in urban areas and 4.0 per 1000 in rural areas (United Nations Statistics Division, 2016).

8.1.2. Neonatal hearing screening

In Croatia, 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 programme for well and at-risk babies was first implemented in 2002, and by 2005, neonatal hearing screening was implemented across the country. Neonatal hearing screening is embedded in the Preventive Child Health Care screening system. Screening is funded through health insurance provided by the state and organized by the government.

Regions use the same protocol for screening well babies, with the exception that locations with aABR devices in the maternity hospitals will screen using aABR (step 3) directly after a step 2 referral, while other areas will screen with OAE at step 2 and then refer to another hospital with aABR technology for step 3 screening. For at-risk babies, there are also slight differences. Three maternity hospitals screen NICU patients with aABR only while the rest screen with OAE then aABR.

8.1.3. Preschool hearing screening

In Croatia, preschool hearing screening is not performed.

8.2. Guidelines & Quality Control

National guidelines and a protocol for hearing screening exists in Croatia, though there is no official publication of these guidelines or protocol. A government document is available stipulating that neonatal hearing screening is mandatory (Ministarstvo zdravstva i socijalne skrbi, 2006).

The content of hearing screening programme was decided on by a professional body of audiologists within the government. The content of the programme has not been revised since its start and data are unavailable on the revision process.

Quality assurance of hearing screening programmes is not imposed by the government; however, in the past, information was previously collected about hearing screening outcomes through the citizen association HURDOS, made up of a group of audiologists who started neonatal screening in Croatia. Currently, the status of future data collection through this organization is unknown. Data from maternity hospitals across Croatia are currently sent to the Children's Hospital in Zagreb for outcome monitoring.

Data are unavailable about annual reports. Apart from auditing, occasional studies have been performed on neonatal hearing screening and its effectiveness in Croatia (Marn, 2005; Marn & Kekić, 2016; Prpić, Mahulja-Stamenković, Bilić, & Haller, 2007).

8.3. Process: Screening, Diagnosis, Intervention

8.3.1. Neonatal hearing screening

Well-babies and at-risk babies are screened first in the hospital, where the average length of stay is estimated to be 3 days. It is roughly estimated that less than 10% of births take place at home. Families of well and at-risk infants are invited to participate in neonatal screening via a letter.

It is estimated that neonatal hearing screening for both well and at-risk babies should be completed before 3 months of age.

The target condition for screening both well and at-risk babies is a unilateral or bilateral hearing loss of greater than 40 dB HL.

In Croatia, at-risk infants are defined as those admitted to the NICU. There is no set duration for how long infants must stay in the NICU to be considered at-risk; though other risk-criteria are considered, including premature birth less than 34 weeks, requiring the use of a respirator, and intracranial bleeding. Data are unavailable regarding how many infants are screened with the at-risk protocol.

The prevalence of CMV infections and meningitis among neonates is not known.

8.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests performed after neonatal hearing screening referral are ABR, ASSR and tympanometry which should be also performed before 3 months of age.

8.3.3. Preschool hearing screening

Not applicable.

8.3.4. Intervention approach

In Croatia, treatment options available include grommets, hearing aids, and cochlear implants. Infants are fitted with hearing aids from less than 6 months of age and cochlear implants from 1-2 years of age.

The hearing aid fitting criteria in Croatia is a bilateral hearing loss of 30 dB HL for the better ear.

8.4. 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

8.4.1. Neonatal hearing screening (well)

There are 2 to 3 steps of screening for well-infants in Croatia before referral to a diagnostic assessment. Step 1 screen occurs on day 2 or later but before discharge. The majority of maternity hospitals refer the infant back to the same hospital for step 2 screening. After a fail/refer from step 2, an aABR may be performed directly if the maternity hospital has aABR equipment available. Otherwise, a referral is made to an Audiology Centre before the infant is 3 months of age. Some maternity hospitals refer to an Audiology Centre directly after step 1. In these instances, both step 2 and step 3 are performed in the Audiology Centre.

Table 15: Screening process for well babies in Croatia.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	24-72 hours	4 dB SNR for 3/6 freq (Maico, 2017)	Maico Ero-Scan†	Yes	Maternity hospital
OAE2	One month			Yes	Maternity hospital/ Audiology centre
aABR		*40 dB nHL*			

† Used in Clinical Medical Center University of Rijeka. May not be used universally in Croatia.

8.4.2. Neonatal hearing screening (at-risk)

The sequence for screening infants at-risk is similar to that for well-infants, in that the infant progresses through three steps of screening before referral to diagnostic assessment. In most NICUs, aABR is used for the step 1 screen before discharge; however, in some NICUs OAE is performed as the initial screen prior to discharge.

Table 16: Screening process for at-risk babies in Croatia.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
aABR1/OAE	< 2 weeks (36-42 weeks gestation)	40 dB nHL or 4 dB SNR for 3/6 freq	-- Maico Ero-Scan†	Yes	NICU
aABR2	One month	40 dB nHL		Yes	Clinic with aABR tech

† Used in Clinical Medical Center University of Rijeka. May not be used universally in Croatia.

8.4.3. Preschool hearing screening

Not applicable.

8.5. Professionals

8.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses supervised by pediatricians in the maternity hospitals. There is no specific training programme for screening professionals, and staff are trained amongst themselves. At the implementation of neonatal hearing screening in Croatia, a training video was developed and supplied to maternity hospitals with the screening equipment (Marn & Kekić, 2016). This training video is still in use for training new screening staff.

8.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by pediatricians. Training is the same for NICU-staff as for staff performing well-baby screening.

8.5.3. Preschool hearing screening

Not applicable.

9. Cyprus

Hearing screening representatives for Cyprus: *Marios Vogazianos, Centre for Preventive Paediatrics and Chryssoula Thodi, European University Cyprus.*

General information acquired from answers by*: Marios Vogazianos, Centre for Preventive Paediatrics and Maria Theocharides, Nicosia Orthoptic Centre.*

9.1. 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.

9.1.1. 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).

9.1.2. 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.

9.1.3. Preschool hearing screening

In Cyprus, there is no preschool hearing screening.

9.2. 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.

9.3. Process: Screening, Diagnosis, Intervention

9.3.1. 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.

9.3.2. 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.

9.3.3. Preschool hearing screening

Not applicable.

9.3.4. 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.

9.4. 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

9.4.1. 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 17: 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

9.4.2. Neonatal hearing screening (at-risk)

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

9.4.3. Preschool hearing screening

Not applicable.

9.5. Professionals

9.5.1. 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.

9.5.2. Neonatal hearing screening (at-risk)

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

9.5.3. Preschool hearing screening

Not applicable.

10. Czech Republic (East Bohemia)

Hearing screening representative for the Czech Republic (East Bohemia): *Jakub Drsata, Department of Otorhinolaryngology and Head and Neck Surgery, University Hospital Hradec Kralove.*

10.1. Background

sIn the Czech Republic, hearing screening is organized by region or area. There are 14 political regions of the Czech Republic grouped into 8 greater-regions or areas, including East Bohemia.

Not all regions provide hearing screening, and some regions provide selective hearing screening. It is not indicated whether other representatives can provide data from other regions. The following report contains information with regards to hearing screening in the region of East Bohemia.

10.1.1. General

East Bohemia is made up of the Hradec Králové (Královéhradecký) and Pardubice (Pardubický) regions. Hradec Králové region has an area of 4 759 and Pardubice region has an area of 4 519 km^2 with mid-2017 populations of 550 848 and 517 243, respectively (total: 1 068 091). In the Czech Republic, each birth be registered. The number of live births in Each Bohemia was calculated to be 11 074 infants in 2017 (Czech Statistical Office (CZSO), 2019).

The World Bank income classification categorizes the Czech Republic as a high-income country (The World Bank, 2018). The gross domestic product (GDP) per capita in 2016 was €15 607 and €14 024 for Hradec Králové and Pardubice regions, respectively (Czech Statistical Office (CZSO), 2019).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in the Czech Republic in 2015 was 1284 USD or €1135 per capita (World Health Organization, 2018).

Data acquired from the 2016 United Nations Demographic Yearbook indicates an infant mortality rate of 2.5 per 1000 for the country of the Czech Republic in 2015 (United Nations Statistics Division, 2016). The regions of Hradec Králové and Pardubice had infant mortality rates in 2016 of 2.6 and 2.3 per 1000, respectively (Czech Statistical Office (CZSO), 2019).

10.1.2. Neonatal hearing screening

In East Bohemia, neonatal hearing screening is conducted universally, with all babies in the region having access to hearing screening. Screening is obligatory for parents, though there is no reward or penalty for accepting or refusing hearing screening. It is roughly estimated that the universal program for well and at-risk babies was first implemented in 1994. By 2015, neonatal hearing screening was implemented across the region. Neonatal hearing screening is embedded in the Preventive Child Health Care screening system. Screening is funded through health insurance. The Czech Republic runs on a compulsory health insurance model.

Regions may use different protocols for neonatal screening for both well babies at at-risk babies, and therefore tests performed and referral criteria may differ.

10.1.3. Preschool hearing screening

In the Czech Republic, preschool hearing screening is not performed systematically. Similar to neonatal hearing screening, there are differences in preschool hearing screening across regions; however, preschool hearing screening is generally not implemented across the country.

10.2. Guidelines & Quality Control

Regional guidelines and a protocol for hearing screening exists in East Bohemia. Regional protocols are not published. A legislative guideline is published online via the Ministry of Health of the Czech Republic outlining basic principles of neonatal hearing screening in the Czech Republic with the goal of establishing nationwide screening, though specific national protocols are not well defined (Ministry of Health, Czech Republic, 2012).

The content of the hearing screening programme in East Bohemia was decided on by regional centres. The methods and algorithms used in the hearing screening programme are continuously under revision within the regional centres. These revisions are not specifically funded.

Quality assurance of the hearing screening programme is not imposed by the government, though it is performed on a regular basis in East Bohemia. Information is not continuously collected about hearing screening outcomes; though quality control is performed through random and yearly checks of the database. A working session is organized annually to check performance and solve ongoing issues within the screening programme.

On a national level, information was collected by questionnaires to the maternity hospitals and ENT wards across the Czech Republic to disseminate on the status of screening across the country (Havlíková, Zeleník, & Komínek, 2015). Currently, universal screening is not yet performed nationwide in the Czech Republic (Komínek, Chrobok, Zeleník, & Dršata, 2017).

Annual reports are not available for East Bohemia. Studies have not been performed on the hearing screening programme in East Bohemia.

10.3. Process: Screening, Diagnosis, Intervention

10.3.1. Neonatal hearing screening

In East Bohemia, well babies and at-risk babies are first screened in the in the hospital or NICU, but invited to participate in neonatal screening via a letter.

Neonatal hearing screening for both well and at-risk babies should be completed before 3 months of age. Specifically, the initial screen should be completed by 1 month of age, and infants that are referred from the first step of screening should be rescreened before 3 months of age (Dršata, Školoudík, Chrobok, Hloušková, & Janouch).

The target condition for screening for well and at-risk babies is a bilateral hearing loss of ≥20 dB HL.

In East Bohemia, at-risk infants are defined as those with congenital abnormalities in addition to infants admitted to the NICU. It is roughly estimated that 0.8% of infants are screened with the at-risk protocol.

The prevalence of CMV infections and meningitis among neonates is not known.

10.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests performed after neonatal hearing screening referral are tympanometry and frequency-specific ABR, which should be completed by 6 months of age (Dršata, Školoudík, Chrobok, Hloušková, & Janouch).

10.3.3. Preschool hearing screening

Not applicable.

10.3.4. Intervention approach

In East Bohemia, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with both hearing aids and cochlear implants from less than 6 months of age up to greater than 2 years of age.

The hearing aid fitting criteria in East Bohemia is a bilateral hearing loss of >35 dB HL.

10.4. 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

10.4.1. Neonatal hearing screening (well)

The neonatal screening programme in East Bohemia for well babies consists of two steps. The first step includes screening in the maternity ward and the second step includes rescreening in the ENT department. In the maternity ward, OAE screening may be performed one or more times before discharge; each of these screening attempts are counted under the initial (step 1) screen. The final OAE result upon discharge determines if a referral to the second step is warranted.

Table 18: Screening process for well babies in East Bohemia.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1*	24-72 hours / Before discharge	8 sign-alt values (Path Medical GmbH, 2017)	Sentiero / Cochlea-scan	Yes	Maternity ward
OAE2	> 10 days			Yes	Audiology/ENT dept

*OAE1 may consist of one or more OAE screens performed before discharge from the maternity hospital.

10.4.2. Neonatal hearing screening (at-risk)

The screening process for infants at-risk is indicated in Table 2. Similar to screening for well babies, the screening process for at-risk infants consists of two steps with an initial aABR performed in the NICU prior to discharge and a second rescreening performed several weeks later before diagnostic referral.

Table 19: Screening process for at-risk babies in East Bohemia.

Test	Age	Referral criteria	Unilateral Referrals?	Location
aABR1	< 2 weeks (36-42 weeks gestation)	30 dB nHL	Yes	NICU
aABR2	> 10 days	30 dB nHL	Yes	Audiology/ ENT dept

10.4.3. Preschool hearing screening

Not applicable.

10.5. Professionals

10.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses or ENT doctors. There is a one-day specific training for professionals to perform hearing screening; however, this training is not accredited, certified, revalidated, monitored or updated.

10.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by nurses. Training for nurses performing at-risk screening is the same process as for staff performing well-baby screening.

10.5.3. Preschool hearing screening

Not applicable.

11. Denmark

***Hearing screening representative for Denmark**: Therese Ovesen, Department of Clinical Medicine, Aarhus University, Denmark.*

11.1. Background

In Denmark, neonatal hearing screening is implemented nationally. Individual regions are responsible for constructing their own protocols; however, most regions follow the national guidelines with some exceptions.

The following report contains information with regards to hearing screening in the entire country of Denmark.

11.1.1. Neonatal hearing screening

In Denmark, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening, though participation is not obligatory for parents. Neonatal hearing screening started in Denmark in 2005 and was also fully implemented across the country for both well-babies and at-risk babies in 2005. Neonatal hearing screening is funded through municipalities or the individual province/region in Denmark and is embedded in the Preventive Child Health Care screening system.

Neonatal hearing screening is organized by the Danish Health Authority. Though national guidelines are available, regional protocols may vary slightly. For example, OAE is used as a screening took in Denmark, except in the Central Region of where aABR is used. The staff that perform the screening may vary across regions, as may the time between each screening step and between screening referral and diagnostic assessment.

11.1.2. Preschool hearing screening

There is no preschool hearing screening programme in Denmark.

11.2. Guidelines & Quality Control

National guidelines for child health care exist in Denmark, including the national hearing screening guidelines (Sundhedsstyrelsen, 2004).

The content of the general hearing screening programme was decided on by the Danish Health Authority, and has not been revised since implementation in 2005. However, the Danish Health Authority would be responsible for making revisions in the future.

Quality assurance of hearing screening programs is not imposed by the government, though information is collected about hearing screening outcomes by the Danish Health Authority via the Danish National Patient Register.

Annual reports are not available for Denmark, though the Danish Health Authority have conducted two quality assurance evaluations since implementation in 2005. One was published in 2007 (Sundhedsstyrelsen, 2007) and follow-up evaluation in 2010 (Sundhedsstyrelsen, 2010).

Studies have been performed on hearing screening in Denmark, including its effectiveness (Konrádsson, Kjaerboel, & Boerch, 2007; Pedersen, Moller, Wetke, & Ovesen, 2008).

11.3. Screening – Diagnosis – Intervention process

11.3.1. Neonatal hearing screening

In Denmark, screening protocols are defined for well-infants and at-risk infants. At-risk infants are defined as those taking medications with ototoxic effects, low birthweight under 1500g, hereditary predisposition, syndromes where hearing loss can occur, and perinatal infections that can cause hearing loss. Aside from those with risk factors, infants admitted to the neonatal intensive care unit for more than 48 hours are also considered at-risk and screened using the at-risk protocol.

The prevalence of the CMV antibody is 20-30% among 1-year-olds (Statens Serum Institut, 2015). The prevalence of meningitis 0.002 to 0.004% per year (Statens Serum Institut, 2013).

Well-babies and at-risk babies are screened in the hospital. Families are invited to participate in screening by nurses, midwives, or doctors via oral information provided directly at the hospital or through an electronic letter.

Neonatal hearing screening for well-babies should be completed before 30 days after birth. For infants at-risk, there is no age limit, but babies should be screened before discharge from the hospital.

The target condition for screening for both well-babies and at-risk babies is a unilateral or bilateral hearing loss greater than 30 dB.

11.3.2. Neonatal diagnostic assessment

The diagnostic assessment test performed after neonatal hearing screening referral is first, an aABR at 35 dB, TEOAE and DPOAE. If no response is still detected, higher intensities on the aABR or a clinical ABR is performed.

The diagnostic assessment for well- and at-risk infants should be completed before 3 months of age.

11.3.3. Preschool hearing screening

Not applicable.

11.3.4. Intervention approach

In Denmark, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. It is estimated that infants are fitted with hearing aids from less than 6 months of age or older, and that infants are fitted with cochlear implants from 6-12 months of age.

While there is no definite consensus on the fitting guidelines for hearing aids in Denmark, most audiologist tend to fit at least a 25 dB HL loss in one or both ears (congruent with the findings in Fitzpatrick, Roberts, Wittingham & Barreria-Nielsen, 2017).

11.4. Hearing Screening 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 (OAE or aABR).
- The Age of the infant is indicated in hours or days for neonatal hearing screening or in years for preschool hearing screening
- The Settings or Device is the protocol specifications of the screening device or name of device used.
- Pass criteria may either be an OAE present at specified frequencies, a specified response-waveform repeatability constant, an ABR detected at specified intensity, or a behavioural response present at a specified intensity. Pass criteria may be defined within a protocol or limited based on the device used.
- Protocols may indicate if an infant is referred with a "no pass" result in either One or Both Ears.
- The Location is where the screen takes place (hospital, clinic, school, etc)

11.4.1. Neonatal hearing screening (well baby)

Neonatal hearing screening for well babies is presented in Table 1. For all regions in Denmark except for the Central Region, OAE is performed at the first step. In Central Region Denmark, aABR is performed.

Table 20: Screening process for well babies in Denmark.

Test	Age	Pass criteria	Settings / Device	One / Both Ear referrals	Location
OAE1/aABR†	<24 hours to 10 days after birth‡	8x peaks of alternating-signs	Accuscreen	One or both	Maternity ward
OAE2 (+aABR*)	< 30 days after birth	*As above* 35 dB nHL	Accuscreen	One or both	Local hospital

† Central Region Denmark performs aABR at 35 dB nHL during the first step.
* aABR is recommended at step 2 if available, in combination with repeat OAE screening.
‡ Though guidelines stipulate screening after 48 hours, screening is performed earlier than 48 hours (and even < 24 hours after birth), if mothers are discharged early.

11.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk infants is presented in Table 2. It is recommended that both OAE and aABR are performed at the initial screening step. Infants that do not pass one or both tests are referred for diagnostic assessment.

Depending on the risk factors presented, infants that pass both screening tests may still be referred for diagnostic assessment. These risk factors include, family history of hearing loss, syndromes associated

with hearing loss, cranio-facial abnormalities, perinatal infections (CMV, rubella, or toxoplasmosis). Infatns with other risk factors that pass both screening tests are discharged from the hearing screening programme.

Table 21: Screening process for at-risk babies in Denmark.

Test	Age	Pass criteria†	Settings / Device	One / Both Ear referrals	Location
OAE + aABR	< 30 days after birth	8x peaks of alternating-signs 35 dB nHL	Accuscreen	One or both	NICU / Audiology department

† Depending on the risk factors presented, infants may be referred for a diagnostic assessment, despite having passed both OAE and aABR.

11.4.3. Preschool hearing screening

There is no preschool hearing screening.

11.5. Screening professionals

11.5.1. Neonatal hearing screening (well baby)

Screening for well-babies is performed by bioanalysts, social and healthcare assistants, midwives or any other staff who has completed the training in neonatal hearing screening. The training is performed by local experienced staff over 2-3 days. If an update to equipment or education is required, the local coordinator for the region will be contacted.

11.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is typically performed by local staff, as with well-babies; however, regardless of the screening test result at-risk infants are referred and rescreened by staff in the audiology department.

11.5.3. Preschool hearing screening

There is no preschool hearing screening.

12. England (South East London)

Hearing screening representatives for England: *Jolanta McCall, Children & Young People's Audiology Centre, Evelina London.*

12.1. Background

In the United Kingdom, hearing screening is performed nationally and organized nationally. The following report contains information with regards to childhood hearing screening across England and includes data corresponding to the region of South East London.

12.1.1. General

The region of South East London (SEL) contains six London boroughs and has a total area of 348.88 km^2 with a population of 1,793,600 as of mid-2016 (Office for National Statistics, 2017).

In the U.K., all births are registered in the maternity ward when issuing an NHS number. The number of live births in the U.K. in 2016 was 774,835, and there are approximately 26,000 live births per year in SEL (Office for National Statistics, 2017).

The World Bank income classification categorizes the U.K. as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2015 was £29 670 per capita in the U.K. or €33 275 (Office for National Statistics, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for the U.K. in 2015 was 3498 USD or €3480 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 3.9 per 1000 is reported for the U.K. in 2015 (United Nations Statistics Division, 2016; Office of National Statistics, 2018). The infant mortality rate in 2015 varies from 3.4 to 4.8 across the six London boroughs making up the region of SEL (Office for National Statistics, 2018).

12.1.2. Neonatal hearing screening

In the United Kingdom, 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 for well and at-risk babies started and was fully implemented across England in 2006. Neonatal hearing screening is funded by the state and embedded in the Preventive Child Health Care screening system (Public Health England, 2017). Neonatal hearing screening is organized by the national Newborn Hearing Screening Programmes.

In the South-East London (SEL) region, hearing screening is offered to all infants born in one of the SEL maternity hospitals or if the general practitioner's office lies within the SEL region and the infant was not screened in the maternity hospital.

National guidelines are available from Public Health England as is a screening protocol that is used across the country. The same protocol is followed across England for performing hearing screening (Public Health England, 2017).

12.1.3. Preschool hearing screening

School-entry screening currently exists in England only in regions where a programme was in effect prior to the 2015 neonatal hearing screening guidelines. For some regions, school-entry screening has been in effect since 1955; however, since 2015 it has been advised that no new school-entry hearing screening programmes be implemented. School entry screening is funded by parents, companies, and the state, though it is not embedded in Preventive Child Health Care.

12.2. Guidelines & Quality Control

There are national guidelines for hearing screening in England.

The content of the general hearing screening programme was decided on by Public Health England (NHS England), and has not been changed since implementation. While there is no set time for when reviews are made, the national Newborn Hearing Screening Programme (NHSP) is reviewed regularly through discussions with the national screening committee and revisions to the programme are performed when necessary. Public Health England decides on and funds revisions.

Quality assurance of the neonatal hearing screening programme is imposed by the government. Quality assurance is performed via national and local reporting and checks and audits within the NHSP. These procedures assure the quality of antenatal and newborn screening, as well as manage safety and reduce risk. Information is collected directly via the national NHSP Patient Management System (Smart4Hearing, formerly ESP), supported by Northgate. Through Smart4Hearing, national and local performance reports are generated on a monthly, quarterly and annual basis, which describe NHSP performance, highlights, activity, outcomes and data quality.

There have been a number of studies published on the hearing screening programme in the U.K., including studies measuring the effectiveness of NHSP (e.g., Uus & Bamford, 2006).

12.3. Process: Screening, Diagnosis, Intervention

12.3.1. Neonatal hearing screening

Well-babies are screened in the hospital, child health care centres, or in outpatient clinics (e.g., general practitioner's office) within the National Health Service. At-risk infants may also be screened in the NICU. The percentage of infants born in a maternity hospital in the U.K. is unknown. It is roughly estimated that the length of stay in the hospital after delivery is 4 hours (minimum) to one day. Parents/caregivers of eligible well and at-risk babies are invited to participate in neonatal hearing screening directly in the maternity hospital. For infants screened in the outpatient clinic, parents/caregivers are invited to participate by phone when an appointment is booked. Appointments are then confirmed via email or letter. For areas without a phone-based booking service, a letter is sent to the parents inviting them to participate by booking an appointment time (SEL NHSP local managers and Head of service, 2017).

Hearing screening should be completed as soon as possible. A key performance indicator (KPI) of the NHSP measures the percentage of neonatal hearing screening for well babies completed before 4 weeks of age; however, hearing screened should be completed before 3 months corrected age. For at-risk babies, screening should be completed after 34 weeks gestational age and before 52 weeks

gestational age. In circumstances where the health of the infant is a limiting factor, screening may be performed up to 64 weeks gestation (Public Health England, 2017; Public Health England, 2016).

Hearing screening is contraindicated among children with bacterial meningitis, atresia and microsia. These children are referred directly for a diagnostic assessment. Infants admitted to the NICU for a minimum of 48 hours are tested with a different protocol compared to the well-baby protocol (Public Health England, 2016). Data collected across South East London from 2006 through 2016 shows that 5.3% of infants are screened according to the NICU protocol (McCall, 2018).

An audit of a pilot of screening pathways for congenital CMV was performed in Evelina London Children's Hospital from 2014-2016. Across the 24-month pilot, 177 infants with ABRs suggesting sensorineural hearing loss were screened for congenital, and a total of 9 cases were confirmed (Martinez-Alier, et al., 2017).

From the NHS England Laboratory, there were a total of 34 confirmed cases of invasive meningococcal infection among infants under 1 year of age from January to March 2018. There were an additional 34 cases among children 1 to 4 years of age, 18 cases among children 5 to 9 years of age and 4 cases among children 10 to 14 years of age across the same time period (Public Health England, 2018).

The target condition for screening for well and at-risk babies is a unilateral or bilateral hearing loss of 40 dB HL or worse.

12.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral should be completed by 44 weeks of gestational age, or 4 weeks after the completion of the screening.

12.3.3. Preschool hearing screening

In places where school-entry hearing screening is performed, the screening takes place in the kindergartens or schools. Schools wishing to conduct preschool or school-entry hearing screening contact the Paediatric Audiology Service, and an audiologist from the Paediatric Audiology Service visits the school to conduct screening. The target condition for preschool hearing screening is a hearing loss of 30 dB HL or worse at 1, 2 and 4 kHz or 35 dB HL or worse at 500 Hz (CYPAC, 2017).

In SEL, 3 schools in the Southwerk sub-region approached the Paediatric Audiology Service in 2018.

12.3.4. Intervention approach

In the U.K., treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids within 4-6 weeks of confirmation of PCHI, regardless of age. Infants are fitted with cochlear implants from 6 months of age or older (National Institute for Health Care and Excellence, 2009).

The local fitting protocol in SEL is that hearing aids are fit on both unilateral and bilateral hearing losses of mild to profound severity. There is not set pre-tone average criteria, but instead, hearing aids are determined suitable based on the individual and configuration of hearing loss.

12.4. 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

12.4.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies is summarized in Table 1. There are two models of well-baby hearing screening in England.

The majority of neonatal hearing screening follows the hospital model, whereby a 3-step OAE - OAE - aABR protocol is in effect. The first OAE is performed in the maternity hospital after birth. If the infant does not pass the first OAE test, rescreening occurs 5 hours later. If the infant is discharged from the maternity hospital before rescreening, an OAE is scheduled in an outpatient clinic as soon as possible and no later than 3 months of age. If the infant does not pass the second OAE, an aABR is performed. If the infant does not pass the aABR, a referral to the ENT department for a diagnostic assessment is made (Public Health England, 2017).

Infants that miss the initial screen in the maternity ward or are born outside of a maternity hospital are screened according to the community model. A 2-step OAE-aABR protocol is in performed in outpatient clinics. For these cases, the OAE is performed once. If the infant does not pass the OAE, an aABR is administered (Public Health England, 2017).

Table 22: Process for neonatal hearing screening for well, healthy infants in England (Public Health England, 2017; Public Health England, 2016).

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	<24 hours or older (10 days in outpatient clinics)	Various	Accuscreen (SEL) / Various (NHSP)	Yes	Maternity hospital / Outpatient clinic
OAE2	5 hours after initial screen (no later than 3 months)			Yes	Maternity hospital / Outpatient clinic
aABR	< 4-5 weeks* (no later than 3 months)	40 dB nHL		Yes	Maternity hospital / Outpatient clinic

*Final screening should be completed by 4 weeks of age for the hospital model or by 5 weeks of age for the community model.

12.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk (NICU) infants is described in Table 2. A combined OAE+aABR protocol is in effect whereby both OAE and aABR are performed.

If the infant does not pass the aABR, a referral is made to diagnostic audiology, regardless of the results of the OAE. If the infant passes aABR but does not pass OAE, the infant is not immediately referred to diagnostic, but may be referred for follow-up at 7-9 months of age. This depends on the presence of risk factors and whether the infant did not pass OAE in one or both ears.

Table 23: Process for neonatal hearing screening for at-risk infants in England (Public Health England, 2017; Public Health England, 2016).

Test	Age	Referral criteria	Unilateral Referrals?	Location
OAE + aABR	34-52 weeks gestation (depending on health of infant)	40 dB nHL	Yes	Maternity hospital / NICU / Outpatient clinic

*The aABR must pass in order for the infant to be discharged from the screening programme. Results of the OAE are used for determining whether surveillance at 7-9 months of age is warranted.

12.4.3. Preschool hearing screening

In places that perform screening, hearing screening is performed in kindergarten schools at 5 years of age. Children are conditioned to the task at higher intensities, and then pure-tone audiometry screening is performed at 25 dB HL at 1-4 kHz and 30 dB HL at 500 Hz. If thresholds are greater than screening levels a referral is then made to the diagnostic audiology services.

Table 24: Process for preschool hearing screening in England (CYPAC, 2017).

Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone screening	5 years	Threshold 25 dB HL (1-4 kHz) Threshold 30 dB HL (500 Hz)	Yes	Kindergarten schools

12.5. Professionals

12.5.1. Neonatal hearing screening (well)

Neonatal hearing screening is performed by NHSP trained screeners or may be performed by health visitors if screened in an outpatient clinic. NHSP trained screeners are registered nurses, or individuals that have received a diploma in population health screening, with a focus on newborn hearing, and have met the subsequent training and examination requirements under the NHSP (Public Health England, 2016).

Health visitors are nurses or midwives that have additional training in paediatric public/community health.

Subsequent training includes an e-learning programme, local training programmes such as safeguarding and infection control, on-site practical training, and monitored practice. An exam, the observed structural clinical examination (OSCE) is typically required for final certification as a NHSP screener (Public Health England, 2016).

The length of training varies as NHSP trained screeners come from various backgrounds. A diploma in population health screening takes approximately 12-18 months. The OSCE is expected to be

administered within 3 months of starting employment as a NHSP screeners (Public Health England, 2016).

Training of certain protocols are regularly updated, and the performance of NHSP trained screeners is monitored on a regular basis (SEL NHSP local managers and Head of service, 2017).

12.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk (NICU) infants is also performed by NHSP trained screeners or health visitors. See 5.1 for details on NHSP screeners and training requirements.

12.5.3. Preschool hearing screening

Screening for preschool-age children is performed by audiologists of the Pediatric Audiology Service (CYPAC, 2017).

13. Estonia

Hearing screening representatives for Estonia: *Made Bambus, Estonian Health Insurance Fund & Maret Lepplaan, East Tallinn Central Hospital.*

General information supplied by: *Made Bambus, Estonian Health Insurance Fund.*

13.1. Background

In Estonia, hearing screening is performed nationally and also organized nationally. The following report contains information with regards to hearing screening across the entire country of Estonia.

13.1.1. General

The country of Estonia has a total area of 43 432 km^2 and a population of 1 315 635 as of January 2017 (Statistics Estonia, 2018). In Estonia, each birth is registered through the Estonian Birth Registry. The number of live births in Estonia in 2016 was either 13 861 as cited by the National Institute for Health Development Database (National Institute for Health Development, 2018) sourced from the Estonian Birth Registry, or 14 053 as cited by Statistics Estonia (2018).

The World Bank income classification categorizes Estonia as a high-income country (The World Bank, 2018). The gross domestic product (GDP) was €16 035 per capita per year in 2016 (Statistics Estonia, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Estonia in 2015 was 1 112 USD or €952 per capita (World Health Organization, 2018).

Infant mortality rate in the country of Estonia was 2.5 and 2.3 per live 1000 births in 2015 and 2016, respectively (National Institute for Health Development, 2018; United Nations Statistics Division, 2016)

13.1.2. Neonatal hearing screening

In the country of Estonia, 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, and by 2014, neonatal hearing screening was implemented across the country.

Neonatal hearing screening is now embedded in the Preventive Child Health Care screening system in combination with phenylketonuria (PKU) and congenital hypothyroidism (KsHT) screening. Prior to 2015, neonatal hearing screening was organized as an independent programme; however, since 2015, it became financed together as part of general maternity care. Screening is funded through Estonian Health Insurance Fund. which is the case for both at-risk and well-baby screening.

In Estonia, the same hearing screening protocol is followed across the country.

13.1.3. Preschool hearing screening

In Estonia, there is no regulated preschool hearing screening programme. Family doctors perform a whisper test as part of general preventative testing when children are 6-8 years of age.

It is unknown when doctors began performing the whisper test as part of pre-school control testing; but this type of testing has been in effect since at least 2009. Hearing screening, as part of the general preventive programme, is funded by Estonian Health Insurance.

The whisper test is performed across the country.

13.2. Guidelines & Quality Control

National guidelines and protocol for neonatal hearing screening were originally published together in 2008. (Kruustük & Luht, 2008).

The content of the original programme was decided on by a project steering group, in cooperation with the University of Manchester. The hearing screening programme was initially implemented by the Estonian Health Insurance Fund in collaboration with Tartu University Hospital. The Estonian Ear, Nose and Throat and Head and Neck Surgeons Society had initial responsibility in managing the programme with leadership from Katrin Kruustük and Liina Luht.

The protocols documented in the screening guidelines have not changed since implementation. However, since 2015, hearing screening has become embedded into the maternity/newborn medical services, and there are no future plans for revision of the programme.

Quality assurance of hearing screening programmes is not imposed by the government. Prior to 2015, hearing screening was managed independently by the Estonian Ear, Nose and Throat and Head and Neck Surgeons Society. During this period data were collected manually.

Since the integration of newborn hearing screening in general maternal and newborn care, quality assurance, data collection, and outcome monitoring are no longer performed. Data are collected on the medical claims made to the Estonian Health Insurance Fund. Because information is available regarding the number of claims filed, the number of infants screened can be estimated. Furthermore, the type of test performed and basic diagnosis by the International Statistical Classification of Diseases and Related Health Problems can be estimated. However, data regarding screening results and follow-up are not available.

Annual reports were available internally from 2004 to 2014: however, some data were missing during these reviews. An audit was published in 2013 with data reported from 2004 to 2012. Since 2014, annual reports are not available.

It is unknown whether research has been performed on hearing screening in Estonia apart from auditing prior to 2015. Research has not been performed since 2015.

13.3. Process: Screening, Diagnosis, Intervention

13.3.1. Neonatal hearing screening

Well-babies are screened in the maternity hospital, and at-risk babies are screened in the hospital, either in the maternity ward, NICU or outpatient centre. Well-baby families and families of infants at-risk are invited for screening directly in person when nurses take consent from the parents to perform

screening. It is roughly estimated that 99.7% of births take place in the maternity hospital, where the average length of stay after delivery is 3 days. Only around 0.3% of births take place at home.

There are no set criteria for when hearing screening should be completed. The ultimate goal is the intervention is provided by 6 months of age, so the diagnostic assessment is ideally completed by 3 months and screening by 2-3 months of age.

The target condition for screening for well- and at-risk babies is bilateral or unilateral hearing loss of ≥ 40 dB HL.

There are no data available on the percentage of infants considered to be at risk. At-risk infants are defined in protocol as those born prematurely and with birth weight <1500 g, hyperbilirubinemia, perinatal infections, bacterial meningitis, NICU admissions, craniofacial abnormalities, administration of ototoxic drugs, or family history of congenital hearing loss.

The prevalence of CMV or meningitis in Estonia is unknown.

Infants with various risk factors have unique schedules for screening and surveillance, depending on the specific risk factor presented. Infants at-risk undergo OAE and aABR screening similar to well infants without risk factors but are also followed-up at a later age according to a specific schedule.

13.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests performed after neonatal hearing screening referral is an ASSR. As indicated diagnostic testing should be performed by 3 months of age for well infants. There is no set benchmark age for diagnostic evaluation among all infants at risk, but for each risk factor, diagnostic follow-up and surveillance ages are independently indicated in protocol.

13.3.3. Preschool hearing screening

The whisper test is performed in primary health care centres by family doctors. Families are invited to participate via a phone call by the doctor or nurse, or are otherwise informed by the schools to participate.

There is no target condition for the whisper test.

13.3.4. Intervention approach

In Estonia, treatment options available include hearing aids, bone conductive devices, cochlear implants, FM-systems and CROS systems. The Estonian Health Insurance Fund has also financed auditory brainstem implants operated abroad. Infants are fitted with hearing aids from 6 months of age and cochlear implants from 12 months of age.

The official hearing aid fitting criteria as stipulated by the government in Estonia is a hearing loss of 30 dB HL, though no further information is provided by the government in terms of frequency or laterality. Professionals choose to fit unilateral hearing loss with amplification on a case-by-case basis, depending on the needs of the child.

13.4. 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

13.4.1. Neonatal hearing screening (well)

The neonatal hearing screening protocol in Estonia is described below. The protocol is 3 steps, including two OAEs and one aABR. However, there is some variability in the sequence of the OAE screens. Some hospitals may perform two OAEs with the first few days of birth before discharge from the maternity hospital. If the second OAE fails, a rescreen will occur at 2 weeks of age. Other hospitals will perform only one OAE before discharge and then rescreen at 2-4 weeks of age. The aABR takes place at 2-3 months of age before referral to diagnostic assessment.

Table 25: Screening process for well babies in Estonia (Kruustük & Luht, 2008).

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location
OAE1*	24-72 hours	3 dB SNR at 3 frequencies	Interacoustics	Yes	Maternity hospital
OAE2	2-4 weeks			Yes	Maternity hospital
aABR	2-3 months	40 dB nHL		Yes	Tartu University Clinic or East Tallinn Central Hospital

*OAE1 may be performed once or twice before discharge, depending on the hospital. Some hospitals will only perform OAE1 once before discharge, and rescreen 2-4 weeks later. Other hospitals will repeat OAE1 before discharge. If the infant still does not pass, they will rescreen 2 weeks later before referring for aABR at 2-3 months.

13.4.2. Neonatal hearing screening (at-risk)

As indicted, screening at-risk infants follows the same protocol as well infants, with the exception that infants with risk factors that pass the screening are followed-up at a time that is specific to their risk indicator. For example, infants that are admitted into the NICU are re-examined at 8 months of age with OAE, ABR and VRA, then examined again at 18 and 36 months of age. Infants with a family history of hearing loss are re-tested with OAEs every 6 months from birth to age 18 months and once per year until age 7. A specific schedule is indicated independently for each risk indicator (Kruustük & Luht, 2008).

13.4.3. Preschool hearing screening

Table 26: Screening process for 6-8-year-old children in Estonia.

Test	Age	Referral criteria	Location
Whisper test	6-8 years	None (physician's discretion)	Health Care Centre

13.5. Professionals

13.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses and midwifes.

During the neonatal hearing screening programme prior to 2015, official training was provided and required for any nurse or midwives to perform neonatal hearing screening. Training involved both theoretical and practical components. The practical component included role playing and professional psychologists were involved in teaching how to deliver information to parents. Written course content was also provided to nurses and midwives who participated in the training. Official neonatal hearing screening training is no longer offered.

13.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by trained intensive care nurses. See section 7.1 for information on training.

13.5.3. Preschool hearing screening

The whisper test is performed by family physicians.

14. Faroe Islands

Hearing screening representative for Faroe Islands: *Bjarki Ellefsen, Otorhinolaryngology, Landssjúkrahúsið, Tórshavn.*

General information supplied by: *Djóni Sandberg Joensen, Kommunulæknaviðtalan í Kollafirði, Streymoy.*

14.1. Background

In the Faroe Islands, childhood hearing screening is implemented nationally across the islands.

The following report contains information with regards to hearing screening on the Faroe Islands.

14.1.1. General

The Faroe Islands are an autonomous constituent nation within the Kingdom of Denmark with a total area of 1400 km^2 across 18 islands and a population of 50 250 as of 2017 (Statistics Faroe Islands, 2018). On the Faroe Islands, each birth is registered. The number of live births on the Faroe Islands was 607 in 2015 and 686 in 2016 (Heilsulýsing Landslæknans, 2017).

The World Bank income classification categorizes Faroe Islands as a high-income country (The World Bank, 2018). The gross domestic product (GDP) was €45 999 per capita as of 2015 (Statistics Faroe Islands, 2018).

Health expenditure per capita on the Faroe Islands is unknown.

Data from the 2016 United Nations Demographic Yearbook do not calculate infant mortality rate for the Faroe Islands in 2015, as only one death was reportedly recorded (United Nations Statistics Division, 2016). The Medical Report from the Chief Medical Officer on the Faroe Islands indicates an infant mortality rate of 2.9 per 1000 in 2016 (Heilsulýsing Landslæknans, 2017).

14.1.2. Neonatal hearing screening

On the Faroe Islands, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening, though participation is not obligatory for parents. Neonatal hearing screening for well babies started and was fully implemented on the Faroe Islands in 2014, though it started much earlier in Denmark. For infants at risk, screening was implemented in 2006. Neonatal hearing screening is funded through the government and embedded in the Preventive Child Health Care screening system.

Neonatal hearing screening is organized by the ENT staff at Thorshaven, which is the main hospital on the Faroe Islands and also houses the maternity ward. National guidelines are available, and protocols are equal across the country.

14.1.3. Preschool hearing screening

Hearing screening is performed on the Faroe Islands for children starting school at the age of 7 years. Screening school-age children began decades ago and is carried out universally. School screening is also funded by the government and embedded in the Preventive Child Health Care screening system.

14.2. Guidelines & Quality Control

National guidelines for hearing screening and a hearing screening protocol exist on the Faroe Islands, and is the same national guidelines used in Denmark (Sundhedsstyrelsen, 2012).

The content of the general hearing screening programme was decided on by the public health care system, and has not been changed since implementation.

The results of neonatal hearing screening are recorded by the ENT department in the patient journals; however, data are not collected on outcome measures such as coverage or referral rates, due to lack of manpower.

Annual reports are available only for all of Denmark, and not specifically for the Faroe Islands.

Studies have only been performed in Denmark on hearing screening effectiveness.

14.3. Process: Screening, Diagnosis, Intervention

14.3.1. Neonatal hearing screening

On the Faroe Islands, all infants are screened in the hospital. It is roughly estimated that only a few infants are born at home each ear and close to 100% are born in maternity hospitals. The average length of stay in the maternity hospital for well infants is up to 5 days and longer for premature infants. Families are invited to participate in screening via a letter or directly in person at the hospital by the ENT department.

The target condition for screening is not defined in protocol but is based on typical screening equipment thresholds.

Neonatal hearing screening for all infants should be completed before 6 months of age. Screening at-risk infants may be performed either by the ENT department on the Faroe Islands or the maternity department at the Righospitalet in Copenhagen if they are transferred to Denmark for care.

There are no differences in protocol for screening well or risk infants. The only infants screened differently are those with microtia or SUCLA 2 deficit.

Data are unavailable on the prevalence of CMV infections or meningitis on the Faroe Islands.

14.3.2. Neonatal diagnostic assessment

The diagnostic assessment for well and at-risk infants should be completed before 6 months of age. Infants are referred for diagnostic assessment at the audiology department at KAS Gentofte/Rigshospitalet in Copenhagen where ASSR and other diagnostic tests are performed.

14.3.3. Preschool hearing screening

The target condition is a threshold at any pure-tone frequency worse than 20 dB HL.

14.3.4. Intervention approach

On the Faroe Islands, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. It is estimated that infants are fitted with hearing aids and cochlear implants from 6-12 months of age. Cochlear implantation is performed in Copenhagen.

There are no specific fitting guidelines for hearing aids on the Faroe Islands; hearing aids are provided on an individual basis provided that they are providing benefit.

14.4. 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

14.4.1. Neonatal hearing screening (well)

Table 27: Screening process for well babies on the Faroe Islands.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	3-5 days	8x peaks of alternating-signs	Accuscreen	Yes	Maternity ward / ENT department
OAE2	Undefined				
aABR	<6 months	35 dB nHL		Yes	ENT department

14.4.2. Neonatal hearing screening (at-risk)

On the Faroe Islands, there is no difference in the screening protocol between well, heathy infants and infants that may be at-risk for hearing loss. Infants under critical condition may be transferred to the Rigshospitalet in Copenhagen, Denmark, where the infant would then undergo the hearing screening protocol outlined in the report for Denmark.

14.4.3. Preschool hearing screening

Pure-tone audiometry is performed in schools for all 7-year olds on the Faroe Islands. There are no set referral criteria, except for a general suspicion for hearing loss.

14.5. Professionals

14.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses from the ENT department. Two nurses are responsible for all screening on the Faroe Islands. Nurses are supervised by the ENT physician and audiologist assistant in the ENT department.

14.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by one of the 2 screening nurses, as with well babies, or by staff at the Rigshospitalet Denmark if the infant is transferred to Copenhagen for intensive care.

14.5.3. Preschool hearing screening

School screening is performed by a health-care nurse.

15. Finland

Hearing screening representatives for Finland: *Riina Niemensivu, Helsinki University Hospital, Department of Ear, Nose, Throat, Head and Neck Surgery & Tytti Willberg, Turku University Hospital.*

General information acquired from: *Marke Hietanen-Peltola, The National Institute for Health and Welfare, Department of Child, Youth and Family.*

15.1. Background

In Finland, there is a national guideline for newborns and for preschool hearing screening. However, for newborn hearing screening, each hospital organizes its own protocol. For pre-school screening, Child Health Centres work regionally but are supervised nationally.

The following report contains information with regards to hearing screening in the entire country of Finland.

15.1.1. General

The country of Finland has a total area of 390 905 km^2 (National Land Survey of Finland, 2018) and a population of 5 506 312 as of May 2017 (Statistics Finland, 2018). In Finland, each birth is registered with the Medical Birth Registry. The number of live births in Finland was 52 814 in 2016 (Statistics Finland, 2018).

The World Bank income classification categorizes Finland as a high-income country (The World Bank, 2018). The gross domestic product (GDP) is €39 327 per capita as of 2016 (Statistics Finland, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Finland in 2015 was 4132 USD or € 3629 per capita (World Health Organization, 2018).

Finland has an infant mortality rate of 1.8 and 1.9 per 1000 in 2015 and 2016, respectively (United Nations Statistics Division, 2016; Statistics Finland, 2018).

15.1.2. Neonatal hearing screening

In Finland, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening. Screening is not obligatory for parents. The universal program for well and at-risk babies was estimated to have been first implemented in 2005, though each hospital started at a different time. By around 2008-2010 by estimate, implementation was complete across all hospitals. Neonatal hearing screening is embedded in the Preventive Child Health Care screening system. The programme is funded through the state, which provides money to the municipalities to organize screening (along with other health care services).

While there is a national hearing screening guideline indicating that childhood screening must be organized by law, hospitals use different protocols for neonatal screening, and therefore tests to perform and when to refer may differ regionally. There is no specific national guideline for screening at-risk babies. At-risk babies may be screened or referred for diagnostic assessment in some hospitals, or at the discretion of the neonatologist or paediatrician, regardless of a pass on screening.

15.1.3. Preschool hearing screening

In Finland, preschool/school hearing screening exists nationally, and each Child Health Care Centre follows a protocol stipulated in the national guideline. Therefore, in contrast to neonatal hearing screening, there are no differences in preschool/school hearing screening protocols across regions. Preschool hearing screening has existed for a long time in Finland. It is estimated that preschool hearing screening in Finland started around the 1950s to 1960s. It is funded by municipalities.

15.2. Guidelines & Quality Control

Neonatal hearing screening in Finland follows the national hearing screening guidelines, though national protocols do not exist for either well or at-risk babies. In contrast, preschool/school hearing screening in Finland follows a national guideline (Aarnisalo & Luostarinen, 2016).

The content of the screening guideline was developed and planned by a group of experts (ENT and pediatricians) together with the public servants in the Ministry of Health. The screening programme is then carried out by municipalities.

Since its initiation, the guidelines have not been revised. The process and funding for revision of the guidelines is unknown.

In Finland. the Ministry of Social Affairs and Health supervises and guides neonatal and preschool/school hearing screening; however, the actual hearing screening programme is run locally, carried out by health care professionals in the maternity hospitals, Child Health Care Centres and schools. It is not indicated how quality assurance is carried out for neonatal hearing screening. The quality of Child Health Care Centres, which are responsible for performing preschool/school hearing screening, are monitored by the government.

Information was not provided on whether annual reports are available on either the neonatal hearing screening program, nationally or locally, or the preschool hearing screening program.

Studies have been performed on the effectiveness of hearing screening in Finland (Finnish Office for Health Technology Assessment (FinOHTA), 2005), and a study is also currently being planned.

15.3. Process: Screening, Diagnosis, Intervention

15.3.1. Neonatal hearing screening

In Finland, there are 5 university hospitals, 16 central hospitals, and about 50 small regional hospitals. Well-babies and at-risk babies are screened in the maternity wards or NICU in the hospital, where the average length of stay after delivery is around 2-3 days. It is estimated that almost 100% of children are born in hospitals and only 0 to 1% of births take place at home. About 10% of neonates are taken in to the NICU for monitoring (lighter surveillance), although the percentage of children fully admitted to the NICU in Finland is much lower.

It is estimated that neonatologists or paediatricians may refer onward babies who have facial anomalies, perinatal infections, cCMV, intrauterine infections, syndromes associated with being at risk

for hearing loss, a family histories of hearing loss, or on ototoxic medications. Babies who meet these conditions may be referred because of the increased risk of hearing loss, or the presence of a medical condition that contraindicates conventional hearing screening (e.g., aural atresia).

The prevalence of CMV infections among neonates is 0.2% and the incidence of meningitis is not known.

Well-baby screening should be completed before 1 month of age. For infants at-risk, screening should be completed between 1-3 months of age, depending on the risks and wellbeing of the infant. However, there is no national guideline on the recommended age to complete screening. Instead, there is general consensus that diagnostic testing should be completed before 3 months of age, and screening should therefore be completed well before that age.

The target condition for screening for well babies is a bilateral hearing loss of 30 dB HL or greater. The target condition for screening at-risk babies is a bilateral or unilateral hearing loss of 30 dB HL or greater.

15.3.2. Neonatal diagnostic assessment

The diagnostic assessment of well-babies should be performed before 3 months of age or 6 months at the very latest; however, there are no national guidelines on age of diagnosis. The diagnostic assessment tests performed are TEOAEs, ABR and ASSR.

15.3.3. Preschool hearing screening

Preschool-age hearing screening takes place at the Child Health Care Centers during the annual well-child visits when the child is 4-5 years old and again at the age of 5-6 years old. There are many Child Health Care Centers in bigger cities and one in small cities and municipalities.

Parents are required to make the appointment through their local public health care centers, otherwise they are contacted for scheduling. Some public health care centers may send out invitations via mail.

The target condition for preschool-age screening is a hearing loss in one or both ears of 25 dB HL or greater.

15.3.4. Intervention approach

In Finland, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids from less than 6 months of age. Infants are fitted with cochlear implants from 6-12 months of age. The hearing aid fitting criteria is a hearing loss of >20 dB HL in the better ear at frequencies from 500 to 4000 Hz.

15.4. 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

15.4.1. Neonatal hearing screening (well)

The neonatal hearing screening process is not defined in a national protocol; instead, each hospital is responsible for developing its own protocol; however, the process for neonatal hearing screening is similar across the country.

In Finland, all newborn babies are screened before leaving the hospital, and if they do not pass screening, they are invited for rescreening within one month. If the rescreening attempt does not pass, the baby is referred to ENT hearing center at about 2-3 months of age.

A screening protocol for well babies is indicated in Table 1. Some maternity clinics have aABR equipment, in which case they may perform aABR as their second or third step, while others only use OAE. Furthermore, some hospitals will refer an infant onwards with a unilateral fail, while other hospitals require both ears to fail screening before referral.

The University Hospitals in Finland are in the process of considering screening both ears, and referring infants for diagnostic with a passing result in one ear only. There is ongoing discussion in Finland over the optimal protocol for well-baby screening.

Table 28: Screening process for well babies in Finland.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	24-72 hours	Not specified	Not specified	Varies	Hospital
OAE2	Before discharge	Not specified	Not specified	Varies	Hospital
OAE3 or aABR (some)	Before discharge / < 1 month	35 dB nHL	Not specified	Varies	Hospital

15.4.2. Neonatal hearing screening (at-risk)

The screening process of infants at-risk is similar to the protocol for well babies in Table 1, except that babies at risk may be referred to ENT clinics for an aABR, regardless of OAE result at the initial screen is a pass or refer. That being said, there is no specific protocol for how to handle at-risk babies or which babies are considered at-risk.

15.4.3. Preschool hearing screening

Hearing screening is performed at two well-child check-ups, at age 4 if possible and again at age 5-6. Screening audiometers are used to perform behavioural air-conduction screening at 20 dB HL at the frequencies 250, 500, 1000, 2000 and 4000 Hz. The first (training) tone is presented at 50 dB HL at 1000 Hz. The child is instructed to indicate a response to each tone presented, often using a toy (e.g., place a stick in a box, a ring on a peg, etc.). After training at 50 dB HL, the 20-dB HL screening level

is presented across frequencies starting with 1000 Hz, then 2000 Hz, 4000 Hz, 1000 Hz (again), 500 Hz, and finally 250 Hz (Aarnisalo & Luostarinen, 2016).

Hearing status is indicated at each frequency with a + or – symbol, and results are recorded in the patient record.

If the child refers from preschool screening, then a diagnostic pure-tone audiogram is performed on the failed frequencies to assess the hearing impairment. A follow-up retest is scheduled in 1-2 months if there is an obvious cause for impairment, such as recent otitis media. Otherwise, the child is referred to an ENT clinic for assessment.

Table 29: Process for preschool and school hearing screening in Finland (Aarnisalo & Luostarinen, 2016).

Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone screening	4 years and 5-6 years	Threshold >20 dB HL (250-4000 Hz)	Yes	Child Health Centre

15.5. Professionals

15.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses or midwives in the hospitals.

Nurses and midwives are trained on how to operate the devices, but this training is done on the job during routine clinical work by nurses and midwives with experience.

15.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants in NICUs is also performed by nurses or midwives in the hospital and audiologists or ENT doctors at the audiology centre (see above).

15.5.3. Preschool hearing screening

Screening for preschool-age children is performed by nurses at the Child Health Care Centres. Nurses are trained on how to perform hearing screening.

16. France

***Hearing screening representatives for France**: Francoise Denoyelle, Hopital necker Enfants malades and Paris Descartes University.*

16.1. Background

In France, neonatal hearing screening and preschool hearing screening are organized both nationally and regionally. In contrast, there are no regional variations in protocol for preschool hearing screening. It is important to note the nomenclature differences, that in France, children attend "preschool" prior to age 3 years, while hearing screening occurs during "maternal school" at the age of 3-4 years.

The following report contains information with regards to hearing screening in the entire country of France.

16.1.1. General

The country of France has an area of 633 208 km^2 and with a population of 66 993 000 as of January 2019 (L'Institut national de la statistique et des études économiques, 2019).

In France, all births are registered with the National Association for Prevention and Screenings at Birth (AFDPHE). The number of live births in France in 2018 was 758 000.

The World Bank income classification categorizes France as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2015 was €34 900 per capita (L'Institut national de la statistique et des études économiques, 2019).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for France in 2015 was 4212 USD or €3735 per capita (World Health Organization (WHO), 2018).

An infant mortality rate in 2015 for France is indicated by the INSEE and United Nations to be 3.7 and 3.5 per 1000, respectively (United Nations Statistics Division, 2016; L'Institut national de la statistique et des études économiques, 2019).

16.1.2. Neonatal hearing screening

In France, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening, though screening is not obligatory.

The universal program for well and at-risk babies was first implemented as an experimental programme in 2005. In 2012, neonatal hearing screening was mandated by law, and in 2013 the ministerial degree was published and funding allowed programme implementation across the country. Neonatal hearing screening is not embedded in the Preventive Child Health Care screening system. The programme is funded through the state and health ministry, which dedicates 18€ per infant for neonatal hearing screening. This funding is included in the birth package.

16.1.3. Preschool hearing screening

In France, preschool hearing screening exists nationally and is embedded in the general Preventive Child Health Care system. In contrast to neonatal hearing screening, there are no differences in

preschool hearing screening across regions. It is estimated that preschool hearing screening in France started many years ago.

16.2. Guidelines & Quality Control

Neonatal hearing screening in France follows the national hearing screening guideline, specifications and funding. The national hearing screening guideline states that childhood hearing screening must be organized by law; however, regional health agencies (ARS) may adapt these guidelines to their own regional specifications. Therefore, tests performed and referral criteria for well babies may differ across the country. In contrast, protocols for at-risk infants follow the national guidelines.

For example, regions may use aABR, OAE or both methods for screening. Additionally, some regions may only refer well-infants to diagnostic assessment with a failed result in both ears, while other regions may have a different strategy for follow-up for infants who fail the screening unilaterally.

Preschool hearing screening in France follows a national guideline.

The content of the neonatal screening guidelines was developed by the health ministry. Since its initiation, the guidelines have not been revised. The process and funding for revision of the guidelines if needed in the future is not indicated.

Quality assurance is imposed on by the national government. Data and quality monitoring of screening performed in maternity hospital is performed regionally.

Annual reports are not available on a national level for neonatal hearing screening, and data are only available from the experimental program from 2005 to 2007.

Studies have been performed on hearing screening in France, including its effectiveness.

16.3. Process: Screening, Diagnosis, Intervention

16.3.1. Neonatal hearing screening

According to 2005 statistics, 99% of children are born in a hospital or maternity clinic, and 1% of births take place at home (L'Institut national de la statistique et des études économiques, 2005). The percentage of children admitted to the NICU in France is roughly estimated to be 4.3%.

Well-babies and at-risk babies are screened in the maternity wards or neonatology unit in the hospital.

Families are invited directly in person in the hospital, where the average length of stay after delivery is calculated to be 4.2 days. Neonatal hearing screening should be completed before discharge from the maternity ward or neonatology unit. Well-baby screening should be completed with a referral for a diagnostic evaluation before 1 month of age. For infants at-risk, the recommended maximum age of screening is not defined in protocol.

In France, at risk infants are defined using the criteria stipulated by the Joint Committee of Infant Hearing (2007), as well as any infant admitted to the NICU. In contrast to well-infants, all regions

follow the mandatory national procedure for at-risk infants. Babies who meet these conditions are screened using a different protocol because of the increased risk of auditory neuropathy. It is estimated that 4.3% of infants are screened with the at-risk protocol, as this the percentage of transfer at birth.

The prevalence of CMV infections among neonates is not described but the prevalence of meningitis is 1.4 per 10000 for children under age 5.

The target condition for screening for well and at-risk babies is a hearing loss of greater than 35 dB HL. Whether unilateral or bilateral hearing is targeted varies across regions. In Ile de France, bilateral hearing loss is targeted, while in other regions both unilateral and bilateral hearing losses are targeted.

16.3.2. Neonatal diagnostic assessment

The diagnostic assessment of well-babies should be performed before 3 months of age; however, with moderate hearing losses it may take longer to achieve the complete and correct diagnosis. Clinical ABR is performed to diagnose hearing impairment.

16.3.3. Preschool hearing screening

School-age hearing screening takes place at maternal school when the child is 4 and 6 years old.

Children are invited to participate in hearing screening at the schools by school doctors.

It is estimated that the target condition for preschool-age screening is a hearing loss is a unilateral or bilateral hearing loss of at least 25 dB HL.

16.3.4. Intervention approach

In France, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Other services include speech therapy. It is estimated that infants are fitted with hearing aids from less than 6 months of age or 6-12 months of age. It is also estimated that infants are fitted with cochlear implants from 1-2 years of age.

It is estimated that hearing aid fitting criteria in France is a sensorineural bilateral or unilateral hearing loss of >30 dB HL. For conductive hearing loss, hearing aids be appropriate depending on the aetiology.

16.4. 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

16.4.1. Neonatal hearing screening (well)

The screening process for well babies in France is indicated in Table 1. The neonatal hearing screening process is partly defined in a national protocol; however, each region also has its own protocol. Some maternity clinics have aABR equipment, in which case they may perform aABR as their first and/or second step. Other clinics have only OAE equipment.

Some regions perform a third screening test (control screen) less than month after discharge from the maternity hospitals. Other regions do not perform this control screen and refer to a diagnostic assessment at discharge.

Some regions recommend follow-up after one year for infants that fail neonatal hearing screening unilaterally. Other regions refer unilateral failed screens for a diagnostic examination.

Table 30: Screening process for well babies in France.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE / aABR	24-72 hours	Various / 35 dB nHL	Varies	Regional variation	Maternity ward
OAE / aABR	Before discharge	Various / 35 dB nHL	Varies	Regional variation	Maternity ward
OAE / aABR (some)	< 1 month	Various / 35 dB nHL	Varies	Regional variation	Diagnostic centres

16.4.2. Neonatal hearing screening (at-risk)

The neonatal screening process for infants at risk is similar to well-babies except that aABR is mandatory for each step, as per the national guidelines.

Table 31: Screening process for at-risk babies in France.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
aABR	24-72 hours	35 dB nHL	Varies	Regional variation	Maternity ward / Neonatology unit
aABR	Before discharge	35 dB nHL	Varies	Regional variation	Maternity ward / Neonatology unit
aABR (some)	< 1 month	35 dB nHL	Varies	Regional variation	Diagnostic centres

Recommendations for referral and follow-up after screening for at-risk infants vary by region. For example, at-risk infants that fail screening unilaterally may be directly referred for diagnostic assessment or they may be followed-up after 3-4 months of age. Regional programmes may also request that all at-risk infants follow up for later retesting (e.g., after 1 year of age).

16.4.3. Preschool hearing screening

Hearing screening (age 3-4) in maternity schools is performed with pure-tone audiometry screening; however, there is no national protocol for how pure-tone screening should be performed.

16.5. Professionals

16.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses or nurse auxiliaries/assistants in the hospitals. Training is required per the national guideline but organized by regional networks. The length of training varies across regions. For example, a training session may be 3 hours of theory plus one half day to one full day of practical training. The training is not accredited or certified.

16.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants in NICUs is performed by NICU nurses. See 7.1 for training details.

16.5.3. Preschool hearing screening

Screening for 3-4-year-old children in maternity schools is performed by school doctors.

17. Germany

Hearing screening representative for Germany: *Peter Matulat, Clinic for Phoniatrics and Pediatric Audiology, University Hospital Münster, Westfalia-Lippe Germany.*

General screening information acquired from answers by*: Peter Matulat, Clinic for Phoniatrics and Pediatric Audiology, University Hospital Münster and Alexander K. Schuster, Department of Ophthalmology, University Medical Center Mainz.*

17.1. Background

In Germany, hearing screening is performed nationally and organized both regionally and nationally. Specifically, guidelines and protocols are followed nationally, but neonatal hearing screening data are collected, and outcomes are monitored via regional tracking centres. The following report contains information with regards to childhood hearing screening in the entire country of Germany with information also provided for the region of Westfalia-Lippe.

17.1.1. General

Germany has a total area of 348 900 km^2 with a population of 82.7 million in 2016 (Statistisches Bundesamt, 2018). Westfalia-Lippe has a total area of 21 427 km^2 with a population of 8 257 634 in 2017 (Landschaftsverband Westfalen-Lippe (LWL), 2017).

In Germany, all births are registered and the number of births in Germany in 2016 was 792 131 (Statistisches Bundesamt, 2018).

The World Bank income classification categorizes Germany as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2016 was €35 734 per capita in Germany (Statistisches Bundesamt, 2018) and €70 542 per capita in Westfalia-Lippe (Landschaftsverband Westfalen-Lippe (LWL), 2017).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for all of Germany in 2015 was 4 592 USD or €4 032 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 2.7 per 1000 is reported for all of Germany by Statistisches Bundesamt (2018), and data from the World Health Organization cites an infant mortality rate of 3.3 per 1000 for 2015 (World Health Organization (WHO), 2018). A mortality rate of 4.1 is reported for the federal state of North Rhine-Westphalia for 2015, which includes the region of Westfalen-Lippe (Landesbetrieb Information und Technik North Rhine-Westphalia (IT.NRW), 2018).

17.1.2. Neonatal hearing screening

In Germany, 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 2002 in various regional projects (e.g., in Hessen) and became available across all of Germany in 2009 when written into national guidelines. Neonatal hearing screening was implemented in Westfalia-Lippe in 2007.

Neonatal hearing screening is embedded in the Preventive Child Health Care screening system (Die vom Gemeinsamen Bundesausschuss (G-BA), 2017). Screening performed in the maternity wards is

funded by health insurance as part of the service coverage for birth, while screening performed externally (during the first outpatient check-up at 3-10 days) is funded through health insurance remuneration to the paediatrician for the routine exam.

National guidelines are available for the detection of childhood disease (Die vom Gemeinsamen Bundesausschuss (G-BA), 2017), and in 2009 this directive was updated to include neonatal hearing screening (Nennstiel-Ratzel & Brockow, 2013). A national protocol is stipulated in the directive for the detection of childhood diseases (Die vom Gemeinsamen Bundesausschuss (G-BA), 2017) as well as in the Guidelines for Peripheral Hearing Disorders in Children, published by the Germany Society of Speech and Pediatric Audiology (Deutschen Gesellschaft für Phoniatrie und Pädaudiologie; Nennstiel-Ratzel & Brockow, 2013). These guidelines and protocol are followed across the entire country.

17.1.3. Preschool hearing screening

Preschool hearing screening is conducted universally in Germany as part of the routine check-up ("U8") at 4 years of age. Preschool hearing screening is embedded in the Preventive Child Health Care screening system and is funded by health insurance for remuneration to the paediatrician for the complete routine examination. The general screening program for childhood disease was first implemented in 1971. Childhood hearing screening was initially part of the U9 examination at 6 years of age, though it was recently moved to the U8 examination during the most recent (2017) revision of the national guideline (Lawrenz, 2017).[1]

17.2. Guidelines & Quality Control

National guidelines for hearing screening exist in Germany, published by Die vom Gemeinsamen Bundesausschuss (GBA), in a document outlining all required childhood examinations. These guidelines describe the protocol for neonatal hearing screening. Preschool-age hearing screening is also stipulated in this guideline, included as one of the tests performed during U8 (or the 8th examination) at 46-48 months of age (Die vom Gemeinsamen Bundesausschuss (G-BA), 2017). Other childhood hearing guidelines are published by the Germany Society of Speech and Pediatric Audiology. These guidelines also describe the protocol for performing neonatal hearing screening, diagnostic assessments on children, in addition to intervention protocols for conductive and sensorineural hearing losses (Deutschen Gesellschaft für Phoniatrie und Pädaudiologie, 2013).

The G-BA guidelines/protocol are followed across all of Germany; however, a recent report on 2011-2012 data noted some deviations across regions and maternity centres (Nennstiel-Ratzel, et al., 2017). Furthermore, there are differences in how data tracking is performed across regions, with regards to the organization, financing, as well as the structural and technical aspects of the tracking service.

Quality assurance of hearing screening programs is imposed by the government. With the implementation of neonatal hearing screening in the national guideline in 2009, an evaluation was stipulated to be carried out after the protocol had been in effect for 5 years. Neonatal hearing screening

[1] It was indicated in the questionnaire responses that preschool hearing screening occurs during the U9 examination; however, an article (https://www.allgemeinarzt-online.de/1588246/a/neue-richtlinie-1808810) indicates that, as of the 2017 revision, the hearing screening test is now part of the U8 examination and removed from U9.

was therefore evaluated in 2011-2012, and the results of this evaluation were recently published in 2017 (Nennstiel-Ratzel, et al., 2017). The content of the programme has not been changed since it was implemented in 2009; to-date there have not been any changes based on the results from the 2017 report.

Aside from this national 5-year evaluative report, data collection and monitoring is performed regionally. Regional-based hearing screening tracking centres record the performance of neonatal hearing screening in connection with relevant data about each birth, as well as monitor the effectiveness of hearing screening across maternity centres. In Westphalia-Lippe, data are collected, and key performance indicators are reported on to maternity centres on a monthly, quarterly and annual basis. Anonymous benchmarking is also available online for the clinics to access (Matulat, Stroe, & am Zehnhoff-Dinnesen, 2014). While all regions in Germany have neonatal hearing screening, not all regions provide this level of tracking services for monitoring outcomes and evaluating to benchmark indicators.

Annual reports are not available on a national level. As indicated, a recent report was published evaluating the neonatal hearing screening programme on a national level from 2011-2012 data. Regional evaluations are conducted on a monthly, quarterly or annual basis, or for the purpose of publication. Research has been performed in Germany on the neonatal hearing screening programme (e.g., Rissman, et al., 2018).

17.3. Process: Screening, Diagnosis, Intervention

17.3.1. Neonatal hearing screening

Well-babies and at-risk babies are usually screened in the maternity hospital or NICU. It is roughly estimated that approximately 91% of screening takes place in the maternity hospital. If hearing screening is not carried out at the birth centre, it can be carried out as part of the infant's standard medical check-up.

Approximately 97% of births take place in the maternity hospital, where the average length of stay after delivery is 4.2 days. Infants with illness stay an average of 9.2 days (Technikerkrankenkasse, 2016). Only around 0.6% of births take place at home.

It was not indicated how parents/caregivers of well and at-risk babies are invited to participate in neonatal hearing screening.

Neonatal hearing screening for well babies should be completed before 14 days of age. For at-risk infants, premature infants should be screened by their calculated day of birth, and infants who are sick or handicapped (where screening becomes delayed) should be screened by at least 3 months of age.

In Germany, at-risk infants are defined as those with a family history of hearing loss, admission into the intensive care unit for more than 48h, the use of ventilation, prematurity of less than 32 weeks, a birth weight <1500g, pre / post-natal infections (e.g., toxoplasmosis, CMV, rubella, herpes, or bacterial infections), the use of ototoxic drugs (e.g., aminoglycosides, loop diuretics), critical hyperbilirubinemia (with exchange transfusion), malformations of the head (e.g., cleft palate, ear tag), or syndromes associated with hearing impairment (e.g., trisomy 21, CHARGE, Waardenburg

syndrome). The percentage of at-risk infants is unknown due to variability in regional documentation of risk factors (Nennstiel-Ratzel, et al., 2017).

Data on the prevalence of CMV is not available in Germany. The prevalence of meningitis is 0.4 per 100 000, with 35% of cases occurring in infants and children 0-4 years of age (Ständigen Impfkommission (STIKO) am Robert Koch-Institut (RKI), 2018).

According to guidelines, the target condition for screening for well- and at-risk babies is a bilateral hearing loss of 35 dB HL or worse (Matulat & Parfitt, 2018).

17.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral, includes otoscopy, tymponometry, TEOAE and a clinical ABR. Higher level centres may also perform DPOAEs, frequency-specific ABR, and behavioural observation audiometry for confirmation. Diagnostic confirmation should be performed before 3 months of age; however, the average age according to current data is 4.3 months.

17.3.3. Preschool hearing screening

Preschool hearing screening is performed at the pediatrician's office as part of routine examination at 4 years of age (examination 8 [U8]). Prior to the 2017 revision, this screening test was performed during the 9th examination (U9) at 6 years of age; however, this was removed in preference for an earlier screening test ate age 4. An earlier hearing exam is also performed at U6 when children are approximately 2 years of age.[2]

The target condition for preschool hearing screening is not specifically indicated in the guideline; however, referral criterion is a threshold of 30 dB HL or worse in at least 2 frequencies in one or both ears.

17.3.4. Intervention approach

In Germany, treatment options available include grommets, hearing aids, bone conductive devices and cochlear implants. Infants are fitted with hearing aids from <6 months of age or older, and cochlear implants from 6 months of age or older.

The fitting criteria in Germany for an immediate hearing aid is a bilateral or unilateral hearing loss of 35 dB HL or worse. Hearing aids for mild losses of 25 and 30 dB HL can be considered at 1 year of age or later.

[2] It was indicated in the questionnaire responses that preschool hearing screening occurs during the U9 examination; however, an article (https://www.allgemeinarzt-online.de/1588246/a/neue-richtlinie-1808810) indicates that, as of the 2017 revision, the hearing screening test is now part of the U8 examination and removed from U9.

17.4. 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

17.4.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies is described in Table 1. A 2-step protocol is in effect, whereby the first test may be either OAE or aABR, and is ideally performed in the maternity hospital before discharge. If the infant fails the first test, rescreening occurs with aABR ideally before discharge. If screening does not take place in the maternity hospital, it is performed during the initial post-discharge check-up ("U2").

According to a report based on 2011-2012 data, TEOAE was performed for 80% of initial screens, while aABR was performed for the remaining 20%. Furthermore, only around 50% of rescreens were conducted using aABR, despite protocol stipulations. This may be due to lack of education about the protocol and pressure on screening staff and/or a shortage of devices able to perform aABR in maternity hospitals (Nennstiel-Ratzel, et al., 2017).

Table 32: Screening process for well babies in Germany.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1 *or* aABR1	<24 hours - 5 days	Various *or* 35 dB nHL[3]	Various	Yes	Maternity hospital / Paediatric Clinic
aABR2	Before discharge (ideal) or < 14 days	35 dB nHL	Various	Yes	Maternity hospital / Paediatric Clinic

17.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk infants is described in Table 2. Whereby well babies are initially screened with either aABR or OAE, infants at-risk should be screened with a 2-step aABR protocol before discharge. The age of screening depends on whether the infant was born prematurely and the health of the infant. Premature infants should be screened by the calculated day of birth.

Table 33: Screening process for at-risk babies in Germany.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location

[3] aABR screening referral information acquired from newborn hearing screening guidelines (Matulat & Parfitt, The newborn hearing screening programme in Germany, 2018).

aABR1	Varies	35 dB nHL	Varies	Yes	Hospital / NICU / Paediatric Clinic
aABR2	Before discharge	35 dB nHL	Varies	Yes	Hospital / NICU / Paediatric Clinic

17.4.3. Preschool hearing screening

Preschool hearing screening is currently (as of 2017) performed during the routine childhood check-up at 4 years of age ("U8"). Pure-tone audiometry is performed in the pediatrician's office, and referral criteria are hearing thresholds greater than 20 dB HL at two or more frequencies in at least one ear.

Table 34: Process for preschool hearing screening in Germany.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
Pure-tone audiometry	4 years	20 dB HL at 2 or more freqs	50-40-30-20 dB HL at 5 freqs (0.5, 1, 2, 4, and 6 kHz)	Yes	Paediatric Clinic

17.5. Professionals

17.5.1. Neonatal hearing screening (well)

Screening for well babies is typically performed by pediatric nurses or midwives. Approximately 85% of the screening staff are nurses, 5% are midwives, 5% are pediatricians, and 5% are pediatric audiologists.

Training involves approximately 4 hours of education, including the medical background of neonatal hearing screening, performing screening on newborns, informing the parents, acquiring consent, data handling, and mediation of screening results. It is assumed that all screening performed is done so by a trained professional. It is the responsibility of the hearing screening centre to train each of its screening staff.

Quality of the screeners is monitored through data received from maternity hospitals. Data includes the number of attempts, electrode impedances and response curves, in addition to actual pass/fail results. The screening centre evaluates results on a monthly, quarterly and annual basis and provides feedback to the maternity hospitals on the quality of their results and whether benchmark indicators (14 in total) have been achieved. Individual feedback on staff is provided if necessary, and updated training may be offered.

17.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by pediatric nurses or doctors (see 7.1 for training requirements).

17.5.3. Preschool hearing screening

Screening for preschool-age children is performed by the staff at the paediatrician's office or by the doctor him/herself.

18. Greece

Hearing screening representative for Greece: *Thomas Nikolopoulos, Professor of ENT, Attikon University Hospital, New Philadelphia.*

General information acquired from: *Thomas Nikolopoulos, Professor of ENT, Attikon University Hospital & Vasiliki Papaevangelou, National and Kapodistrian University of Athens.*

18.1. Background

In Greece, hearing screening is organized and implemented locally.

The following report contains information with regards to hearing screening in the entire country of Greece. The details of the hearing screening protocol and the data provided are specific to Attikon University Hospital in Athens.

18.1.1. General

The country of Greece has a total area of 131 960 km^2 and a population of 10 816 286 according to the 2011 census (Hellenic Statistical Authority, 2014). In Greece, each birth is registered with the government. The number of live births in Greece was 94 134 in 2013 (Hellenic Statistical Authority, 2016)

The World Bank income classification categorizes Greece as a high-income country (The World Bank, 2018). The gross domestic product (GDP) is €16 475 per capita as of 2013 (Hellenic Statistical Authority, 2016)

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Greece in 2015 was 1505 USD or € 1287 per capita (World Health Organization, 2018).

Data acquired from the 2016 United Nations Demographic Yearbook indicate an infant mortality rate of 4.0 and 4.2 per 1000 for the country of Greece in 2015 and 2016, respectively (United Nations Statistics Division, 2016).

18.1.2. Neonatal hearing screening

Only some hospitals in Greece have implemented universal neonatal hearing screening. Universal hearing screening is not carried out across the entire country. Neonatal hearing screening is also not carried out on all at-risk or NICU infants.

The year that hearing screening for well and at-risk babies was first implemented is dependent on the hospital. In one local hospital, screening for well and at-risk babies was first implemented in 2008. As indicated, it is not yet implemented across the entire country. Neonatal hearing screening is not embedded in the Preventive Child Health Care screening system. Screening is funded through parents and through research funding. Some research articles in other hospitals should hearing screening being implemented some years earlier (Korres, Balatsouras, Nikolopoulos, Korres, & Ferekidis, 2006; Korres, et al., 2005).

Hospitals across Greece use the different protocols for screening well and at-risk babies. There are no national or regional protocols. Only local protocols are available.

18.1.3. Preschool hearing screening

In Greece, preschool hearing screening is not performed. Paediatricians may roughly estimate a child's hearing around preschool age.

18.2. Guidelines & Quality Control

National guidelines for hearing screening exist in Greece, consisting of a 60-page document; however, these guidelines were never implemented due to financial reasons.

The content of hearing screening programme was decided on by the Ministry of Health through an appointed committee of professionals. As indicated, the committee wrote national guidelines; however, these guidelines were never implemented into clinical practice. Therefore, a universal neonatal hearing screening programme has not yet been implemented. Each hospital decides whether it will implement neoenatal screening and follow or change the guidelines.

In some hospitals, outcomes of hearing screening are collected in local databases; however, quality assurance of hearing screening programmes is not imposed in Greece.

Annual reports are not available in Greece. Some studies have been performed on neonatal hearing screening and its effectiveness in Greece (Korres, Balatsouras, Nikolopoulos, Korres, & Ferekidis, 2006; Korres, et al., 2005; Korres, et al., 2008; Nikolopoulos, 2015; Papacharalampous, Nikolopoulos, Davilis, Xenellis, & Korres, 2011; Tzanakakis, et al., 2016; Vlastarakos & Kalampalikis, 2015).

18.3. Process: Screening, Diagnosis, Intervention

18.3.1. Neonatal hearing screening

Well babies and at-risk babies are screened in the hospital, where the average length of stay is estimated to be 3 days (2-5 days). It is roughly estimated that more than 90% of births take place at the maternity hospital, while less than 10% of births take place at home. Families of well and at-risk infants are invited to participate in neonatal screening directly in person while in the hospital by the doctor or staff at the delivery hospital.

It is roughly estimated that neonatal hearing screening for well and at-risk infants should be completed before 6 months of age. Typically, infants that fail initial screening are rescreened at 3-5 months of age, depending on the hospitals local protocol.

The target condition for screening well babies is a bilateral or unilateral hearing loss of greater than 40 dB HL, and the target condition for screening at-risk babies is s a bilateral or unilateral hearing loss of greater than 40 dB HL.

At Attikon University Hospital, at-risk infants are defined as infants admitted to the NICU and those with risk factors for hearing loss according the international guidelines (e.g., family history of hearing

loss, stigmata, etc). All parents in the maternity ward are asked if the child meets the criteria for being at risk for hearing loss, and if so, these children are screened with the at-risk protocol. Data are unavailable regarding how many infants are screened with the at-risk protocol.

The prevalence of CMV infections and meningitis among neonates is not known.

18.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests performed after neonatal hearing screening referral are tympanometry, ABR and ASSR. Well infants and at-risk infants should have their diagnostic assessment completed by 6 months of age.

18.3.3. Preschool hearing screening

Preschool hearing screening is not performed, but hearing status is estimated at the discretion of the pediatrician. There are no reliable tests performed.

18.3.4. Intervention approach

In Greece, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids from 6-12 months of age and cochlear implants from 11-12 months of age. The average age of cochlear implantation is 2 years of age.

There are no fixed hearing aid fitting criteria in Greece.

18.4. 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

18.4.1. Neonatal hearing screening (well)

For well babies in Greece, there is no universal screening protocol. In Attikon University Hospital, 2-3 OAEs are performed for well-baby neonatal hearing screening. The first OAE takes place within 1-4 days after birth in the newborn units in the hospitals. For infants that fail the first OAE, a rescreening occurs at 1 month of age. Finally, infants that fail the 1-month rescreen return for a screening test with aABR and tymponometry at 3 months of age before being referred to full diagnostic assessment with ABR and ASSR.

Table 35: Screening process for well babies in Attikon University Hospital, Greece.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	24-72 hours	Not indicated	Not indicated	Yes	Maternity ward
OAE2	1 month	Not indicated	Not indicated	Yes	Hospital clinic
aABR + tymp	3 months	40 dB nHL		Yes	Hospital clinic

18.4.2. Neonatal hearing screening (at-risk)

The sequence for screening infants at-risk at Attikon University Hospital is described in Table 2. As described, all neonates in the NICU are screened with the at-risk protocol as well as well babies with risk factors for hearing loss. A combined OAE+aABR protocol is in effect, whereby all infants are screened with both tests. Infants in the NICU are screened directly with both tests, and those that do not pass the aABR screen are referred for a rescreen at 3-months of age. Well babies with risk factors are screened with OAE in the maternity ward, but are referred for aABR testing at 3-months of age, regardless of the OAE results. At this 3-month test, tympanometry is also performed.

Table 36: Screening process for at-risk babies in Attikon University Hospital, Greece.

Test	Age	Referral criteria	Unilateral Referrals?	Location
OAE (+aABR*)	4 days / before discharge	40 dB nHL	Yes	Hospital /NICU
aABR+tymp	3 months	40 dB nHL	Yes	Hospital clinic

*aABR is performed before discharge from the NICU. At-risk infants born in well-baby unit are referred for aABR at 3 months of age.

18.4.3. Preschool hearing screening

Not applicable.

18.5. Professionals

18.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by paediatricians, midwives, nurses, specialist nurses, assistant nurses, ENT physicians, audiologists, audiologist assistants, or health care support workers. There is no specific training for hearing screeners in Greece.

18.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by paediatricians, nurses, specialist nurses, ENT physicians, or audiologists.

18.5.3. Preschool hearing screening

Not applicable.

19. Hungary

Hearing screening representative for Hungary: *Anita Gáborján, Dept. of Otorhinolaryngology, Head and Neck Surgery, Semmelweis University.*

General information provided by: *Anita Gáborján, Dept. of Otorhinolaryngology, Head and Neck Surgery, Semmelweis University & Berkes Szilvia, Department of Ophthalmology, University of Szeged.*

19.1. Background

In Hungary, hearing screening is organized nationally. Neonatal hearing screening is implemented across the entire country and is universally provided to all babies. A national guidance document was published in 2015. Neonatal hearing screening protocols are followed across all hospitals in Hungary, though data collection on a national level is still in progress since widespread implementation in 2015. Preschool hearing screening is also organized nationally and is a mandatory screening test for school admission.

The following report contains information with regards to hearing screening for the entire country of Hungary.

19.1.1. General

The country of Hungary has a total area of 93 030 km^2 and a population of 9 753 000 as of 2017 (Hungarian Central Statistics Office, 2018). In Hungary, each birth is registered. The number of live births in Hungary was 91 577 in 2017 (Hungarian Central Statistics Office, 2018).

The World Bank income classification categorizes Hungary as a high-income country (The World Bank, 2018). The gross domestic product (GDP) was €12 673 per capita in 2017 (Hungarian Central Statistics, 2018)

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Hungary in 2015 was 888 USD or €782 per capita (World Health Organization, 2018).

Infant mortality rate in the country of Hungary was 3.9 per 1000 in 2015 (United Nations Statistics Division, 2016) and 3.6 per 1000 in 2017 (Hungarian Central Statistics, 2018)

19.1.2. Neonatal hearing screening

In Hungary, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening, though participation is obligatory for parents. Hearing screening for well and at-risk babies started in 1997. In 2015, it was fully implemented, and objective measures were mandated through a guidance document published by the State Secretariat for Health Care. Neonatal hearing screening is funded by health insurance but is not embedded into the Preventive Child Health Care screening system.

Neonatal hearing screening is organized by the hospitals or NICU departments, though hospitals should comply with the national guidance document and protocol (State Secretariat for Health Care, 2015). The same protocol is used for screening well and at-risk infants.

19.1.3. Preschool hearing screening

In Hungary, preschool hearing screening is universally performed prior to school entry. Preschool hearing screening in Hungary was fully implemented across the country in 1997 and is funded by council. It is part of the Preventive Child Health Care Programme. Recommendations for screening at age 5 is also stipulated in the guidance document (State Secretariat for Health Care, 2015).

19.2. Guidelines & Quality Control

National guidelines for childhood hearing screening exist in Hungary, published by the Ministry of Human Resources - State Secretariat for Health Care, and decided on by a professional body of audiologists and neonatologists (State Secretariat for Health Care, 2015). The 2015 publication of guidelines for childhood hearing screening stipulate the widespread use of objective measures for universal neonatal hearing screening, specifically that aABR should be carried out.

Quality assurance of hearing screening programmes is not imposed by the federal government, though data collection has just recently started on a national level. Annually reports are not yet available.

There have not been any studies performed yet on the neonatal hearing screening programme in Hungary.

19.3. Process: Screening, Diagnosis, Intervention

19.3.1. Neonatal hearing screening

In Hungary, infants are screened in the hospital maternity ward, or in the NICU. In 2016, 0.61% of infants were born outside the hospital (either at home or on the way to the hospital).The average length of stay in the maternity hospital after birth is roughly estimated to be 3 days. Families are not invited to participate in screening, but screening is performed directly at the hospital or in the NICU by screening staff.

The target condition for screening both well- and at-risk infants is a bilateral or unilateral hearing loss of 35 dB HL. Screening should be completed by 1 month of age for both well and at-risk infants (State Secretariat for Health Care, 2015).

All infants (both well and at-risk) undergo the same screening protocol. There is no difference in screening protocol between groups of infants. However, the guidelines indicate that infants at-risk for hearing loss should be monitored, and a follow-up test should be performed at the age of 1 year and then annually up to 3 years of age (State Secretariat for Health Care, 2015). Data are unavailable on the childhood/infant prevalence of CMV infections or meningitis in Hungary.

19.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral should be completed by 3 months of age for both well, healthy infants and at-risk infants when possible (depending on the health of the infant). Tests perform for confirmation of hearing loss include a clinical-ABR and ASSR as well tympanometry and an ENT exam (State Secretariat for Health Care, 2015).

19.3.3. Preschool hearing screening

In Hungary, preschool screening takes place in the kindergartens or in a district consultation room by a paediatric district nurse. Children are invited to participate in screening directly in person in the kindergartens.

The target condition for preschool hearing screening is a unilateral or bilateral hearing loss of 30 dB HL.

19.3.4. Intervention approach

In Hungary, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Children are fitted with hearing aids from < 6 months of age and with cochlear implants from 1-2 years of age.

Fitting criteria for hearing aids in Hungary is a bilateral hearing loss of at least 25 dB HL.

19.4. 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

19.4.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies in Hungary is summarized in Table 1, whereby a 1-step aABR protocol is in effect. The aABR is performed in the maternity hospital after birth and up to 72 hours (i.e., before discharge). In some cases, screening may be performed later, but should be performed before 1-month of age. Only one aABR is required for referral to a diagnostic assessment; however, the guidelines recommend rescreening when possible in order to reduce false positives. Therefore, the aABR may be performed once if the baby is quiet/sleeping, or it may be performed a second time if possible (State Secretariat for Health Care, 2015).

Table 37: Process for neonatal hearing screening of all babies in Hungary.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
aABR*	<72 hours	35 dB nHL		Yes	Maternity ward

*The aABR may be performed one or more times before referral.

19.4.2. Neonatal hearing screening (at-risk)

There is no difference in screening protocol for well or at-risk infants. See section 4.1 and Table 1 for details.

19.4.3. Preschool hearing screening

In Hungary, hearing screening is performed in kindergartens at 5 years of age. Pure-tone audiometry screening (with headphones) is performed (State Secretariat for Health Care, 2015). If one or more thresholds are worse than 25 dB HL a referral is made to an ENT for a diagnostic assessment.

Table 38: Process for preschool hearing screening in Hungary

Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone screening	5	25 dB HL	Yes	Kindergarten schools / District office

19.5. Professionals

19.5.1. Neonatal hearing screening (well)

Screening for well-babies is performed by nurses.

There is a specific training programme for nurses to learn aABR screening, which consists of 1 day of certified training. Monitoring of screening staff and training updates are performed in Hungary.

19.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by NICU nurses. See 7.1 for details.

19.5.3. Preschool hearing screening

Preschool screening is performed by paediatric district nurses.

20. Iceland

Hearing screening representative for Iceland: *Ingibjorg Hinriksdottir, Chief Physician at The National Hearing and Speech Institute of Iceland.*

20.1. Background

In Iceland, hearing screening is performed nationally and also organized nationally. The following report contains information with regards to hearing screening in the entire country of Iceland.

20.1.1. General

The total country of Iceland has an area of 103 000 km^2 with a population of 348 450 as of January 1, 2018 (Statistics Iceland, 2018).

In Iceland, all births are registered. The number of live births in Iceland in 2017 was 4071 (Statistics Iceland, 2018).

The World Bank income classification categorizes Iceland as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2015 was €41 928 per capita (Statistics Iceland, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Iceland in 2015 was 4282 USD or €3733 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 2.1 per 1000 is reported for Iceland for 2015 (Statistics Iceland, 2018). The United Nations does not provide infant mortality rates due to low number of infants born per year (United Nations Statistics Division, 2016).

20.1.2. Neonatal hearing screening

In the country of Iceland, 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 babies was first implemented in 2007, and by 2009, neonatal hearing screening was available across the country. Screening for at-risk infants began much earlier in 1982. Neonatal hearing screening is embedded in the Preventive Child Health Care screening system. Screening is organized and coordinated through the National Hearing and Speech Institute. The institute is part of the Icelandic health care system financed by the government.

In Iceland, the same hearing screening protocol is followed across the country.

20.1.3. Preschool hearing screening

In Iceland, preschool hearing screening is not performed.

20.2. Guidelines & Quality Control

National guidelines for hearing screening exist in Iceland.

The content of hearing screening programme was decided on by the National Hearing and Speech Institute, where certain employees take care of the neonatal hearing screening programme. The hearing division is made up of a medical doctor, an audiologist and an audiologist assistant. The content of the screening programme was changed in 2009 when neonatal hearing screening was included nationally and in 2012 when preschool hearing screening was terminated. The revision/review process is performed every 2 years through a meeting of National Hearing and Speech Institute. The revision process is funded through the state.

Quality assurance of hearing screening programmes is not imposed by the government; however, information is collected about hearing screening outcomes through a collection of results at the National Hearing and Speech Institute. At this time, data are aggregated for well babies only. Data for at-risk infants are collected, but not sent to the National Hearing and Speech Institute.

Data are collected at the National Hearing and Speech Institute for well and at-risk babies combined; however, it is not indicated whether reports are regularly produced from these collected data. Research has been performed on hearing screening in Iceland apart from auditing, though not on a regular basis. A cost-effectiveness study has not been performed.

20.3. Process: Screening, Diagnosis, Intervention

20.3.1. Neonatal hearing screening

Well-babies are screened in the hospital or at Child Health Care Centres, and at-risk babies are screened in the hospital/NICU. Well-baby families are invited to participate in neonatal screening as a part of the general preventive health care for newborns infants. Families of infants at-risk are invited for screening directly in person in the hospital. The staff of the National Hearing and Speech Institute and the staff at the maternity ward invite families to participate. Around 80-90% of infants are born in maternity hospitals. The average length of stay is not indicated.

It is roughly estimated that neonatal hearing screening for well-babies should be completed before 2-4 weeks of age, though this age may vary for infants born in rural areas. For at-risk infants, it is roughly estimated that screening should be completed by 8-12 weeks of age.

Data are unavailable regarding the percentage of infants screened with the at-risk protocol. At-risk infants are defined as those with a family history of hearing loss, a syndrome associated with hearing impairment, postnatal infections (e.g, CMV, asphyxia, intracranial hemorrhage, IPPV/ECMO), prematurity, NICU stay > 48 hours, or hyperbilirubinemia.

The prevalence of CMV infections and meningitis among neonates is registered when detected. In 2016, one neonate was diagnosed with CMV. This infant showed normal hearing.

The target condition for screening well babies is bilateral or unilateral hearing loss > 30 dB HL, and the target condition for screening at-risk babies is a bilateral or unilateral hearing loss > 30 dB HL as well as auditory neuropathy.

20.3.2. Neonatal diagnostic assessment

The diagnostic assessment should be performed by 12 weeks of age.

20.3.3. Preschool hearing screening

Preschool hearing screening is not performed in Iceland.

20.3.4. Intervention approach

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

The hearing aid fitting criteria Iceland is a bilateral hearing loss of >20-25 dB HL depending on the frequencies or a unilateral hearing loss of 25-30 dB HL, depending on the frequencies of hearing loss.

20.4. 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

20.4.1. Neonatal hearing screening (well)

TEOAE tests are performed every day at the two biggest maternity hospitals, and organized tours are made to the rural areas 2 to 4 times per year to test the infants born in the smaller villages. The screening process for well babies in Iceland is described in Table 1, whereby a 3-step OAE-OAE-aABR protocol is in place.

Table 39: Screening process for well babies in Iceland.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	<5 days (older in rural areas)	8x peaks of alternating-signs	Accuscreen	Yes	Maternity hospital / Child Health Care Centre
OAE2	≤ 10 days			Yes	Maternity hospital / Hearing Clinic
aABR	≤ 4 weeks (bilateral referral) ≤ 12 weeks (unilateral referral)	35 dB nHL		Yes	Hearing Clinic

20.4.2. Neonatal hearing screening (at-risk)

The protocol for testing at-risk infants is described below, whereby a 2-step TEOAE+aABR - aABR protocol is in place. Specifically, the first step is a combined OAE and aABR, and the second step is an aABR at lower intensity. The same protocol is followed across the country for at-risk infants; however, a personal family-centred approach is taken in rural areas to ensure contact is maintained.

Table 40: Screening process for at-risk babies in Iceland.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
TEOAE +aABR	36-42 weeks gestation	8x peaks of alternating-signs 45 dB nHL	Accuscreen	Yes	NICU / Maternity hospital
aABR		35 dB nHL		Yes	

20.4.3. Preschool hearing screening

Not applicable.

20.5. Professionals

20.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses, midwives, audiologists or specially trained health care employees. There is accredited training for hearing screening staff. The training is offered and accredited through The National Hearing and Speech Institute, however, data are unavailable regarding the length of this training.

20.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by the same professionals performing screening for well-infants.

20.5.3. Preschool hearing screening

Not applicable.

21. India

***Hearing screening information acquired from answers by**: Zia Chaudhuri, Lady Hardinge Medical College, University of Delhi, PGIMER, Dr RML Hospital, New Delhi, India.*

21.1. Background

In India, hearing screening is performed regionally, but according to the national guideline. The following report contains information with regards to childhood hearing screening across India.

21.1.1. General

India has a total area of 3 287 469 km^2 with an estimated population of 1 298 041 000 in 2018.

In India, all births are registered to the National Portal of India Birth Registry. The number of live births in India is 27 million births per year.

The World Bank income classification categorizes India as a lower middle-income country (The World Bank, 2018). The gross domestic product (GDP) in 2018 was an estimated €1 800 per capita in India.

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for India in 2015 was 59 USD or €53 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 37 per 1000 is reported for India in 2015 (United Nations Statistics Division, 2016).

21.1.2. Neonatal hearing screening

In India, neonatal hearing screening is conducted locally and often selectively, with variation across the country in how screening is implemented. In some jurisdictions, screening is only performed on babies who show risk factors. In private healthcare sector, screening could be carried out universally. Participation is not obligatory for parents. Because of the diversity of programmes across the country, neonatal hearing screening may be funded by parents, charity, companies, health insurance, council, municipalities, employers, states/provinces, and the government of India.

A national programme for the prevention of deafness, including neonatal hearing screening, was launched in 2006 with a plan for scale-up; however, hearing screening it is not yet available across the entire country. The national programme to date is to build the infrastructure for future screening.

21.1.3. Preschool hearing screening

Preschool hearing screening falls under the National Programme of Deafness in India; however, no routine screening is performed. As of December 2016, 335 screening camps have been performed in some states. During camps, all children (and adults) of any age are invited for routine testing, including hearing screening. In these camps, hearing screening is embedded in Preventive Child Health Care screening. When a child is suspected to have hearing loss, a referral is made to a hospital, and intervention, when warranted, is provided to children under 15 years of age under the National Programme.

In other areas, children are referred to ENT specialists if there are indications or a suspicion of hearing loss.

Because of the variability in care, preschool hearing screening may be funded by parents, charity, companies, health insurance, council, municipalities, employers, states/provinces, and the government of India.

21.2. Guidelines & Quality Control

There is a national guideline for the building infrastructure for hearing screening in India (Ministry of Health and Welfare, 2016). The guideline covers aspect such as training, procurement of equipment, recruitment of manpower, and provision of free hearing aids. A consensus document on newborn screening has also been published by experts in the field (Paul, et al., 2017); however, there is currently no universal protocol followed for performing neonatal hearing screening.

The content of the national guideline was decided on by the technical committee of the Government of India. It has not been revised since implementation, and no information is available on how revisions would take place or be funded.

Quality assurance is imposed by the government via audits of services when performed. There is no information as to whether annual reports are available.

Data are unavailable as to whether research has been performed on the national neonatal hearing screening programme. Some studies have been performed on local screening programmes, as reviewed by Ramkumar (2017). There have not been studies published on the effectiveness of hearing screening in India.

21.3. Screening – Diagnosis – Intervention process

21.3.1. Neonatal hearing screening

Well and at-risk babies may be screened in the hospital, child health clinic, private clinic, or school. At-risk infants may also be screened in the NICU. Data are not available regarding the percentage of infants born in maternity hospitals, nor the average length of stay in a maternity hospital after birth.

Hearing screening protocols are not identical across all of India. Data are not available regarding how the protocol varies across the country. Data are not available regarding the differences in well or risk babies. Data are not available regarding whether there are differences in protocols between groups of infants. Data are not available regarding the prevalence of CMV or meningitis among infants or children in India.

The goal is that hearing screening should be completed within 3 months after birth, for both well and at-risk infants.

21.3.2. Neonatal diagnostic assessment

Currently, diagnostic assessment referral is typically completed around 2 years of age when a suspicion of hearing loss is noted, unless a syndrome or other factor indicates deafness earlier. However, the goal is to diagnose infants by 6 months of age.

21.3.3. Preschool hearing screening

Data are not available regarding the protocol of preschool hearing screening or differences across regions. Data are not available regarding the target condition.

21.3.4. Intervention approach

In India, treatment options available include grommets, hearing aids or cochlear implants. The goal of intervention is to fit hearing aids from 6-12 months of age or older and with cochlear implants from <6 months of age or older depending on the extent and severity of deafness. However, given the age at which most children are identified, the age of fitting/implantation is much older. The goal of the national programme is to initiate rehabilitation by 9 months of age.

Hearing aid fitting criteria is a hearing loss of greater than 40 dB HL.

21.4. 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

21.4.1. Neonatal hearing screening (well)

There is no single sequence of screening for neonates in India.

21.4.2. Neonatal hearing screening (at-risk)

There is no single sequence of screening for at-risk neonates in India.

21.4.3. Preschool hearing screening

There is no single sequence of screening for preschool-age children in India.

21.5. Professionals

21.5.1. Neonatal hearing screening (well)

Neonatal hearing screening when performed is done by ENT physicians or audiologists.

Training is part of the 3-year education for an ENT physician or audiologist.

21.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk (NICU) infants when performed is done by ENT physicians or audiologists. See 7.1 for details on training.

21.5.3. Preschool hearing screening

Preschool hearing screening when performed is done by ENT physicians or audiologists.

22. Ireland

***Hearing screening representatives for Ireland**: Gary Norman, National Clinical Lead for Audiology, HSE.*

***General information acquired from answers by**: Gary Norman, HSE and Alex Doherty, Community Eye Clinic.*

22.1. Background

In Ireland, hearing screening is performed nationally and organized nationally across the nine community health organizations (CHOs) of the Health Service Executive (HSE).

The Health Service Executive (HSE) is a public sector organization implemented after the publication of the Health Act of 2004, and is the universal organization providing health and personal social services to residents of Ireland. The HSE is funded by the government with a budget of around 15 billion euros, employing over 65 000 individuals and funding an additional 35 000 workers. Information about the HSE is available through their website (www.hse.ie).

The nine CHOs are organized geographically, where each CHO area has about 350 000 to 670 000 population.

The following report contains information with regards to childhood hearing screening across the entire country of Ireland.

22.1.1. General

The total island of Ireland has an area of 84 421 km^2 and the republic of Ireland has an area of 70 282 km^2 with a population of 4 749 153 as of 2017 (Central Statistics Office, 2018).

In Ireland, all births are registered. The number of live births in Ireland in 2015 was 65 607 (Central Statistics Office, 2018).

The World Bank income classification categorizes Ireland as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2015 was €61 928 per capita (Central Statistics Office, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Ireland in 2015 was 4626 USD or €4027 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 3.4 per 1000 and 3.3 per 1000 is reported for Ireland for 2015 and 2017, respectfully (United Nations Statistics Division, 2016; Central Statistics Office, 2018).

22.1.2. Neonatal hearing screening

In Ireland, 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 is

offered to all eligible infants[4] covered by the Irish health system without contraindications for hearing screening.

Hearing screening for well and at-risk babies started in April 2011 through a phased roll out and was fully implemented as a national programme across all of Ireland by November 2013. Neonatal hearing screening is funded by the state and embedded in the Preventive Child Health Care screening system. An information-communication technology (ICT) system is nationally implemented in Ireland for national control of data. Neonatal hearing screening is provided by Northgate Public Services (NPS) across all of Ireland under contract with the HSE.

22.1.3. Preschool hearing screening

School-entry screening currently exists in Ireland, though contrary to neonatal hearing screening, there is no national programme. It is unknown when school-entry screening began in Ireland or since when it became available across the entire country. Screening is funded by the state and also embedded in the Preventive Child Health Care screening system.

22.2. Guidelines & Quality Control

There are national guidelines for hearing screening in Ireland. Specifically, for neonatal hearing screening, policies, procedures, protocols and guidelines (PPPG) are in effect, and all screening is managed through a central ITC system (Health Service Executive (HSE), 2014). For school-entry hearing screening, there is a school hearing screening policy; however, there is no central management or data collection (Health Service Executive (HSE), 2017).

The content of the hearing screening programme is decided on by the HSE national technical group for hearing screening (NTGCHS). The NTGCHS specifies the requirements for newborn hearing screening. It is based upon the English NHSP programme. The HSE tenders for the screening service nationally, in line with HSE procurement requirement. This is typically on a 3 +2 +2-year contract, pending successful metrics by the provider.

The current Universal Newborn Hearing Screening (UNHS) Governance document provides details related to the service provision for UNHS, including care pathways and guidelines. The service reviews the need for new or amended PPPGs and these are developed on an as needs basis (e.g. change in CMV pathway, where suspected or confirmed referral for diagnostic services are expedited. The governance guidelines are reviewed by the NTGCHS every 3 years.

Since the establishment of the programme, there have been some revisions. First, the age for hearing screening was increased from 3 to 6 months for infants with complex medical needs who have been hospitalized from birth. Second, a protocol for managing cases of infants undergoing palliative care was established. And within most recent UNHS tender, an ABR peer review ICT system (SONAR: system for online ABR peer review) was initiated to provide a quality assurance mechanism for diagnostic ABRs.

[4] *Babies who are not eligible for UNHS include: a) Those born with congenital atresia. b) Those where meningitis is contracted, or where suspected, prior to screening being offered. c) Those who have suspected / Zika virus. d) Babies who have a prolonged period in Special Care Baby Unit, greater than 6 months. e) Babies receiving palliative care (in these cases the decision to screen or not is for the parents in discussion with the neonatologist). Infants will be referred to the local audiology service for diagnostic hearing assessment as and when appropriate by the hearing screening team or the child's paediatrician or neonatologist.*

The protocol for school screening has been changed once since implementation, specifically with the removal of 500 Hz as a test frequency. In theory, school-entry screening protocols should be reviewed every two years. The revision process takes place by formulating a consensus document within the NTGCHS using external feedback, such as those from school screeners.

Quality assurance of the HSE national neonatal hearing screening programme is imposed and provided at different levels. Within each of the CHO structures, there is an oversight group who reviews local KPIs / metrics and communicates risks and issues with the national technical group for children's hearing screening. This governance group now reports to the National Group for Child Health Screening and Surveillance.

The universal newborn hearing screening governance document describes the process of quality assurance, though this document is currently under revision. First, the programme should adhere to quality standards outlined in the governance document. Second, quality assurance is performed via the central collection of universal newborn hearing screening metrics, which are reviewed by the National Technical Group for Childhood Hearing Screening. Third, clinical audits are performed. Fourth, programme staff are qualified and monitored. Finally, internal quality assurance procedures are expected by screening providers (e.g., monitoring of day-to-day operations, risk management, data downloading practice, etc).

While key performance indicators are regularly monitored, only one annual report has been published to date (Health Service Executive (HSE), 2012).

The UNHS programme is relatively new and research to date has been limited though is a priority for 2019. There have not been studies published on the effectiveness of hearing screening in Ireland.

22.3. Process: Screening, Diagnosis, Intervention

22.3.1. Neonatal hearing screening

Well and at-risk babies are screened in the hospital, in a quiet room if possible. At-risk infants may also be screened in the NICU. In Ireland, 99.72% of infants are born in a hospital, and 0.28% are born at home. For single normal births, 54% of infants/mothers stayed up to 2 days in the maternity hospital after delivery, and 44% stayed for 3-5 days. The average length of stay was 3.2 days (Healthcare Pricing Office (HPO), Health Service Executive (HSE), 2014). A list of the 19 maternity unit sites and two paediatric hospitals (for complex needs babies) that perform neonatal hearing screening is available in Appendix A.

Parents/caregivers of eligible well and at-risk babies are invited to participate in neonatal hearing screening directly in person in the hospital by dedicated screeners.

Hearing screening should be completed within 4 weeks after birth; however, some NICU babies, particularly if premature, have screening completed within 3 months as screening would not be age-appropriate by 4 weeks.

The same hearing screening protocol is carried out across all of Ireland. Protocol states that hearing screening is contraindicated among children with bacterial meningitis, atresia, suspected or confirmed CMV, suspected or confirmed zika virus and those under palliative care.

Infants admitted to the NICU for more than 48 hours are tested with a different protocol than well-babies due to the higher incidence of hearing loss and greater likelihood of auditory neuropathy spectrum disorder among these infants. Approximately 1% of neonates are admitted to the NICU.

Data are not available regarding the prevalence of CMV or meningitis among infants or children in Ireland.

The target condition for screening for well and at-risk babies is a bilateral hearing loss of 40 dB HL or worse.

22.3.2. Neonatal diagnostic assessment

Diagnostic audiological assessments are regionalized into nine central services to ensure that each diagnostic clinician performs a sufficient number of electrophysiologial assessments.

The diagnostic assessment after neonatal hearing screening referral should be completed after 40 weeks gestational age and before 12 weeks after birth.

22.3.3. Preschool hearing screening

Screening takes place in schools in Ireland by a school or public health nurse. The target condition for school hearing screening is a hearing loss greater than 25 dB HL at 1, 2 and 4 kHz in one or both ears.

22.3.4. Intervention approach

In Ireland, treatment options available include grommets, hearing aids, bone conductive devices, cochlear implants, and Irish sign language. Parents / caregivers are offered amplification where clinically appropriate and depending upon parental consent are fitted with hearing aids within 2 weeks of diagnosis, significantly less than the 6 months of age target. Where parents have deferred the decision to aid or there has been progression of hearing loss some children may be older than 6 months of age when they receive amplification. Children with a severe / profound bilateral loss at diagnostic assessment are referred immediately to the national cochlear implant programme for consideration of implantation, whilst hearing aid fitting and initial management occurs in the community audiology services. Children are implanted typically at around 6-12 months of age or older, depending upon clinical / medical requirements

Hearing aid fitting recommendations depend on the degree of hearing loss. Guidelines are available in a document from the HSE (Integrated Audiology Programme, 2017). Specifically, amplification is recommended for infants with bilateral sensorineural hearing loss >40 dB eHL and fixed conductive hearing loss > 40 dB eHL. Immediate amplification is not recommended for mild or unilateral hearing loss or for cases of ANSD. Recommendation for amplification of bilateral high- or low-frequency sloping hearing losses depend on the threshold of individual frequencies (Integrated Audiology Programme, 2017a; Integrated Audiology Programme, 2017b)

22.4. 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

22.4.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies is summarized in Table 1, whereby a 3-step OAE - OAE - aABR protocol is in effect. The first OAE is performed in the maternity hospital after birth. If the infant does not pass the first OAE test, rescreening occurs at least 5 hours after the first test and before discharge from the maternity hospital. If the infant does not pass the second OAE attempt, an aABR is performed. If the infant does not pass the aABR, a referral to the ENT department for a diagnostic assessment is made (Health Service Executive (HSE), 2014).

Table 41: Process for neonatal hearing screening for well, healthy infants in Ireland **(Health Service Executive (HSE), 2014)**.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	<24-72 hours		Accuscreen	Yes	Maternity hospital
OAE2	24-72 hours (at least 5 hours after OAE1)		Accuscreen	Yes	Maternity hospital / Outpatient clinic
aABR	< 4-5 weeks	45 dB nHL	Accuscreen	Yes	Maternity hospital / Outpatient clinic

22.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk (NICU) infants is described in Table 2. A combined OAE+aABR protocol is in effect whereby both OAE and aABR are performed (Health Service Executive (HSE), 2014).

If the infant does not pass the OAE but passes the aABR, they are listed for targeted follow-up at 9 months of age. If the infant does not pass both the OAE and aABR, a referral is made to diagnostic audiology.

Table 42: Process for neonatal hearing screening for at-risk (NICU) infants in Ireland **(Health Service Executive (HSE), 2014)**.

Test	Age	Referral criteria	Unilateral Referrals?	Location
OAE + aABR	>37 weeks gestation (depending on health of child)	45 dB nHL	Yes	Maternity hospital / NICU

22.4.3. Preschool hearing screening

Hearing screening is performed in schools at 5 years of age. Children are conditioned to the task at 50 dB HL first as a group and individually. Pure-tone audiometry screening is performed at 25 dB HL at 1-4 kHz in both ears. If thresholds are greater than screening levels, the child does not pass initial screening. Repeat screening is performed 6-8 weeks later. If the child does not pass repeat screening, a referral is made to diagnostic audiology (Health Service Executive (HSE), 2017).

Table 43: Process for school hearing screening in Ireland (Health Service Executive (HSE), 2017).

Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone screening 1	4-5 years	Threshold >25 dB HL(1-4 kHz)	Yes	Schools (quiet room)
Pure-tone screening 2	6-8 weeks after initial screen			

22.5. Professionals

22.5.1. Neonatal hearing screening (well)

Neonatal hearing screening is performed by dedicated newborn screeners. Newborn screeners do not require specific background education. Instead, training is performed internally and includes an e-learning program and training provided by Northgate Public Services.

Training is generally carried out over a 6-week period and includes eLearning, on-the-ward training and shadowing existing screeners. An objective structured clinical examination is then undertaken and any advisory notes on screener performance are then addressed by the screener and their manager. Ongoing ward observations/support and screener stats produced through the central IT system ensure that all screeners are monitored closely on a regular basis.

22.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk (NICU) infants is also performed by dedicated trained newborn screeners. See 7.1 for details on newborn hearing screeners and training requirements.

22.5.3. Preschool hearing screening

Screening for school-age children is performed by public health nurses. Training is provided locally by HSE audiologists for 2 days, plus additional mentoring. Training is updated every two years, though performance is not monitored by HSE audiology.

23. Israel

Hearing screening representative for Israel: *Lisa Rubin, Department of Maternal and Child Health, Public Health Services, Ministry of Health, Israel.*

23.1. Background

In Israel, hearing screening is performed nationally and also organized nationally. The following report contains information with regards to hearing screening in the entire country of Israel.

23.1.1. General

The country of Israel has a total area of 20 770 km^2 and a population of 8 654 900 as of February 2017 (The State of Israel, 2018). In Israel, each birth is registered and infants are assigned an ID number. The number of live births in Israel was 181 351 in 2016.

The World Bank income classification categorizes Israel as a high-income country (The World Bank, 2018). The gross domestic product (GDP) was € 30 888 per capita in 2016 (The State of Israel, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Israel in 2015 was 2 756 USD or €2 378 per capita (World Health Organization, 2018).

Infant mortality rate in the country of Israel was 3.1 per 1000 in 2015 (United Nations Statistics Division, 2016; The State of Israel, 2018).

23.1.2. Neonatal hearing screening

In Israel, 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 babies was first implemented in 1997 locally in some hospitals, and by 2010, neonatal hearing screening was implemented nationally in all hospitals. Screening for at-risk infants began much earlier in around 1985 when premature infants were followed after discharge and underwent a hearing screen. However, pre-discharge objective screening for-risk infants also began nationally in 2010.

Neonatal hearing screening is not embedded in the Preventive Child Health Care screening performed in the well child care centres. It is embedded in the funds for births provided by the state. The National Social Security Institute distributes these funds to the maternity hospitals to cover hospital costs for performing neonatal hearing screening on all infants, including both at-risk and well-baby screening.

In Israel, the same hearing screening protocol is followed across the country.

23.1.3. Preschool hearing screening

In Israel, there is no preschool hearing screening. Hearing screening performed in first grade at the age of 6 years.

First-grade hearing screening began in Israel around the 1970s. Unlike neonatal hearing screening, first-grade screening is embedded in the general Preventive Child Health Care system. Hearing screening, as part of the total school health services programme, is funded by the state.

The same hearing screening protocol is followed across the country for the first-grade hearing screening.

23.2. Guidelines & Quality Control

National guidelines for hearing screening exists in Israel (Ministry of Health, 2018).

The content of hearing screening programme was decided on by Public Health Service with expert consultation. Revised directives were published in the beginning of 2018. The basic programme remains the same; however, revisions were made regarding the definition of high-risk infants as well as pass criteria for high-risk infants. There are no set criteria for performing revisions; however, in practice, the content of the programme is planned for revision every 7-10 years. The Public Health Service along with the National Audiologist Supervisor and expert consultants are responsible for revising the programme. Once updated guidelines are issued, training and conference sessions would be held to publicize the new recommendations.

Quality assurance of hearing screening programmes is imposed by the government. Referral rate data are calculated across hospital sites, and site visits are made to hospitals and schools. While follow-up data are not routinely collected, national surveys of age of diagnosis and entry to rehabilitation are performed, collecting information across rehabilitation units.

Annual reports are not available in Israel.

Research has been performed on hearing screening in Israel apart from auditing.

23.3. Process: Screening, Diagnosis, Intervention

23.3.1. Neonatal hearing screening

Well babies are screened in the maternity hospital, and at-risk babies are screened in the hospital nursery or a quiet room near the NICU. It is estimated that 99% of infants are born in hospitals each year and less than 1% are born at home. The minimum stay in the maternity hospital is typically 48 hours after birth, with the exception of two busy hospitals that can discharge by 36 hours. Well-baby families and families of infants at-risk are invited for screening directly in person, as screening is part of the discharge process from the hospitals.

There is no set age for when neonatal hearing screening should be completed in Israel, with the exception that screening for well and at-risk infants should be completed before discharge (i.e., in 48 hours) from the hospital.

The target condition for screening for well and at-risk babies is not specifically indicated in protocol; however, typical target condition for neonatal screening for both groups of infants is a unilateral or bilateral hearing loss of ≥ 40 dB HL.

There is a definition of high-risk infants that determines which infants are screened with the high-risk protocol, an aABR in addition to an OAE. Approximately 5% of infants are screened with the at-risk screening protocol, though this figure varies. At-risk infants are defined as those with a family history

of permanent hearing loss, the presence of a syndrome associated with hearing loss, 5 or more days in the NICU; or bilirubin levels necessitating exchange transfusion.

Furthermore, infants with risk factors are followed-up regardless of the results of the hearing screening performed in the hospital. These risk factors include those tested with the high-risk protocol and additional risk factors. There are no established deadlines regarding when this follow-up examination should occur or the percentage of infants that are followed up.

With regards to the prevalence of CMV, a study by Barkai et al. (2014) found that 56 of 9824 infants (0.56%) had a positive saliva assay. Of these, 47 were confirmed with urine rt-PCR and culture and one with confirmed maternal sero-conversion during pregnancy. Screening of CMV is not universally performed in Israel; however, it is suggested that that all infants with failed hearing screening should be tested for CMV.

23.3.2. Neonatal diagnostic assessment

Infants are referred to a diagnostic centre after neonatal hearing screening referral. Well, healthy infants without risk factor may either undergo a rescreening examination including both OAE and aABR or a full diagnostic assessment, including a clinical ABR. Infants at-risk must have a full diagnostic assessment after hearing screening referral.

There is no set protocol for testing performed during the diagnostic appointment. Confirmation of hearing impairment should be performed by 3 months of age for all babies.

23.3.3. Preschool hearing screening

Six-year old hearing screening is performed in schools (first-grade) in Israel. Children are invited to participate by the school health service provider via a letter sent to families.

The target condition for first-grade screening is a unilateral or bilateral hearing loss of ≥ 25 dB HL.

23.3.4. Intervention approach

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

The hearing aid fitting criteria Israel is a bilateral or unilateral hearing loss of greater than 20 dB HL average hearing threshold across a 4-frequency pure-tone threshold of 500, 1000, 2000 and 4000 Hz.

23.4. 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

23.4.1. Neonatal hearing screening (well)

The neonatal hearing screening programme in Israel for well babies described includes two or three screening tests before discharge from the maternity hospital. The first test (OAE) is performed at least 24 hours after birth, and the second test (aABR) is performed before discharge for infants that do not pass the OAE. As indicated, it is roughly estimated that discharge is at least 48 hours after birth for most hospitals, with the exception of two busy hospitals where discharge may be after 36 hours. There is variation across hospitals as to when the OAE test is performed, and whether it is repeated at a later time before attempting aABR.

Table 44: Screening process for well babies in Israel.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE*	24-72 hours	Various	Various	Yes	Maternity hospital
aABR	Before discharge	Various		Yes	Maternity hospital

*OAE can either be DPOAE or TEOAE and conducted one or two times before aABR is performed.

23.4.2. Neonatal hearing screening (at-risk)

The neonatal hearing screening programme in Israel for at-risk babies is described in Table 2. Both OAE and aABR are performed on infants considered at-risk. Prior to a 2018 revision to protocol, only the results of the aABR determined a referral to diagnostic assessment. The current protocol requires a passing result for both OAE and aABR screening, or a referral to a diagnostic assessment is warranted.

Table 45: Screening process for at-risk babies in Israel.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE +aABR	Before discharge (usually 36 weeks gestation)	Various	Various	Yes	Quiet room near NICU / Nursery

23.4.3. Preschool hearing screening

Table 46: Screening process for first-grade children in Israel.

Test	Age	Referral criteria	Location
Pure-tone sweep	6-years	25 dB HL at 500 Hz & 20 dB HL at 1, 2 and 4 kHz	School

23.5. Professionals

23.5.1. Neonatal hearing screening (well)

OAE screening for well babies is performed by medical technicians, audiologists or specially trained employees; aABR screening is performed by audiologists or medical technicians in the maternity hospitals.

There is a recommended syllabus and 2-day on-the-job supervision for training new hearing screening staff; however, training is not formally accredited. An online training manual is currently in progress.

23.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by medical technicians or audiologists.

23.5.3. Preschool hearing screening

Screening first-grade children is performed by nurses or audiologists.

24. Italy (Veneto Region)

Hearing screening representative for Italy (Veneto Region): *Alessandro Martini, ENT Clinic, Padua Hospital, University of Padua.*

24.1. Background

In Italy, hearing screening is performed and organized regionally. The first universal program for well and at-risk infants in Italy was implemented in 2003, though it is not yet conducted across the entire country. The majority of regions in Italy have universal neonatal hearing screening established; however, some regions do not yet have complete coverage, including Sicily, Calabria, Basilicata, Puglia, Sardinia, Abruzzo, Lazio and Trentino-Alto Adige.

The following report contains information with regards to hearing screening in the region of Veneto.

24.1.1. General

The Region of Veneto has a total area of 18,345 km^2 with a population of 4 903 722 in 2017. In Veneto Region, all births are registered. The number of births is 36 587 per year, from 2017 data (UrbiStat, 2019).

The World Bank income classification categorizes Italy as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2017 in Veneto Region was €30 710 per capita (Statista, 2019).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for all of Italy in 2015 was 2 709 USD or €2 421 per capita (World Health Organization (WHO), 2018).

Data acquired from the 2016 United Nations Demographic Yearbook indicates an infant mortality rate of 2.9 per 1000 for the country of Italy in 2015 (United Nations Statistical Division, 2016)

24.1.2. Neonatal hearing screening

In the region of Veneto, neonatal hearing screening is conducted universally, with all babies in the region having access to hearing screening, as it is embedded in the Preventive Child Health Care screening system in Veneto. It is not obligatory, however, for parents to participate in neonatal screening. Screening is funded by the region as well as by parents. More specifically, the first step of screening is funded by the public health care system. Screening of step 2 is funded by the state when the screening occurs at the same maternity hospital as step 1. Otherwise, the cost of must be covered by the parents. The Regional decree indicates that screening should be free for all families, but this is not yet practically applied.

In Veneto, a different hearing screening protocol will soon be used compared to most other regions across the country. A recent change in protocol states that all infants in Veneto are to undergo one aABR screen instead of a multistage OAE protocol. With NICU babies, a combined OAE+aABR is recommended across Italy, while in Veneto the protocol has recently changed to only aABR.

24.1.3. Preschool hearing screening

In Veneto, there is no preschool hearing screening programme. The majority of regions in Italy do not perform preschool hearing screening.

24.2. Guidelines & Quality Control

National guidelines for hearing screening are available, as well as regional decrees for the region of Veneto specifying explicit guidelines for the region (Official Bulletin of the Region of Veneto, 2018).

It was not indicated who had decided on the contents of the screening programme. The content of the screening programme has recently changed. Since 2015, hearing screening has become embedded into the mandatory medical services available for newborns, and in 2018 it was decided to adjust the protocol so that aABR is the single test used for all infants in Veneto.

A review of the hearing screening programme typically takes place every 1-3 years, depending on the region, though quality assurance of hearing screening programmes is not imposed by the government.

Information about the outcome of hearing screening is not collected across the entire region of Veneto. While the Regional decree indicates that monitoring of outcomes should be performed, this is not yet in practice. Currently, outcomes are only monitored at individual birth centres.

Annual reports are not available on a regional or national level. In Veneto region, each birth centre formulates their own annual report.

Research has been performed on hearing screening in Italy apart from auditing.

24.3. Process: Screening, Diagnosis, Intervention

24.3.1. Neonatal hearing screening

Well-babies are screened in the maternity hospital or child health care centre, and at-risk babies are screened in the hospital. Well-baby families and families of infants at-risk are invited for screening directly in person by health care professionals in the hospital. It is estimated that 99% of infants are born in maternity hospitals where the average length of stay after delivery is 2-3 days.

Hearing screening for both well and at-risk infants should be completed by 3 months of age. The goal is that a diagnostic assessment can begin by 3-months of age.

The target condition for screening for well- and at-risk babies is bilateral or unilateral hearing loss of > 35 dB HL.

In Veneto, 9% of infants are considered at-risk, as having one of the risk factors indicated by the Joint Committee of Infant Hearing (Joint Committee on Infant Hearing, 2007). Infants admitted into the NICU are screened with a different protocol than well babies because of the higher risk of being affected by auditory neuropathy / auditory dyssynchrony). They are included in a follow-up programme with one or two tests per year, depending on the risk factor. Well babies with at least one risk factor for hearing impairment undergo the well-baby screening protocol, but are followed up by 6

months (aABR screening) and 18 months of age (full assessment). Infants positive for CMV are referred for diagnostic ABR assessment, regardless of the results of the screening test.

The prevalence of CMV in Italy varies between 0.15% and 0.51% as indicated by the Portal of Epidemiology for Public Health (National Center for Disease Prevention and Health Promotion , 2019).

The incidence of meningitis in Italy can be divided into meningitis by Neisseria meningitides (4.8 per 100 000 infants < 1 year old), meningitis by Streptococcus pneumoniae (5 per 100 000 infants < 1 year old), and meningitis by Haemophilus influenza (3.75 per 100 000 infants < 1 year old). Specifically, for the Veneto region in 2016, the incidence of meningitis by Neisseria meningitidis for children 0-4 years of age was 1.7 per 100 000 children, the incidence of meningitis by Streptococcus pneumoniae was 8.63 per 100 000 infants < 1 year old, and the incidence of meningitis by Haemophilus influenza was 7.67 per 100 000 infants < 1 year old (National Institute of Health, 2017).

24.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests performed after neonatal hearing screening referral are auditory brainstem response testing, as well as tympanometry, DPOAE, and a medical (ENT or audiologist) examination. Diagnostic testing should be performed by 3 months of age (or corrected age) for well and at-risk babies.

24.3.3. Preschool hearing screening

Not applicable.

24.3.4. Intervention approach

In Italy, treatment options available include hearing aids, bone conductive devices and cochlear implants. Infants are fitted with hearing aids from <6 months of age and cochlear implants from 6-12 months of age or older.

The hearing aid fitting criteria in Veneto region is a bilateral or unilateral hearing loss of >30 dB HL.

24.4. 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

24.4.1. Neonatal hearing screening (well)

The neonatal hearing screening protocol in the Region of Veneto for well infants is currently a 3-step OAE-OAE-aABR protocol. This is the protocol that is performed predominantly across Italy. However, recently (Spring 2018) a Regional Decree was published indicating that the protocol will be changed. Instead, a one stage aABR protocol will be performed on all infants (Official Bulletin of the Region of Veneto, 2018).

Table 47: Screening process for well babies in Veneto Region, Italy.

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location
OAE1	24-72 hours	8x peaks of alternating-signs	Accuscreen PRO	Yes	Maternity hospital
OAE2	1 month		Accuscreen PRO	Yes	Maternity hospital
aABR	(same session as OAE2)	35 dB nHL	Accuscreen PRO	Yes	Maternity hospital

24.4.2. Neonatal hearing screening (at-risk)

Table 2 describes the 2-step OAE+aABR screening protocol currently used in Veneto Region of Italy. As with well infants, the 2018 Regional Decree (Official Bulletin of the Region of Veneto, 2018) is also relevant for NICU infants, whereby one aABR will soon be performed instead of the current multi-stage screening approach.

Table 48: Screening process for at-risk babies in Veneto Region, Italy.

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location
OAE+aABR1	36-42 weeks; depends on health of newborn	35 dB nHL	Accuscreen Pro	Yes	NICU
OAE+aABR2	1 month	35 dB nHL		Yes	Hospital Clinic / NICU

24.4.3. Preschool hearing screening

Not applicable.

24.5. Professionals

24.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses.

Screening staff, both doctors and nurses, are trained on hearing screening via a 6-hour course for nurses and an 8-hour course for doctors. Training is certified and updated every 1-3 years.

24.5.2. Neonatal hearing screening (at-risk)

Screening for NICU infants is performed by audiometric technicians or audiologist physicians. See 7.2 for training requirements.

24.5.3. Preschool hearing screening

Not applicable.

25. Kosovo

Hearing screening representatives for Kosovo: *Dugagjin Spanca, University Clinical Center of Kosovo, ENT Clinic.*

General information acquired from answers by*: Naser Salihu, University Clinical Center of Kosovo, Eye Clinic.*

25.1. Background

In Kosovo, there are no childhood hearing screening programmes. The following report contains information with regards to childhood hearing screening in the entire country of Kosovo.

25.1.1. General

Kosovo has a total area of 10 905 km^2 with a population of 1 783 531 million in 2016 (Kosovo Agency for Statistics, 2018).

In Kosovo, all births are registered in the civil state office where the baby is born. The number of live births in Kosovo in 2016 was 23 416 (Kosovo Agency for Statistics, 2018).

The World Bank income classification categorizes Kosovo as an lower middle-income country (The World Bank, 2018). The gross domestic product (GDP) was €3386 per capita in 2016 (Kosovo Agency for Statistics, 2018).

Data for Kosovo are not available from the World Health Organization (WHO) Global Health Expenditure Database (2018); however, health expenditure for Kosovo in 2015 was 164.8 million euros, which equates to approximately €92 per capita (Kosovo Agency for Statistics, 2018).

Data on infant mortality rate for Kosovo are not published by the United Nations Statistics Division (2016); however, data from the Kosovo Agency for Statistics (2018) indicate that 238 infants died in 2015, and as 24 594 born that year, an infant mortality rate can be estimated to be 9.4 per 1000 live births.

25.1.2. Neonatal hearing screening

In Kosovo, there is no neonatal hearing screening programme. Parents may seek out hearing screening services from private clinics, and payment would then also be provided by the parents for this service. It may be recommended to parents to seek private services if their child is at risk for hearing loss; however, it is not obligatory for parents to have their child's hearing screened.

Neonatal hearing screening is not embedded in the Preventive Child Health Care screening system. As indicated, any screening performed would be funded directly by the parents.

National guidelines or a national screening protocol are not yet available in Kosovo.

25.1.3. Preschool hearing screening

There is no preschool hearing screening programme in Kosovo. A teacher may recommend to a parent to have their child's hearing screened if they notice a potential problem; however, the parents must seek out these services privately and pay out-of-pocket.

25.2. Guidelines & Quality Control

National guidelines for hearing screening do not exist in Kosovo.

A hearing screening programme has not yet been implemented. A project for neonatal hearing screening was submitted to the Ministry of Health by the University Clinical Center of Kosovo and is awaiting approval.

Quality assurance of hearing screening programmes is not imposed by the government. Information on cases of hearing loss is collected locally by the Audiology Department at the University Clinical Center of Kosovo (tertiary centre); however, the government does not yet collect screening data or publish reports.

25.3. Process: Screening, Diagnosis, Intervention

25.3.1. Neonatal hearing screening

At the request of parents, well-babies and at-risk babies are screened in private clinics. There are two private clinics that perform hearing screening.

In 2016, 99.7% of births took place in a maternity hospital, where the average length of stay after delivery is estimated to be 3-5 days. It is roughly estimated that home deliveries account for the other 0.3% of births (Kosovo Agency of Statistics, 2017).

Parents/caregivers of well and at-risk babies are not invited to participate in neonatal hearing screening, but may be recommended to have their child's hearing screened privately depending on the presence of a risk factor.

There is no age by which hearing should be screened.

At-risk infants are defined as those with a positive family history of hearing loss, who were admitted to the NICU, born prematurely (less than 37 weeks), with a birth weight <1000 g, with multiple malformations, or with meningitis.

Data on the prevalence of CMV or meningitis are not available in Kosovo.

There is no target condition for screening well- or at-risk babies.

25.3.2. Neonatal diagnostic assessment

For infants that are screened and referred to the Audiology department in the public hospital, ABR is performed. ABRs are performed after 6 months of age.

25.3.3. Preschool hearing screening

There is no preschool hearing screening in Kosovo.

25.3.4. Intervention approach

In Kosovo, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids and cochlear implants from 1-2 years of age or

older. Because of the lack of universal screening, most hearing aid fittings are on children age 3-4 years. For cochlear implantation, it is preferred that children are under 2 years of age in order to gain optimal development; however, children are implanted up to the age of 5 years.

There are no official criteria for hearing aid fittings; however, it is preferred that children have a bilateral hearing loss of at least 30 dB HL in the better ear. Hearing aids for unilateral hearing loss are often refused by parents due to an associated social stigma with hearing aids.

25.4. 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

25.4.1. Neonatal hearing screening (well)

There is no official protocol for screening well babies. Screening at private clinics is done with OAEs.

25.4.2. Neonatal hearing screening (at-risk)

There is no official protocol for screening at-risk babies. Screening at private clinics is done with OAEs.

25.4.3. Preschool hearing screening

There is no preschool hearing screening programme in Kosovo.

25.5. Professionals

25.5.1. Neonatal hearing screening (well)

There are two private clinics that perform neonatal hearing screening. At these two clinics, ENT physicians perform the test.

There is no specific training for hearing screening staff. Previously, one ENT physician and one nurse were sent abroad to participate in a 3-month course on neonatal hearing screening.

25.5.2. Neonatal hearing screening (at-risk)

There are two private clinics that perform neonatal hearing screening. At these two clinics, ENT physicians perform the test. (see 7.1 for training details).

25.5.3. Preschool hearing screening

Not applicable.

26. Latvia

Hearing screening representatives for Latvia: *Māreta Audere, Latvian Children Hearing Center & Antra Valdmane, Ministry of Health.*

General information acquired from answers by*: Antra Valdmane, Ministry of Health.*

26.1. Background

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

26.1.1. General

Latvia has a total area of 64,589 km^2 with a population of 1.95 million in 2017 (Central Statistical Bureau, 2018).

In Latvia, all births are registered in two locations, the Medical Birth Register (a perinatal database) and the Population Register through the Office of Citizenship and Migration Affairs (an administrative database). The number of live births in Latvia in 2016 was 21646 (Centre for Disease Prevention and Control (CDPC) of Latvia, 2017).

The World Bank income classification categorizes Latvia as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2016 was € 12691 per capita in Latvia (Central Statistical Bureau, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Latvia in 2015 was 784 USD or €689 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 3.7 per 1000 is reported for Latvia by Centre for Disease Prevention and Control (CDPC) of Latvia for 2016 (2017) , and data from the World Health Organization cites an infant mortality rate of 4.1 per 1000 for 2015, with a higher mortality rate in rural areas (4.5 per 1000) compared to urban areas (3.9 per 1000; World Health Organization (WHO), 2018).

26.1.2. Neonatal hearing screening

In Latvia, 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 2007 and implemented across the entire country from the onset.

Neonatal hearing screening is embedded in the Preventive Child Health Care screening system (The National Health Service, 2018). Screening for well and at-risk infants is funded by the state.

National guidelines are available in the legal document, The Provision of Childbirth Assistance which stipulates that hearing screening is to be performed during early neonatal care (Cabinet of Ministers, 2006). This law also stipulates a protocol that is followed across the entire country.

26.1.3. Preschool hearing screening

Preschool hearing screening is conducted universally in Latvia as part of the routine check-up prior to school entry. It is embedded in the Preventive Child Health Care screening system and is funded by the state. The exact date of when preschool hearing screening began is not known; however routine examination of hearing during childhood has been performed since the implementation of the preventative care programme.

26.2. Guidelines & Quality Control

National guidelines for hearing screening exist in Latvia by law in a document outlining the standard of maternal and neonatal care. These guidelines describe a short protocol for neonatal hearing screening, which is followed across Latvia.

Quality assurance of hearing screening programs is not imposed by the government; however, data are collected by the National Health Service. A united information database is available where all information about outpatient and inpatient services is collected. The Ministry of Health does not collect data about neonatal hearing screening nor produce annual reports; however, the Centre for Disease Prevention and Control (CDPC) provides annual reports on general information regarding newborns and deliveries. These annual reports do not, however, include hearing screening data.

26.3. Process: Screening, Diagnosis, Intervention

26.3.1. Neonatal hearing screening

Well-babies and at-risk babies are screened in the hospital or child health centre. In 2016, 98.4% of births take place in the maternity hospital, where the average length of stay after delivery is 3.7 days (Centre for Disease Prevention and Control (CDPC) of Latvia, 2016; 2017). Planned home deliveries accounted for 1.2 % of births in 2016 (Centre for Disease Prevention and Control (CDPC) of Latvia, 2017). Parents/caregivers of well and at-risk babies are invited to participate in neonatal hearing screening directly in person at the hospital.

Neonatal hearing screening for well and at-risk babies should be completed before 3 months of age.

At-risk infants are defined as those with a birth weight less than 1.5 kg or prematurity less than 37 weeks; however, in Latvia all infants (well or at-risk) are screened using the same protocol. There is no specific “at-risk” protocol.

Data on the prevalence of CMV is not available in Latvia. The prevalence of meningitis on children (0-17 years) is 0.3 per 100 000.

The target condition for screening for well- and at-risk babies is a hearing loss of 40 dB or worse.

26.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral includes an OAE test to confirm screening results, and if confirmed, an objective audiometry test (Cabinet of Ministers, 2006), such as ABR or ASSR. The diagnostic assessment should be completed by 3 months of age. All diagnostics follow-up assessments are performed at the Latvian Children’s Hearing Center in Riga.

26.3.3. Preschool hearing screening

Preschool hearing screening is performed at the child health clinic /physician as part of routine examination or at the Latvian Children's Hearing Center in Riga. Children and parents are invited to participate via a discussion at the family physician's office. Testing is performed by the family doctor, or by an otolaryngologist when indicated.

The target condition for preschool hearing screening is a bilateral hearing loss of 25 dB or worse.

26.3.4. Intervention approach

In Latvia, treatment options available include grommets, hearing aids, bone conductive devices, cochlear implants, as well as various assistive devices and FM systems. Infants are fitted with hearing aids from <6 months of age or older or as soon a hearing loss is identified. Infants are fitted with cochlear implants from 6 months of age or older.

The fitting criteria in Latvia for a hearing aid is bilateral hearing loss of at least 25 dB in the better ear (Latvian Association of the Deaf (LAD), 2018).

26.4. 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

26.4.1. 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 before discharge. If the infant fails the first test, rescreening occurs at 1 month of age at the Latvian Children's Hearing Center in Riga. A subsequent fail at age 1-month would warrant a follow-up diagnostic assessment at 3-months of age, also at the Latvian Children's Hearing Center in Riga.

Table 49: Process for neonatal hearing screening in Latvia.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	3-5 days		GSI 70, GSI Corti	Yes	Maternity hospital

OAE2	1 month	Locked: 4 dB SNR for 3 of 6 freqs (1.5 – 4 kHz)	GSI 70, GSI Corti	Yes	Latvian Children's Hearing Center

26.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk infants is identical to screening well infants. See 4.1 for the protocol.

26.4.3. Preschool hearing screening

Preschool hearing screening is performed during a routine childhood check-up at 5-6 years of age. Pure-tone audiometry and speech audiometry is performed in the physician's office, or in special cases at the otolaryngologist or Latvian Children's Hearing Centre.

Table 50: Process for preschool hearing screening in Latvia.

Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone audiometry + Speech audiometry	5-6 yrs	Threshold >20 dB	Yes	Physician / [Otolaryngologist, Latvian Children's Hearing Centre]

26.5. Professionals

26.5.1. Neonatal hearing screening (well)

Screening is performed by trained nurses or otolaryngologists.

Training involves a full day (approximately 8 hours) of education. This training is certified and regularly updated. The training is provided by the OAE device company and is updated when a new device is introduced. All medical personnel, including nurses, are certified through this training and must renew their certificate after a certain period.

26.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by pediatric nurses or doctors (see 7.1 for training requirements).

26.5.3. Preschool hearing screening

Screening for preschool-age children is performed by a general physician or otolaryngologist.

27. Lithuania

Hearing screening representative for Lithuania: *Nijole Drazdiene, Vilnius University, Faculty of Medicine, Institute of Clinical Medicine.*

27.1. Background

In Lithuania, hearing screening is organized nationally.

The following report contains information with regards to hearing screening in the entire country of Lithuania.

27.1.1. General

Lithuania has a total area of 65 300 km^2 and a population of 2 819 753 as of 2016. The birthrate in Lithuania was 30 623 in 2016 (Lithuanian Department of Statistics, 2018).

The World Bank income classification categorizes Lithuania as a high-income country (The World Bank, 2018). The gross domestic product (GDP) is €3653.2 per capita (Lithuanian Department of Statistics, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Lithuania in 2015 was 923 USD or €795 per capita (World Health Organization, 2018).

In Lithuania, each birth is registered with the Information Society Development Committee according to law. Data acquired from the 2016 United Nations Demographic Yearbook and from the Lithuanian Department of Statistics (2018) indicate an infant mortality rate of 4.2 per 1000 for the country of Lithuania in 2015, a rate of 4.3 per 1000 in urban areas and 4.0 per 1000 in rural areas (United Nations Statistics Division, 2016). Infant mortality rate was 4.5 in 2016 (Lithuanian Department of Statistics, 2018).

27.1.2. Neonatal hearing screening

In Lithuania, 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 programme for well and at-risk babies was first implemented in 1998 through an initiative led by neonatologists and hearing specialists in the country, and by 2014, neonatal hearing screening was available across the country. Neonatal hearing screening is embedded in the Preventive Child Health Care screening system. Today, screening is funded through the Health Insurance and organized by the Ministry of Health.

There are no regional differences in Lithuania with regards to the protocol used for screening either well babies and at-risk babies.

27.1.3. Preschool hearing screening

In Lithuania, preschool hearing screening is not performed.

27.2. Guidelines & Quality Control

National guidelines for hearing screening exists in Lithuania together with a national protocol (Ministry of Health, Republic of Lithuania, 2013).

The content of hearing screening programme was decided on by the Ministry of Health, a professional body of ENT specialists, specialists for children's health care, and the public health organization. The content of the programme has not been changed since its start and there is no revision process in place.

Quality assurance of hearing screening programmes is not imposed by the government; however, information is collected about hearing screening outcomes through auditing. Through the Health Information Centre in the Institute of Hygiene of the Ministry of Health, data are aggregated across maternity hospitals in Lithuania on hearing screening results. These data include all groups of infants, including well, healthy babies, premature infants, infants with risk factors, and infants admitted to the NICU. However, these data contain only screening results; follow-up results are not collected in this centralized database, and therefore, these data cannot be used for monitoring the effectiveness of the hearing screening protocol.

Annual reports are not published; however, as indicated, screening data from maternity hospitals are reviewed by the Ministry of Health and the Perinatology Integrated Healthcare Management Committee. Findings from each review are discussed among neonatal hearing screening professionals and shared with the maternity hospitals.

Data are unavailable on whether research has been performed on hearing screening in Lithuania apart from auditing.

27.3. Process: Screening, Diagnosis, Intervention

27.3.1. Neonatal hearing screening

In Lithuania, well babies and at-risk babies are screened in the hospital, where the average length of stay is estimated to be 2-3 days. If the infant was not born in a hospital, the family physician is responsible for referring the infant to a health care centre or private clinic where screening can be performed. It is estimated that up to 0.7% of infants are born at home. Well-baby and at-risk families are invited to participate in neonatal screening by pediatricians. Parents are informed of the importance of screening and provided written information in the form of a leaflet.

Neonatal hearing screening for both well- and at-risk babies should be completed before 3 months of age. If for any reason an infant is not screened directly in the maternity ward, this initial screen should take place within 28 days.

The target condition for screening for well- and at-risk babies is a unilateral or bilateral hearing loss of ≥25 dB HL.

In Lithuania, there are no differences in screening protocol between well and at-risk babies. However, for approximately 5% of infants, their health condition, risk factors and gestational age are considered when performing newborn hearing screening.

At-risk infants are defined as those with a family history of permanent childhood hearing impairment, maternal infections during pregnancy or delivery (e.g., toxoplasmosis, syphilis, HIV, hepatitis B, rubella, CMV, herpes simplex), physical problems of the head, face, ears or neck (e.g. cleft lip/palate, ear pits/tags, atresia), ototoxic medications given in the neonatal period, syndromes associated with hearing loss (Pendred, Usher, Waardenburg, neurofibromatosis), admission to the neonatal intensive care unit for > 5 days, prematurity < 37 weeks, or hyperbilirubinemia.

Approximately 5.8% of infants are born prematurely and approximately 1.8% of neonates are admitted to NICUs or hospitals other than maternity hospitals. The prevalence of CMV infections among neonates or meningitis is unknown.

27.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests performed after neonatal hearing screening referral are an ABR and ASSR test, which should be completed by 6 months of age.

27.3.3. Preschool hearing screening

Not applicable.

27.3.4. Intervention approach

In Lithuania, treatment options available include grommets, hearing aids, bone conductive devices and cochlear implants. Infants are fitted with hearing aids from less than 6 months of age to 12 months of age. They are fitted with cochlear implants from 6 months of age to 2 years of age.

The hearing aid fitting criteria in Lithuania is a bilateral hearing loss of >30 dB HL.

27.4. Hearing Screening 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

27.4.1. Neonatal hearing screening (well)

The neonatal hearing screening programme in Lithuania for well babies without risk factors is a two-step OAE protocol. The first step typically occurs before discharge from the maternity ward and a re-screening test occurs at the hearing centre no more than 3 months after birth.

The first step is typically performed before discharge from the maternity ward; however, if screening was not performed before discharge or the infant was born outside of the maternity centre, then OAE1 can be performed in another institution (usually the hearing centre) no later than 28 days after discharge. Re-screening (step 2) is performed at the hearing centre in cases of a "no pass" result for OAE, no later than 3 months after birth.

Table 51: Screening process for well babies in Lithuania.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1*	24-72 hours†	4 dB SNR for 3/6 freq (Interacoustics, 2017)	Otoread	Yes	Maternity hospital
OAE2	< 3 months			Yes	Hearing centre

* A second OAE may be performed in the maternity hospital before discharge if the results indicate a noisy recording or if the baby is not settled. Otherwise, only one OAE is performed before discharge.
† Infants are routinely screened in the maternity hospital at 24-72 hours; however, screening can also occur at outpatient clinics around the age of 3-5 days (and no later than 28 days) if screening was not performed before discharge or if the infant was born outside of the hospital.

27.4.2. Neonatal hearing screening (at-risk)

The screening process for infants considered at risk is identical to the process for well, healthy babies, with the exception that infants with risk factors that pass the OAE will be referred for a diagnostic assessment using behavioural measures at the age of 6-12 months.

27.4.3. Preschool hearing screening

Not applicable.

27.5. Professionals

27.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses, midwives, neonatologists and/or pediatricians. Newborns not screened in the hospital will be referred by their family physician to an ENT clinic where ENT physicians or hearing specialists will screen hearing. Training is provided across 2 to 5 days in two parts, theoretical and practical, with the practical component taking place in the workplace.

27.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is typically performed by nurses, though neonatologists and pediatricians are responsible for screening supervision. Practical training occurs in the workplace for these professionals.

27.5.3. Preschool hearing screening

Not applicable

28. Luxembourg

Hearing screening representatives for Luxembourg: *Jean-Marc Hild, Service Audiophonologique.*

General information acquired from answers by*: Jean-Marc Hild, Service Audiophonologique.*

28.1. Background

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

28.1.1. General

Luxembourg has a total area of 2586 km^2 with a population of 590 700 in 2017 (STATEC, 2018).

In Luxembourg, all births are registered to the Ministry of Health. The number of live births in Luxembourg in 2017 was 7128 (Ministry of Health, 2018).

The World Bank income classification categorizes Luxembourg as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2017 was €92 600 per capita in Luxembourg (STATEC, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Luxembourg in 2015 was 6236 USD or €5470 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 4.13 per 1000 is reported for Luxembourg in 2016 (Ministry of Health, 2018). The United Nations Statistics Division does not report a mortality rate given the low number of infants born in Luxembourg each year; 17 infant deaths were reported in 2015 (United Nations Statistics Division, 2016).

28.1.2. Neonatal hearing screening

In Luxembourg, 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 using behavioural measures started and was fully implemented in 1970 and moved from birth to 6-months of age around 1983. In 2000, screening using objective measures (TEOAE) was introduced and screening was moved to the neonatal period (2-3 days of age). Finally, screening using aABR was introduced in 2012 for at-risk babies.

Neonatal hearing screening is funded through the state, though it is not embedded in the Preventive Child Health Care screening system. Neonatal hearing screening is organized by the Ministry of Health and performed by the Service Audiophonologique.

National guidelines are available as is a screening protocol used across the country. Across Luxembourg, the same protocol is followed for performing hearing screening.

28.1.3. Preschool hearing screening

Preschool hearing screening is conducted universally in Luxembourg. It is not embedded in the Preventive Child Health Care screening system though is funded by the state. Preschool hearing screening started and was fully implemented in 1974. It is organized by the Ministry of Health and performed by the Service Audiophonologique.

28.2. Guidelines & Quality Control

There are national guidelines for hearing screening in Luxembourg.

The content of the general hearing screening programme was decided on by the Ministry of Health, and there have been some changes since its initiation. The most recent change was the implementation of aABR for at-risk babies in 2012.

Quality assurance of hearing screening programmes is not imposed by the government; however, information is collected directly by the government service doing the screening (neonatal and preschool). In Luxembourg, all neonatal hearing screening is performed by the Service Audiophonologique, and data are collected in their internal database. Annual reports are available, produced by the Ministry of Health (e.g., Ministry of Health, 2018); however, data are not separated for well and at-risk infants.

There have not been any studies on hearing screening programmes in Luxembourg, nor has there been research performed on the effectiveness of screening in Luxembourg.

28.3. Process: Screening, Diagnosis, Intervention

28.3.1. Neonatal hearing screening

Well babies and at-risk babies are screened in the hospital or NICU. The percentage of infants born in a maternity hospital in Luxembourg is 98%, but the average length of stay in the hospital after delivery is unknown. Parents/caregivers of well and at-risk babies are invited to participate in neonatal hearing screening directly in the maternity hospital or via a letter if missed in the hospital.

Neonatal hearing screening for well babies should be completed before 4 weeks of age if not completed in the maternity hospital, or before 3 months of age if born outside the maternity hospitals. For at-risk babies, screening should be completed before discharge from the hospital or by 3 months of age.

At-risk infants are defined as those with low birth weight, prematurity, family history of hearing loss, gestational infections such as CMV, toxoplasmosis, or measles, history of drug abuse, low APGAR score, craniofacial anomalies, admission to the NICU for more than 5 days, anoxia, meningitis, or the use of ototoxic medications. These infants are screened with a different protocol due to the increased risk of retrocochlear hearing loss.

Data on the prevalence of CMV or meningitis is not available in Luxembourg.

The target condition for screening for well babies is hearing loss of 35 dB HL or worse and for at-risk babies is a hearing loss of 40 dB HL or worse. The target condition is defined based on the device used for screening.

28.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral should be completed by 6 months of age for well infants, and 4-6 months of age for at-risk infants.

28.3.3. Preschool hearing screening

Preschool hearing screening is performed in the kindergarten schools, and children are invited to participate directly by the Ministry of Health in the kindergartens. Testing is performed by a speech-language pathologist.

The target condition for preschool hearing screening is a hearing loss of 20 dB HL or worse.

28.3.4. Intervention approach

In Luxembourg, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids and cochlear implants from less than 6 months of age or older.

The fitting criteria in Luxembourg for a hearing aid is hearing loss of at least 30 dB HL in two or more frequencies from 500 to 3000 Hz, or a 10 dB HL or 10% reduction in speech audiometry with the addition of noise.

28.4. 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

28.4.1. 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 2nd day of life. If the infant fails the first step, rescreening occurs either before discharge on day 3 or at 1 month of age if the infant is discharged from the hospital before day 3. Infants that miss screening in the

maternity hospital are also referred directly to step 2 screening. A subsequent fail at step 2 screening would warrant a referral to the ENT department for a diagnostic assessment.

Table 52: Process for neonatal hearing screening for well, healthy infants in Luxembourg.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1*	24-72 hours		Madsen Accuscreen	Yes	Maternity hospital
OAE2	3 days / 1 month			Yes	Maternity hospital

* Although OAE1 is performed in the maternity ward, all infants that *miss* screening in the maternity ward are automatically referred to step 2 (OAE2) of the screening protocol. Therefore, these infants that miss OAE1 are only screened once before a referral to a diagnostic assessment.

28.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk infants is described in Table 2. A two-step process is in effect where aABR is performed during both initial screening and rescreening. Similar to well babies, infants that miss screening in the hospital are referred directly to aABR2 for screening.

Table 53: Process for neonatal hearing screening for at-risk infants in Luxembourg.

Test	Age	Referral criteria	Unilateral Referrals?	Location
aABR1*	24-72 hours	35 dB nHL	Yes	Maternity hospital / NICU
aABR2	Before discharge / 1 month	35 dB nHL	Yes	Maternity hospital / NICU

* Although aABR1 is performed in the maternity ward/NICU, all infants that *miss* initial screening are automatically referred to step 2 (aABR2) of the screening protocol. Therefore, these infants that miss aABR1 are only screened once before a referral to a diagnostic assessment

28.4.3. Preschool hearing screening

Hearing screening is performed in kindergartens at 5-6 years of age. Pure-tone audiometry with headphones is performed at 20 dB HL in the kindergartens. If thresholds are greater than 20 dB HL, a retest is performed. If thresholds are still greater than 20 dB HL, a referral is made to the ENT clinic.

Table 54: Process for preschool hearing screening in Luxembourg.

Test	Age	Referral criteria	Location
Pure-tone audiometry1	5-6 years	Threshold >20 dB HL	Kindergarten
Pure-tone audiometry2	5-6 years	Threshold >20 dB HL	Kindergarten

28.5. Professionals

28.5.1. Neonatal hearing screening (well)

Neonatal hearing screening is performed by speech-language pathologists and audiologists.

There is no specific training for hearing screening staff.

28.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by speech-language pathologists and audiologists.

28.5.3. Preschool hearing screening

Screening for preschool-age children is performed by speech-language pathologists.

29. Malawi

***Hearing screening representatives for Malawi**: Wakisa Mulwafu, College of Medicine, University of Malawi.*

***General information acquired from answers by**: Wakisa Mulwafu, College of Medicine, University of Malawi.*

29.1. Background

In Malawi, hearing screening is organized locally in hospitals and schools. The following report contains information with regards to childhood hearing screening across Malawi.

29.1.1. General

The country of Malawi has an area of 118 484 km^2 and with an estimated population of 16 310 000 in 2015 and 19 196 246 as of 2017. (CountrySTAT Malawi, 2019).

In Malawi, it is estimated that all births are registered. The number of live births in Malawi is an estimated 663 000 per year (United Nations Population Fund, 2011).

The World Bank income classification categorizes Malawi as a low-income country (The World Bank, 2018). The gross domestic product (GDP) in 2015 was €195 per capita in 2008 (CountrySTAT Malawi, 2019).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Malawi in 2015 was 34 USD or €30 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 69 per 1000 was reported in 2009 (WHO Regional Office for Africa., 2010) which has decreased to an estimated 38.5 per 1000 for 2017 (Statistica, 2019).

29.1.2. Neonatal hearing screening

In Malawi, neonatal hearing screening is not conducted universally, as only selected, targeted infants are offered hearing screening. It is also not offered in all hospitals in Malawi due to lack of resources, and participation is not obligatory.

Hearing screening that exists in Malawi started in 2015-2016.

29.1.3. Preschool hearing screening

There is no preschool hearing screening in Malawi.

29.2. Guidelines & Quality Control

There are no guidelines for hearing screening in Malawi, nor is there a dedicated protocol.

Audiologists and ENT specialists decide on how to perform neonatal hearing screening.

Quality assurance of the neonatal hearing screening programme is not imposed by the government, though data on screening outcome are collected in hospital files. Annual reporting is not performed.

Research has not been performed on neonatal hearing screening in Malawi, nor have there been studies published on the effectiveness of hearing screening in Malawi.

29.3. Process: Screening, Diagnosis, Intervention

29.3.1. Neonatal hearing screening

At-risk/NICU infants are screened in the hospital in the audiology clinic and invited to participate directly in person in the hospital. The percentage of infants are born in a hospital or at home is unknown. The average length of stay in a hospital after delivery is unknown.

It is not known by what age hearing screening should be completed; however, pre-mature infants may have their hearing screened after 36 weeks. Hearing screening occurs around 2-8 weeks of age.

Infants that are considered at risk are when the caregiver has concerns about hearing or development, there is a family history of permanent childhood hearing loss, a NICU stay exceeds 48 hours, or when one of the following criteria are met, regardless of length of stay: the use of assisted ventilation, presence of jaundice, exposure to ototoxic medications (gentamycin, streptomycin, quinine) or loop diuretics (furosemide/Lasix), the presence of in-utero infections (cytomegalovirus, herpes, rubella, syphilis, toxoplasmosis, HIV, malaria), presence of craniofacial abnormalities, presence of syndrome associated with hearing loss, presence of neurodegenerative disorders, postnatal infection including meningitis, head trauma, or chemotherapy. It is not known the percentage of infants that meet these risk factor criteria.

Data are not available regarding the prevalence of CMV or meningitis among infants or children in Malawi.

The target condition for screening for well and at-risk babies is not indicated.

29.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral should be completed after 36 weeks gestation. It is not indicated by when the diagnostic assessment should be completed.

29.3.3. Preschool hearing screening

Not applicable.

29.3.4. Intervention approach

In Malawi, treatment options available include grommets, hearing aids, or cochlear implants. Infants are fitted with hearing aids from 6 months of age or older and with cochlear implants from 5 years of age or older.

The hearing aid fitting recommendations are a unilateral or bilateral hearing loss of more than 25 dB HL and less than 110 dB HL.

29.4. Protocols

Hearing screening protocols are described for neonatal hearing screening (well-baby 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

29.4.1. Neonatal hearing screening (well)

Not applicable.

29.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk infants is described in Table 1. Specifically, otoscopy, tympanomety, and aABR/ASSR is performed in the audiology clinic.

Table 55: Process for neonatal hearing screening for at-risk infants in Malawi

Test	Age	Referral Criteria	Unilateral Referrals?	Location
Otoscopy + Tymp+ aABR/ASSR*	2-8 weeks	25 dB nHL	Yes	Audiology clinic

* Testing is performed twice before referral to full diagnostic assessment

29.4.3. Preschool hearing screening

Not applicable.

29.5. Professionals

29.5.1. Neonatal hearing screening (well)

Not applicable.

29.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by audiologists and audiology officers. There is no specific training for these professionals to perform hearing screening.

29.5.3. Preschool hearing screening

Not applicable.

30. Malta

***Hearing screening representative for Malta**: Anthony J. Fenech, Mater Dei Hospital / University of Malta.*

30.1. Background

In Malta, there is no universal neonatal hearing screening program.

The following report contains information with regards to status of hearing screening in the entire country of Malta.

30.1.1. General

Malta has a total area of 316 km^2 with a population of 475 701 in 2017 (National Statistics Office, 2019).

In Malta, all births are registered. The number of live births in Malta in 2014 was 4308 (Department of Health Information and Research, 2015).

The World Bank income classification categorizes Malta as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2017 was €24 016 per capita in Malta (The World Bank Group, 2019).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Malta in 2015 was 2250 USD or €2006 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 7.4 per 1000 is reported for Malta in 2016 (United Nations Statistics Division, 2016).

30.1.2. Neonatal hearing screening

In Malta, neonatal hearing screening is selective, with only babies in the single NICU in Malta having access to hearing screening. Neonatal NICU screening is funded through state, but participation is not obligatory for parents. Neonatal NICU hearing screening in Malta was started and fully implemented in 2005, as there is only one NICU in the country. It is not embedded in the Preventive Child Health Care screening system.

In Malta, at-risk infants are defined as those admitted to the NICU. Data is unavailable on the prevalence of CMV or meningitis in Malta.

30.1.3. Preschool hearing screening

Preschool hearing screening does not exist in Malta.

30.2. Guidelines & Quality Control

National guidelines for child health care do not exist in Malta, and there is also no general hearing screening programme.

Quality assurance or data collection on hearing screening is not performed and there have been no annual reports or studies performed on hearing screening in Malta.

30.3. Process: Screening, Diagnosis, Intervention

30.3.1. Neonatal hearing screening

In Malta, it is roughly estimated that the percentage of children admitted to the NICU is less than 10% (NICU specialist resident, 2017).

At-risk babies are screened in the NICU located in the main state hospital by audiology assistants. Families are invited to participate in screening via information provided directly at the hospital.

Babies should be screened before discharge from the hospital.

The target condition for screening for at-risk babies is not quantified. Once referred with OAEs, hearing loss is assessed for any degree or severity.

30.3.2. Neonatal diagnostic assessment

Infants referred from neonatal hearing screening to diagnostic assessment are tested with a secondary OAE and ABR. The ABR is performed under chloral hydrate sedation, if indicated.

There is no criterion for when the diagnostic assessment of well-babies should be completed; a diagnostic assessment is performed once there is a possibility of a hearing loss of any degree or severity. No timeline is indicated.

30.3.3. Preschool hearing screening

Not applicable.

30.3.4. Intervention approach

In Malta, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids from less than 6 months of age or older, and infants are fitted with cochlear implants from 6-12 months of age or older.

The hearing aid fitting criteria in Malta is at least a 40-45 dB hearing loss in one or both ears (Department of Audiology / Otolaryngology, 2017).

30.4. 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

30.4.1. Neonatal hearing screening (well)

Hearing screening for well babies does not exist in Malta, though implementation plans are in progress.

30.4.2. Neonatal hearing screening (at-risk)

A two-step OAE protocol is in effect in the NICU in Malta. See Table 1 for details.

Table 56: Screening process for at-risk (NICU) babies in Malta.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	Immediately	Waveform peak fit (8/8 peaks detected)	Madsen Accuscreen	Yes	NICU
OAE2	Before discharge			Yes	NICU

30.4.3. Preschool hearing screening

There is no preschool hearing screening.

30.5. Professionals

30.5.1. Neonatal hearing screening (well)

Well baby neonatal hearing screening is not yet performed in Malta.

30.5.2. Neonatal hearing screening (at-risk)

Screening of at-risk infants is performed by audiology assistants. There is currently no specific training, but staff are given hands-on experience.

30.5.3. Preschool hearing screening

There is no preschool hearing screening.

31. Moldova

Hearing screening representative for Moldova: *Doina Chiaburu-Chiosa, The Republican Center of Audiology, Hearing Impairment, and Psycho-pedagogical Rehabilitation IMSP IMSC & ENT Chair of the State University of Medicine and Pharmacy "Nicolae Testemitanu".*

General information acquired from answers by: *Doina Chiaburu-Chiosa, The Republican Center of Audiology, Hearing Impairment, and Psycho-pedagogical Rehabilitation IMSP IMSC, ENT Chair of the State University of Medicine and Pharmacy "Nicolae Testemitanu" and Ala Paduca, State University Of Medicine and Pharmacy "Nicolae Testemitanu".*

31.1. Background

In the Republic of Moldova, hereafter Moldova, hearing screening is organized and implemented locally.

The following report contains information with regards to hearing screening in the entire country of Moldova.

31.1.1. General

The country of Moldova has a total area of 33 851 km^2 or 29 683 excluding Transnistria. The population of the Republic of Moldova is 3 550 852 as of January 2017 (National Bureau of Statistics of the Republic of Moldova, 2019). In Moldova, each birth is registered with the Office of the Civil Status. The number of live births in Moldova was 37 394 in 2016 (National Bureau of Statistics of the Republic of Moldova, 2019).

The World Bank income classification categorizes Moldova as a lower-middle-income country (The World Bank, 2018). The gross domestic product (GDP) is €2 176 per capita in 2017 (National Bureau of Statistics of the Republic of Moldova, 2019).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Moldova in 2015 was 171 USD or €150 per capita (World Health Organization, 2018).

Data acquired from the 2016 United Nations Demographic Yearbook indicate an infant mortality rate of 9.4 per 1000 for the country of Moldova in 2014 (United Nations Statistics Division, 2016). Infant mortality rate remained similar for the years 2015 and 2016 at 9.7 and 9.4, respectively (National Bureau of Statistics of the Republic of Moldova, 2019).

31.1.2. Neonatal hearing screening

Only some hospitals in Moldova have implemented universal neonatal hearing screening. Universal hearing screening is not carried out across the entire country. Neonatal hearing screening is also not carried out on all at-risk or NICU infants.

Screening for well and at-risk babies was first implemented in 2017. As indicated, it is not yet implemented across the entire country. Neonatal hearing screening is not embedded in the Preventive Child Health Care screening system. Well-baby screening is funded through health insurance and at-risk-baby screening is funded by the hospitals.

Hospitals across Moldova performing neonatal hearing screening use the same protocols for screening.

31.1.3. Preschool hearing screening

In Moldova, preschool hearing screening is not conducted universally, nor is it embedded in the Preventive Child Health Care screening system. Preschool hearing screening, when conducted, is organized through international projects and through ENT or family doctors. Specifically, three projects have been carried out in Moldova by Pediatres du Monde from France, a Moldovan-Polish project, and a Swiss project since 2007. These projects were carried out within a limited timeframe on a limited number of infants.

31.2. Guidelines & Quality Control

National guidelines for hearing screening exist in Moldova and are used across hospitals.

The content of hearing screening programme was decided on by the Ministry of Health through a multidisciplinary team of experts, doctors, representatives from the Ministry with the help of experience of advanced countries. Guidelines have not been changed since its implementation.

The neonatal hearing screening programme is still in early stages in some hospitals, and therefore data are not yet collected for many indicators. Data collection is in progress and annual reports will be available.

31.3. Process: Screening, Diagnosis, Intervention

31.3.1. Neonatal hearing screening

Well-babies and at-risk babies are screened in the hospital, where the average length of stay is estimated to be 3 days. It is estimated that 97% of births take place at the maternity hospital, while 2% of births take place at home. Families of well and at-risk infants are invited to participate in neonatal screening directly in the maternity ward by ENT-audiologists.

It is not clear at what age screening should be completed according to guidelines; however, screening is completed in the maternity ward before discharge.

The target condition for screening well or at-risk babies is not specifically defined in guidelines.

In Moldova, at-risk infants are defined as infants born earlier than 34 weeks or with a weight of less than 1500 grams; however, there are no differences in protocol between well and at-risk infants. All infants are screened with the same protocol.

The prevalence of CMV infections and meningitis among neonates is not known.

31.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests performed after neonatal hearing screening referral are OAE, impedance audiometry and ASSRs. Well infants should have their diagnostic assessment completed by 12 months of age and at-risk infants should have the process completed by 2 years of age.

31.3.3. Preschool hearing screening

When international projects are underway, preschool hearing screening is performed in kindergartens and schools. Children are invited to participate via their family doctors through administration within preschool institutions. Testing is performed by a ENT-audiologist or family physician.

When hearing screening was performed, the target condition for preschool hearing screening was a bilateral hearing loss of ≥ 25 dB HL.

31.3.4. Intervention approach

In Moldova, treatment options available include hearing aids. Infants are fitted with hearing aids from 1-2 years of age. Cochlear implants are only available in Moldova when European projects are in effect. In these instances, cochlear implants may be implanted as early as 6-12 months of age; however, they are typically implanted at 2-4 years of age. Other children that have citizenship in Romania may be fitted there.

Hearing aid fitting criteria in Moldova is a bilateral hearing loss of 60 dB HL or worse.

31.4. Protocols

Hearing screening protocols are described for neonatal hearing screening (well-baby 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

31.4.1. Neonatal hearing screening (well)

For babies that are screened in Moldova, a 2-step OAE-OAE protocol is in effect whereby both OAEs are performed in the maternity ward before discharge. Infants that do not pass the OAEs are referred to the audiological centre for follow-up testing.

Table 57: Screening process for neonates in Moldova.

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location
OAE1	2-3 days	Not specified	Not specified	Yes	Maternity ward
OAE2	Before discharge	Not specified	Not specified	Yes	Maternity ward

31.4.2. Neonatal hearing screening (at-risk)

Infants considered at risk do not have a separate protocol. See section 6.1 for the protocol used for all babies that are screened in Moldova.

31.4.3. Preschool hearing screening

In Moldova, audiometry from 500 to 4000 Hz and tympanometry may be performed at the age of 6-8 years. The referral criteria are thresholds of 30 to 35 dB HL or worse.

31.5. Professionals

31.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by ENT-audiologists and ENT resident doctors. In the future, neonatologists and nurses with also perform hearing screening. There is currently no specific training for hearing screeners in Moldova; however, a training programme is in progress.

31.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by ENT-audiologists and ENT resident doctors. In the future, neonatologists and nurses with also perform hearing screening.

31.5.3. Preschool hearing screening

ENT-audiologist and family doctors perform preschool hearing screening.

32. Montenegro

***Hearing screening representative for Montenegro**: Tarik Kujundžić, Department of Otorhinolaryngology, General Hospital Pljevlja.*

32.1. Background

In Montenegro, hearing screening is not implemented. Any testing performed is locally organized. The following report contains information with regards to status of hearing screening in the entire country of Montenegro.

32.1.1. General

Montenegro has a total area of 13 812 km^2 and a population of 620 029 as of 2011 (Statistical Office of Montenegro, 2011). In Montenegro, each birth is registered. The number of births in Montenegro was 7569 in 2016 (Statistical Office of Montenegro, 2015)

The World Bank income classification categorizes Montenegro as an upper-middle income country (The World Bank, 2018). The gross domestic product (GDP) is €6 354 per capita as of 2015 (Statistical Office of Montenegro, 2016).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Montenegro in 2015 was 381 USD or €331 per capita (World Health Organization, 2018).

Data acquired from the 2016 United Nations Demographic Yearbook indicate an infant mortality rate of 4.9 per 1000 for the country of Montenegro in 2014 (United Nations Statistics Division, 2016).

32.1.2. Neonatal hearing screening

In Montenegro, there is no universal neonatal hearing screening. Only the Clinical Centre of Montenegro has equipment for screening children; however, testing or screening is not performed on a regular basis. There is no protocol or procedure used to screen infants. Any tests performed are funded by the state, but it is not embedded into the general Preventive Child Health Care screening system. Screening is not obligatory for parents.

32.1.3. Preschool hearing screening

There is no preschool hearing screening in Montenegro.

32.2. Guidelines & Quality Control

There are no guidelines or protocols for hearing screening in Montenegro.

Quality assurance or data collection on hearing screening is not performed and there have been no annual reports or studies performed on hearing screening in Montenegro.

32.3. Process: Screening, Diagnosis, Intervention

32.3.1. Neonatal hearing screening

For hospitals that have neonatal hearing screening, infants are screened in the hospitals. At-risk babies are screened in the hospital. Families are invited to participate in screening directly in person in the hospital.

The average length of stay in the maternity ward after delivery is estimated to be 3 days. According to the Ministry of Health (2016), 99.5% of births in Montenegro take place in the hospital, while 0.5% of births take place at home.

There is no neonatal hearing screening protocol that indicates the targeted maximum age of screening or target condition for screening.

32.3.2. Neonatal diagnostic assessment

There is no protocol that indicates details of the diagnostic assessment or by when the diagnostic audiological evaluation should be completed.

32.3.3. Preschool hearing screening

Not applicable.

32.3.4. Intervention approach

In Montenegro, treatment options available include grommets, hearing aids, bone conductive devices and cochlear implants. Infants are fitted with hearing aids from 1-2 years of age, and infants are fitted with cochlear implants from 1-2 years of age or older.

The hearing aid fitting criteria for children in Montenegro is a bilateral hearing loss of at least 25 dB HL, according to the Policy on Hearing Aids (The Health Insurance Fund of Montenegro, 2017).

32.4. Protocols

32.4.1. Neonatal hearing screening (well)

There is no set protocol in place for screening well, healthy infants. For hospitals that have neonatal hearing screening, infants are screened with OAE during the first week of life in either one or both ears. Infants that do not pass the initial screening are rescreened after one month.

32.4.2. Neonatal hearing screening (at-risk)

There is no set protocol in place for screening at-risk infants. For hospitals that perform screening, infants at risk are screened with OAEs during the first 3 months of life in either one or both ears.

32.4.3. Preschool hearing screening

Not applicable.

32.5. Professionals

32.5.1. Neonatal hearing screening (well)

ENT specialists and nurses perform neonatal hearing screening, when applicable. There is no specific training for hearing screening.

32.5.2. Neonatal hearing screening (at-risk)

ENT specialists and nurses perform neonatal hearing screening, when applicable.

32.5.3. Preschool hearing screening

Not applicable.

33. Netherlands

Hearing screening representatives for the Netherlands: *Anneke Meuwese-Jongejeugd, National Institute for Public Health and the Environment (Centre for Population screening)***.**

33.1. Background

In the Netherlands, hearing screening is performed nationally and also organized nationally. The following report contains information with regards to hearing screening in the entire country of the Netherlands.

33.1.1. General

The country of the Netherlands has an area of 41 543 km^2 with a population of 16 979 120 as of January 2016 (CBS, 2019).

In the Netherlands, all births are registered. The number of live births in the Netherlands in 2017 was 169 836 (CBS, 2019).

The World Bank income classification categorizes the Netherlands as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2015 was €40 733 per capita (CBS, 2019).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for the Netherlands in 2015 was 4662 USD or €4178 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 3.3 per 1000 is reported for the Netherlands for 2015 (United Nations Statistics Division, 2016; CBS, 2019).

33.1.2. Neonatal hearing screening

In the Netherlands, 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 babies was implemented nationwide during the period of 2002-2006 (Kauffman-de Boer, o.a., 2006) and was fully implemented nationwide by the end of this period. Screening for at-risk babies began in 1998, and was fully implemented by 2003 (Van Straaten, van Dommelen, & Verkerk, 2014) .

Neonatal hearing screening for well babies is embedded in the Preventive Child Health Care screening system and typically performed at home in combination with the heelprick screening test. These tests are funded through the municipalities or local council (*gemeente*). The The Centre for Population Screening of the National Institute for Public Health and the Environment (RIVM-CvB) directs and coordinates the neonatal hearing screening programe.

Neonatal hearing screening for NICU infants is organized separately and does not belong to the well-baby national screening programme. Instead, it is organized as part of NICU care and data are collected by TNO who monitor the quality of screening. It is funded through health care insurance.

Well-baby and NICU protocols for hearing screening are followed across the entire country.

33.1.3. Preschool hearing screening

School-age (age 5-6 years) hearing screening currently exists in Netherlands organized through the Youth Health Care (YHC) organizations (*jeugdgezondheidszorg, JGZ*). The first guideline for hearing screening was published in the Netherlands in 1998, and since then it has been implemented across the entire country.

School-age hearing screening is part of the YHC law and funded by the local government. Hearing screening at school age is part of the compulsory elements of the YHC law.

The national guideline for YHC includes screening protocols, and therefore the same protocol is followed across the country; however, YHC organizations have the right to adjust the guidelines if warranted (Lanting, Deurloo, Wiefferink, & Uilenburg, 2016). Adjustments are not documented; however, differences may exist, for example, with regards to the age of screening when there is suspicion of a hearing loss from medical history or from parental or teacher concern.

33.2. Guidelines & Quality Control

National guidelines for hearing screening exist in the Netherlands. The organization and quality assurance of the NHS programme are not part of the professional guideline but are included in a standard (Draaiboek). All professionals need to comply with this standard. The professional guideline refers the neonatal hearing screening to this standard.

At a national level, the screening programme is directed and coordinated by the National Institute for Public Health and the Environment's Centre for Population Screening, on behalf of the Ministry of Health, Welfare and Sport. The content of the screening programme has not been changed since implementation, with the exception of small adjustments since 2009.

The Ministry of Health, Welfare, and Sport allows for small revisions to be made to the guidelines, and the Centre for Population Screening (CvB) determines the changes to be made based on recommendations from the programme committee for neonatal hearing screening. Participants of the programme committee are made up of individuals from various organizations involved in neonatal hearing screening. To date, the revision process has not required extra funding.

The directive including preschool hearing screening was first published in 1998 and most recently updated in 2015 (Lanting, Deurloo, Wiefferink, & Uilenburg, 2016).

Quality assurance of neonatal hearing screening programmes is performed on a yearly basis. An independent organization ("TNO") performs the annual review. Information is collected from the Neonatal Screening Information System used by all Youth Health Care Organizations, and the programme is monitored against predetermined quality indicators.

Annual reports are published from these yearly monitoring results and published online. The most recent report, published in November 2018, showed screening results from 2018 (Van Der Ploeg, Pot, & Verkerk, 2018)

Research has been performed on hearing screening in the Netherlands apart from monitoring.

33.3. Process: Screening, Diagnosis, Intervention

33.3.1. Neonatal hearing screening

Well-babies are screened in the child's home (75%) or in a child health care centre (25%). and at-risk babies are screened by NICU nurses. Well-baby families are invited for screening via a telephone appointment scheduled at the child's home (for 75%). If the parents cannot be reached via phone, an impromptu visit may be performed. For the other 25% of families, a screening appointment is made at the child health care centre. Families of infants at-risk are invited and screened directly in the NICU.

According to the Central Bureau for Statistics, 80.7% of infants are born in a maternity hospital where the average length of stay is 3.2 days.

For well infants, neonatal hearing screening should be completed by 6 weeks of age in the Netherlands. For at-risk infants, neonatal hearing screening should be completed by 6 weeks corrected age (Van Straaten, van Dommelen, & Verkerk, 2014).

The target condition for screening both well and at-risk babies is a unilateral or bilateral permanent hearing loss ≥ 40 dB HL (RIVM - Center for Population Screening, 2018; Van Straaten, van Dommelen, & Verkerk, 2014).

At-risk infants are defined as those admitted to the NICU, and/or have had meningitis or exchange transfusion. The indication for screening with a separate protocol is because of the increased risk of auditory neuropathy. Infants that are admitted to the NICU are screened according to a separately-organized NICU-protocol. Approximately 2% of infants are screened with the NICU screening protocol (Van Der Ploeg, Pot, & Verkerk, 2017). Infants that are not admitted to the NICU, but have had meningitis or exchange transfusion are screened under the well-baby program with a separate (at-risk) screening protocol. In 2015, 0.16% of infants were screened under the at-risk protocol within the well-baby neonatal hearing screening programme (Van Der Ploeg, Pot, & Verkerk, 2017).

A study by Gaytant et al. (2005) found that 0.9 per 1000 infants were found to have congenital CMV in the Netherlands (metropolitan regions of Amsterdam and Rotterdam) and a more recent study by de Vries et al. (2011) found that the birth prevalence of congenital CMV was 0.54%.

The incidence of bacterial meningitis in the Netherlands is 0.04 per 1000 per year (mostly in young children). Furthermore, in an investigation of risk factors for hearing loss, out of 185 infants with permanent hearing impairment who participated in a research study, 6 had meningitis as the cause to their hearing impairment (Korver et al., 2010).

33.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests performed after neonatal hearing screening referral are click-ABR, OAE, 1 kHz tympanometry, ENT examination and parent discussion. Testing should be performed by 92 days after birth for well and at-risk babies. This target age may be corrected to gestational age in cases of prematurity.

33.3.3. Preschool hearing screening

Screening of school-age children in the Netherlands takes place in schools or in the YHC clinics. Families of school-age children are invited to participate in hearing screening by the YHC clinic. The target condition for school-age hearing screening is not indicated.

33.3.4. Intervention approach

In the Netherlands, treatment options available include grommets, hearing aids, bone conductive devices, cochlear implants, as well as family services. Infants are fitted with hearing aids from <6 months of age (specifically within 4 months of age) and cochlear implants from < 6 months of age.

The hearing aid fitting criteria in the Netherlands is not indicated.

33.4. 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

33.4.1. Neonatal hearing screening (well)

The neonatal hearing screening programme in the Netherlands for well babies described includes three screening tests before referral to a diagnostic assessment. The programme aims for the initial OAE screening to be performed by midwives at the infants' home in combination with the heelprick test at 4 to 7 days of age. If OAE screening is not performed during the visit by the midwife, the initial OAE hearing screening will be offered in the Youth Health Care clinic at 2-3 weeks of age. The second OAE test is performed a week after the first test, and the third screening stage (aABR) should be completed before 6 weeks of age. There is an ongoing review of other devices to allow the potential use of other screening equipment in the future.

Table 58: Screening process for well babies in the Netherlands.

Test*	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	4-7 days	Automatic pass/fail	Echoscreen II/III	Yes	Home†
OAE2	2-3 weeks			Yes	YHC clinic / Home
aABR	< 6 weeks	35 dB nHL		Yes	YHC clinic /Home

*Protocol indicates that for each test, a screening-fail should be repeated up to 3 times before indicating a result of 'refer.'

† 75% of infants are screened at home and 25% are screened in the youth health care clinic. The initial screen, when performed in the health clinic, occurs at 2-3 weeks of age (not 4-7 days). These 25% of infants are made up of infants from a few YHC organizations in two provinces in the Netherlands.

33.4.2. Neonatal hearing screening (at-risk)

The sequence of hearing screening for NICU infants is a 2-step aABR-aABR protocol, as described in Table 2. The first screening step is performed in the hospital prior to discharge from the NICU, and the second step is performed in a hospital outpatient setting.

Table 59: Screening process for at-risk babies in the Netherlands.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
aABR1	Before 1 month corrected age*	35 dB nHL		Yes	NICU
aABR2	6+ weeks after aABR1 (42 weeks post-conceptional age)	35 dB nHL		Yes	Outpatient Clinic /NICU

*96.9% of infants were screened before 1 month of age (corrected) in 2014.

33.4.3. Preschool hearing screening

The sequence of hearing screening for school-age children is described in Table 3.

Children are conditioned first with a tone of higher intensity before screening at 30 dB HL. Children pass the screening if hearing thresholds from 500 to 4000 Hz are 30 dB HL or better. Children that do not meet passing criteria may either be classified as doubtful or insufficient. Doubtful results are a hearing loss of 35 dB HL in 1-2 frequencies and in one or both ears, or a hearing loss of 40 dB HL in 1 frequency in one or both ears. Insufficient results are when the threshold is more severe or present more frequencies.

A 3-step protocol is in effect; however, the third step is bypassed when children meet the criteria for “insufficient” according to the screening protocol. In cases where the results from pure-tone screening step 2 is doubtful, or when there is a likely middle-ear infection, a third screening step will be performed.

Table 60: Screening process for school-aged children in the Netherlands.

Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone screening 1	5-6 years	Threshold > 30 dB HL (0.5-4 kHz)	Yes	Schools (quiet room)
Pure-tone screening 2	10-16 weeks after screening 1			
Pure-tone screening 3*	10-16 weeks after screening 2			

* Step 3 is only performed when results from Pure-tone screening step 2 are doubtful, or when middle-ear fluid is potentially involved.

33.5. Professionals

33.5.1. Neonatal hearing screening (well)

OAE screening for well babies is performed by staff of the Youth Health Care programme with various backgrounds. Specifically, to be offered a position as a OAE/heel-prick screener, paramedical

training at MBO level 4. This is equivalent to higher level vocational education. Despite these standards, exceptions can be made for candidates with a different prior education (e.g., maternity or doctors assistants trained to MBO level 3) if it is deemed feasible that these candidates will successfully meet the training requirements stipulated in Appendix F of the newborn hearing screening standard (RIVM - Center for Population Screening, 2018). The aABR screening performed at step 3 is typically performed by the regional coordinator, a nurse or speech-language therapist.

Training is a full day, with additional on-site training under supervision. The regional coordinator is then responsible for approving the trainee for independent screening. The training day itself is provided through a certified national organization (NSDSK), which makes necessary updates to training material. The trainee is provided certification for hearing screening once they have undergone the training session and revealed practical competency.

33.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by nurses. Training is the full responsibility of the NICU department and varies between clinics. Training is not accredited or certified training. For example, training may be provided by the manufacturer of the screening equipment.

33.5.3. Preschool hearing screening

Hearing screening for school-aged children is performed by assistants or nurses from the Youth Health Care organizations.

34. North Macedonia (Skopje Region)

***Hearing screening representative for North Macedonia**: Marina Cakar, University Clinic of ENT, Skopje.*

34.1. Background

In North Macedonia, hearing screening is implemented and organized regionally. The following report contains information with regards to status of hearing screening in the region of Skopje in North Macedonia.

34.1.1. General

North Macedonia has a total area of 25 713 km^2 with an estimated population of 2 073 703 in 2016. Skopje region has an area of 1818 km^2 with an estimated population of 624 585 in 2016 (State Statistical Office, 2018).

In North Macedonia, all births are registered through the Ministry of Justice on a national and regional level. In 2016, there were 23 002 births registered for all of North Macedonia and 8466 births registered for Skopje region (State Statistical Office, 2018).

The World Bank income classification categorizes North Macedonia as an upper-middle-income country (The World Bank, 2018). The gross domestic product (GDP) in 2015 was €4377 per capita in North Macedonia and €6290 per capita for Skopje region (State Statistical Office, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for North Macedonia in 2015 was 328 USD or €289 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 8.6 and 11.9 per 1000 is reported across all of North Macedonia in 2016 and 2017, respectively. An infant mortality rate of 8.3 and 12.0 per 1000 is reported for Skopje region in 2016 and 2017, respectively (State Statistical Office, 2018). The United Nations Statistics Division also shows a similar mortality rate in North Macedonia in rural areas compared to urban areas. Infant mortality rates in 2015 were 8.7 and 8.4 for rural and urban areas, respectively (United Nations Statistics Division, 2016).

34.1.2. Neonatal hearing screening

In North Macedonia, the universal neonatal hearing screening programme is under development. Neonatal hearing screening is selective, with only NICU babies having access to hearing screening. Neonatal NICU screening is funded through health insurance, but participation is not obligatory for parents. Screening started approximately 10 years ago, but is not yet fully implemented. It is not embedded in the Preventive Child Health Care screening system.

In the last 3 months, a project has started by the medical faculty in Skopje whereby all groups of infants are offered screening, including well infants, infants with risk factors, and infants in the NICU. This project is in preparation for the development of universal hearing screening across North Macedonia.

34.1.3. Preschool hearing screening

Preschool hearing screening in Skopje is provided at the ENT clinic at the University Hospital and at the Center for Hearing and Speech. All children in Skopje are offered to come in to have their hearing screened. Screening at this age started approximately 20 years ago and is funded through health insurance. It is incorporated in the Preventive Child Health Care screening system.

34.2. Guidelines & Quality Control

There are no national hearing screening guidelines for North Macedonia. However, there is a protocol used for neonatal hearing screening for Skopje region.

Neonatal screening and revisions to the programme is decided on by the North Macedonian Society of ENT doctors. The hearing screening protocol follows the standard European protocols and makes updates accordingly.

Quality assurance or data collection on hearing screening is not performed and there have been no annual reports or studies performed on hearing screening in North Macedonia.

34.3. Process: Screening, Diagnosis, Intervention

34.3.1. Neonatal hearing screening

In Skopje region, it is roughly estimated that around 6% of neonates are admitted to the NICU.

NICU babies are screened in the hospital. Families are invited to participate in screening via a letter provided to the parents.

In North Macedonia, at-risk infants are defined as those with the following risk factors: prematurity, toxemia during pregnancy, lack of oxygen (anoxia), low APGAR scores, prolonged mechanical ventilation, low birth weight, viral infection, sepsis, hyperbilirubinemia, ototoxic exposure, family history of congenital hearing loss, or craniofacial anomalies. However, with regards to the current project, these infants with risk factors are not screened differently than NICU infants. Data are unavailable on the prevalence of CMV or meningitis in North Macedonia.

At-risk babies should be screened before 5-6 months of age.

Hearing screening for well babies is currently being performed in the region of Skopje in North Macedonia but not in other regions of North Macedonia. In the past 3 months, well babies were added in the project for neonatal screening with support by the medical faculty in Skopje, North Macedonia.

North Macedonia is preparing screening in neonatal screening program to all groups of newborns; including healthy infants, infants at risk, and infant which are at the NICU.

The target condition for screening for at-risk babies is not quantified but is only according to the OAE results.

34.3.2. Neonatal diagnostic assessment

Infants referred from neonatal hearing screening to diagnostic assessment are tested with a combination of expanded audiological assessment including diagnostic ABR (testing from 70 to 40 dB nHL) and behavioral assessment, as well as tests of middle ear function using acoustical impedance /admittance.

The diagnostic assessment is completed around 3-4 months of age and should be completed by 6-7 months of age.

34.3.3. Preschool hearing screening

Preschool hearing screening takes place at the Department of Audiology, ENT University Hospital or at the Center for Hearing and Speech. The target condition is not indicated; however, the referral criterion is 30 dB HL.

34.3.4. Intervention approach

In North Macedonia, treatment options available include grommets, hearing aids and cochlear implants. Infants are fitted with hearing aids from less than 6 months of age or older, and infants are fitted with cochlear implants from 1-2 years of age.

The hearing aid fitting criteria in Skopje, North Macedonia is a hearing loss of at least 40-50 dB HL. Both bilateral and unilateral hearing loss are treated with hearing aids in Skopje, North Macedonia.

34.4. 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

34.4.1. Neonatal hearing screening (well)

This screening process for well babies was recently implemented as a pilot project in the past few months. The pilot protocol for neonatal hearing screening for well babies is summarized in Table 1, whereby a 2-step OAE - OAE protocol is in effect. If the infant does not pass the OAE in one or both ears prior to discharge, a rescreening OAE is held at the age of 1 month.

Table 61: Screening process for well, healthy babies in Skopje, North Macedonia.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	2-3 days / Before discharge	500-4000 Hz	OtoRead	Yes	Maternity
OAE2	1 month	500-4000 Hz	OtoRead	Yes	ENT Dept, University Hospital

34.4.2. Neonatal hearing screening (at-risk)

For at-risk infants, the same protocol is followed as for well babies. There are no differences in the protocols.

Prior to 3 months age, only selective at-risk babies were screened using this protocol indicated in Table 1. However, just in few the recent months have well babies been included in the screening in Skopje, North Macedonia. This is in preparation of a universal newborn hearing screening programme.

34.4.3. Preschool hearing screening

Pure-tone audiometry is performed in the ENT department at the University Hospital and at the Center for Hearing and Speech in Skopje, North Macedonia. Children age 5-6 years are invited for screening, which is performed by speech therapists.

Table 62: Screening process for preschool-age children in Skopje, North Macedonia.

Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone audiometry	5-6 years	30 dB HL	Yes	Hearing Clinic

34.5. Professionals

34.5.1. Neonatal hearing screening (well)

In Skopje, North Macedonia, screening for well babies only started 3 months ago. So far, well-baby newborn screening has been performed by audiologists, as have been the case previously for at-risk infants. Audiologists education is one year in length, and a training programme is included specifically for learning about how to perform hearing screening. The training program is about knowing how to use the screening devices and how to prepare newborns for testing.

34.5.2. Neonatal hearing screening (at-risk)

Screening of at-risk infants is also performed by audiologists. See 7.1 for training details.

34.5.3. Preschool hearing screening

Preschool hearing screening is performed by speech therapists in Skopje, North Macedonia.

35. Poland

Hearing screening representative for Poland: *Grażyna Greczka, Department of Otolaryngology, Poznan University of Medical Science.*

General information provided by: *Monika Zych, Department of Otolaryngology, Poznan University of Medical Science.*

35.1. Background

In Poland, newborn hearing screening is organized nationally while preschool hearing screening is organized regionally. The following report contains information with regards to hearing screening in the entire country of Poland.

35.1.1. General

Poland has a total area of 312 679 km^2 with a population of 38 424 000.

In Poland, each birth is registered with the Central Statistics Office. The number of births in Poland in 2016 was 382 300 (Statistics Poland, 2017).

The World Bank income classification categorizes Poland as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2016 was 48 364 PLN or €11 346 per capita (Statistics Poland, 2017).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Poland in 2015 was 797 USD or €682 per capita (World Health Organization (WHO), 2018a).

Data from the World Health Organization indicates a child mortality rate (under age 5) in Poland of 4.9 per 1000 in 2015 (World Health Organization (WHO), 2018b). Data acquired from the 2016 United Nations Demographic Yearbook indicates an infant mortality rate of 4.0 per 1000 for the country of Poland in 2015, a rate of 4.0 per 1000 in urban areas and 4.1 per 1000 in rural areas (United Nations Statistical Division, 2016).

35.1.2. Neonatal hearing screening

In Poland, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening. Screening is obligatory for parents, though parents are not rewarded or penalized for participation or refusal to participate. The universal program for well and at-risk babies was first implemented in 2002 and expanded to universally cover all well- and at-risk babies in 2003. Neonatal hearing screening is embedded in the Preventive Child Health Care screening system. The programme for well- and at-risk babies is funded through charity and health insurance.

The Polish Universal Neonatal Hearing Screening Programme (PUNHSP) implements screening procedures which are followed across the country (described in a later section). There are no differences in protocol for well or at-risk infants across regions in Poland. A national registration system for neonatal hearing screening is centralized for data monitoring.

35.1.3. Preschool hearing screening

In Poland, preschool hearing screening exists only in some regions or local areas. Preschool screening has not been implemented nationally; and therefore, there is no centralized information available for preschool hearing screening that applies to this report.

35.2. Guidelines & Quality Control

Neonatal hearing screening in Poland follows the national hearing screening guidelines. A protocol exists for both well babies and babies at-risk for hearing loss.

The content of the screening guidelines was developed by the medical coordinator with the cooperation of the Great Orchestra of Christmas Charity Foundation.

Since its initiation in 2002-2003, the guidelines have not been revised, except for modifications on information structure and internet capability. If required in the future, the medical coordinator office would decide on the revisions across all departments. Revisions would be funded through the Great Orchestra of Christmas Charity Foundation.

Quality monitoring of the PUNHSP is performed, as indicated by law, since 2004. Quality is controlled by comparison of data from the PUNHSP central database to two independent databases, the Central Statistical Office and the National Health Fund. Each of the 400 neonatal units in Poland contains a terminal for entering data into the neonatal hearing screening central database, which then become available immediately for central analysis. According to regulation, data should be entered immediately after delivery / screening, but can be entered up to 1 month after birth.

Annual reports of neonatal hearing screening results are available in Poland and published regularly (Greczka, Zych, Szyfter, & Wróbel, 2018; Szyfter, Greczka, Dąbrowski, & Wróbel, 2016; Zych et al., 2018). Additional research has also been completed on the PUNHSP (Greczka et al., 2017; Greczka, Wróbel, Dąbrowski, Mikołajczak, & Szyfter, 2015; Greczka, Wróbel, Dąbrowski, Szyfter-Harris, & Szyfter, 2016; Szyfter et al., 2016; Szyfter, Wróbel, Radziszewska-Konopka, Szyfter-Harris, & Karlik, 2008; Szyfter, Wróbel, Szyfter-Harris, & Greczka, 2013; Szyfter, Wróbel, Karlik, & Greczka, 2013; Wróbel, Greczka, & Szyfter, 2014; K. E. Wroblewska-Seniuk, Dabrowski, Szyfter, & Mazela, 2017; K. Wroblewska-Seniuk, Greczka, Dabrowski, Szyfter-Harris, & Mazela, 2017; K. Wroblewska-Seniuk, Greczka, Dabrowski, Szyfter, & Mazela, 2017).

35.3. Process: Screening, Diagnosis, Intervention

35.3.1. Neonatal hearing screening

In Poland, hearing screening occurs in the in the hospital (or NICU) for both well babies and babies at risk for hearing loss. Parents are contacted directly while in the hospital or NICU. According to the Central Statistical Office in Poland, 99.8% of children were born in a hospital or maternity clinic and 0.2% births took place at home in 2016 (Statistics Poland, 2017). The average stay in the maternity hospital after birth is estimated to be 2-3 days.

Well-baby screening should be completed before discharge from the hospital. For infants at risk, screening should be completed as soon as possible, but some follow-up screening (e.g., if on ototoxic medications) continues until 3 years of age.

The target condition for screening (both well babies and at-risk babies) is a unilateral or bilateral hearing loss of greater than 20 dB HL.

Well babies and at-risk babies are screened with the same protocol, with the exception that at-risk babies are referred directly to diagnostic assessment irrespective of screening result.

At-risk babies are defined as those with a family history of hearing loss (including parents, siblings, grandparents, aunts/uncles, and/or cousins), congenital abnormalities of the head or neck[5], a congenital syndrome associated with hearing loss[6], prematurity, use of ototoxic medications[7], TORCH infection or other serious infection[8], low birth weight (<1500 g), APGAR score of <4 in 1 minute, APGAR score of <6 in 5 minutes, jaundice requiring exchange transfusion, intensive therapy > 7 days, or artificial ventilation > 5 days.

Data is unavailable regarding the number of infants admitted into a NICU, but 11.3% of babies screened are identified as being at-risk for hearing loss according to Poland's hearing screening protocol (K. Wroblewska-Seniuk, Greczka, Dabrowski, Szyfter, et al., 2017).

The prevalence of cytomegalovirus (CMV) infections or meningitis is not known.

35.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests performed are OAEs, tympanometry / impedance measures, and ABR.

The diagnostic assessment of well-babies and at-risk babies should be performed before 3 months of age and a final diagnosis of hearing loss should be made before 6 months of age.

35.3.3. Preschool hearing screening

Not applicable.

35.3.4. Intervention approach

In Poland, treatment options available include hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids from less than 6 months to 1-2 years age. Infants are fitted with cochlear implants from 1 year of age and older.

The hearing aid fitting criterion is a hearing loss of > 30 dB HL bilaterally. Unilateral hearing losses are also considered for amplification, though hearing aids are fit on a child-by-child basis, depending on the results of the overall assessment and with close parental support and involvement (Skarżyński et al., 2011).

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[5] *Deformation of the pinna, underdevelopment of the pinna, lack of auricular ear, narrowing of the external auditory canal, underdevelopment of the external auditory canal, absence of external auditory canal, fistula ear, cove, fistula or cyst of gill gap, bay and pre-cyst cyst, or cleft lip, ridge, hard palate or soft palate*

[6] *Alberts-Schonberg, Alstrom-Hallgren, Cogan, Crouzon, Down's, Escher-Hirt, Feinmesser-Zelig, Franceschetti, Goldenhar, Gregg, Hallgren, Klippel-Feil, Leopard, Pendred, Pierre-Robin, Treacher-Collins, Turner, Usher, Vourmann-Vourmann, Waardenburg, Wildervank, or other.*

[7] *Gentamicin, amikacin, netilmicin, vancomycin-erythromycin, azithromycin, furosemide, biodacin, or other.*

[8] *Cytomegalovirus (CMV), rubella, mumps, toxoplasmosis, herpes, meningitis, or other*

35.4. 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

35.4.1. Neonatal hearing screening (well)

The neonatal hearing screening programme in Poland for well babies without risk factors includes one or two OAE tests before the infant is discharged from the hospital. The screening process for well babies is indicated in Table 1. No screening is performed after the infant is discharged. Infants that are not screened before discharge from the hospital are provided a referral to the second level of the programme, which is the diagnostic assessment.

Table 63: Neonatal hearing screening process for well babies in Poland.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	24-72 hours	4 dB SNR for 3/6 freq	OtoRead	Yes	Maternity ward
OAE2	Before discharge	(Interacoustics, 2017)	TEOAE	Yes	Maternity ward

35.4.2. Neonatal hearing screening (at-risk)

The screening process of infants at-risk is very similar to the process for well babies. However, all babies at risk for hearing loss are automatically referred to the second phase of hearing screening in the audiology centre, regardless of the OAE result at the screen. Risk factor information is collected in the maternity ward or NICU.

35.4.3. Preschool hearing screening

Not applicable.

35.5. Professionals

35.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses or midwives in the hospitals.

Nurses and midwives undergo 1-day training, which is provided as part of the contract in the purchasing of hearing screening equipment. After training, nurses and midwives who participated

receive a certificate, which is a mandatory requirement to perform hearing screening. Internal training by an experienced nurse or midwife is also considered on an individual basis if a new staff member requires training.

Before each training session, the material of the 1-day course is re-assessed by considering the questions, concerns and comments raised previously.

35.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by nurses or midwives in the hospital. See section 5.1 for training details.

35.5.3. Preschool hearing screening

Not applicable.

36. Portugal

Hearing screening representatives for Portugal: *Luisa Monteiro, ENT Unit, Hospital Lusíadas Lisbon.*

36.1. Background

In Portugal, hearing screening is performed nationally and organized regionally. The following report contains information with regards to childhood hearing screening in the entire country of Portugal with specific data presented for the Lisbon region.

36.1.1. General

Portugal has a total area of 92 212 km^2 with a population of 10 562 178 in 2011 (Instituto Nacional de Estatística – Portugal (Statistics Portugal), 2018).

In Portugal, all births are registered to the Direção-Geral da Saúde (Department of Public Health). The number of live births in Portugal in 2017 was 86 154 (Instituto Nacional de Estatística – Portugal (Statistics Portugal), 2018).

The World Bank income classification categorizes Portugal as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2016 was €18 060 per capita in Portugal (Instituto Nacional de Estatística – Portugal (Statistics Portugal), 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Portugal in 2015 was 1722 USD or €1514 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 2.9 per 1000 is reported for Portugal in 2015 (United Nations Statistics Division, 2016). Similarly, Statistics Portugal reports an infant mortality rate of 2.7 per 1000 for 2017 (Instituto Nacional de Estatística – Portugal (Statistics Portugal), 2018).

36.1.2. Neonatal hearing screening

In Portugal, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening, though participation is not obligatory for parents. Screening is available in all regions in Portugal, at all maternity hospitals, including private and state-owned hospitals, mainland and Atlantic islands. Hearing screening for well babies started in Portugal is 2001 and was fully implemented across the country by 2008. For at-risk infants, hearing screening was available in only a few maternity hospitals in 1998, and also became fully implemented across the country by 2008. Neonatal hearing screening is funded by parents, health insurance and the state, though it is not embedded in the Preventive Child Health Care screening system. Neonatal hearing screening is organized by central or regional Health Ministries for maternity hospitals under the National Health Authority and independently for private hospitals.

National guidelines are available as is a screening protocol used across the country. Across Portugal, the same protocol is followed for performing hearing screening.

36.1.3. Preschool hearing screening

There is no preschool hearing screening programme in Portugal.

36.2. Guidelines & Quality Control

There are national guidelines for hearing screening in Portugal.

The national guidelines (DGS Standard) came into effect in 2015. Prior to then, local committees were responsible implementing and organizing neonatal hearing screening in individual hospitals. The content of the general hearing screening programme in 2015 was decided on by the National Health Authority and the Public Health Organization (DGS) in consultation with an advisory board of ENTs (Direção-Geral da Saúde (DGS), 2015). The guidelines were last revised in 2016, and funding for revisions is provided by the government.

Quality assurance of hearing screening programmes is theoretically imposed by the government in the form of clinical audits, as stipulated in the Standard (Direção-Geral da Saúde (DGS), 2015); however, these audits have not yet occurred. At the current time, data are only collected on a local or regional level voluntarily. Annual reports are not yet available.

There have been studies on hearing screening programmes in Portugal, where data is collected locally and presented at national meetings. There has not been research performed measuring the effectiveness of neonatal hearing screening in Portugal.

36.3. Process: Screening, Diagnosis, Intervention

36.3.1. Neonatal hearing screening

Well-babies and at-risk babies are screened in the hospital, private clinic, NICU or pediatric clinic after discharge from the NICU. The percentage of infants born in a maternity hospital in Portugal was 99.3% in 2016, where the average length of stay is estimated to be 3 days. Parents/caregivers of well and at-risk babies are invited to participate in neonatal hearing screening directly in the maternity hospital by maternity ward staff and hospital audiologists.

Neonatal hearing screening for well and at-risk babies should be completed before 1 month of age.

At-risk babies are those that have at least one of the risk factors listed in the guidelines (Direção-Geral da Saúde (DGS), 2015). These include the following: viral infections (cytomegalovirus, herpes, rubella, or toxoplasmosis), NICU admission lasting more than 48 hours, prematurity, APGAR index less than 5, birth weight less than 1500 grams, hypoxia or hyperbilirubinemia, neonatal infections, family history of hearing loss, malformation or syndrome associated with hearing loss, craniofacial abnormalities, postnatal infection (specifically, bacterial meningitis), later syndromes associated with hearing loss, traumatic brain injury, or exposure to ototoxic drugs.

Data on the prevalence of CMV or meningitis is not available in Portugal.

The target condition for screening for well and at-risk babies is a bilateral hearing loss of 40 dB HL or worse.

36.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral should be completed by 3 months of age or 3 months corrected age for both well and at-risk infants.

36.3.3. Preschool hearing screening

Not applicable.

36.3.4. Intervention approach

In Portugal, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids from less than 6 months of age or older, and are fitted cochlear implants from 6 months of age or older.

The fitting criteria in Portugal for a hearing aid is a bilateral hearing loss of at least 40 dB HL.

36.4. 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

36.4.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies is described in Table 1. A 2-step protocol is in effect, whereby the first test may either be an OAE or aABR performed in the maternity hospital before discharge. Only one aABR fail is sufficient to warrant referral to the ENT department for evaluation. If the infant fails the OAE, a rescreening occurs as soon as possible after discharge (around week 2). The rescreening test may be an OAE or aABR. A subsequent fail at rescreening would warrant a referral to the ENT department for a diagnostic assessment.

The 3rd stage (if only OAE are used in the 1st and 2nd stages) is the diagnostic/audiologic assessment stage. They all have the same protocol.

According to a 2013 master's thesis analyzing the status of neonatal hearing screening across Portugal, the bulk of institutions surveyed (26 out of 32) indicated that they used OAE for both steps of screening. Five institutions used a combined OAE and aABR screening for both steps 1 and 2 (Canas, 2013).

The second step of screening occurs between 2 and 4 weeks after initial screening, varying by institution (Canas, 2013).

Table 64: Process for neonatal hearing screening for well, healthy infants in Portugal.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1/aABR	24-72 hours	Predefined criteria / 35 dB nHL		Yes	Maternity hospital
OAE2/aABR	>10 days	Predefined criteria / 35 dB nHL		Yes	Maternity hospital

36.4.2. Neonatal hearing screening (at-risk)

The screening process for all at-risk infants is described in Table 2. A one-step process is in effect where aABR is performed as soon as possible after 36 weeks gestational age or before discharge from the NICU.

Although not expressed in the guidelines, it is recommended that at-risk babies are also screened with OAE in addition to aABR during this initial step. At-risk infants that pass neonatal hearing screening may be followed-up and rescreened every 6 months until 2 years of age. Follow-up screening on a bi-annual basis is typically performed with aABR. Children are only referred to ENT and audiologic assessment if they fail the screening; however, an ENT consultation may also be performed if requested by parents or when a medical prescription is required by the insurance company.

Table 65: Process for neonatal hearing screening at-risk infants in Portugal.

Test	Age	Referral criteria	Unilateral Referrals?	Location
aABR (+OAE recommended)	24-72 hours	35 dB nHL	Yes	NICU

36.4.3. Preschool hearing screening

Not applicable.

36.5. Professionals

36.5.1. Neonatal hearing screening (well)

Neonatal hearing screening is typically performed by audiologists and nurses. Some pediatricians perform screening (Canas, 2013).

For audiologists, nurses and pediatricians involved in hearing screening, there is a 1-week formal training programme; however, it is not certified or accredited. Furthermore, training is not updated or revalidated.

36.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by audiologists and nurses. See 35.3.1 for training details.

36.5.3. Preschool hearing screening

Not applicable.

37. Romania

Hearing screening representative for Romania: *Madalina Georgescu, Audiology department, University of Medicine and Pharmacy, Bucharest; Oana Geambasu, Asociatia Sonia Maria.*

37.1. Background

In Romania, hearing screening is performed only locally but organized nationally. The following report contains information with regards to hearing screening across the entire country of Romania.

37.1.1. General

The country of Romania has a total area of 238 391 km^2 and a population of 19 644 350 as of January 2017 (National Institute of Statistics, 2017). In Romania, each newborn is registered at birth. The number of live births in Romania in 2017 was 191 694 (National Institute of Statistics, 2017).

The World Bank income classification categorizes Romania as an upper-middle-income country (The World Bank, 2018). The annual gross domestic product (GDP) is 10 932 USD €9 459 per capita.

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Romania in 2015 was 442 USD or €382 per capita (World Health Organization, 2018).

Infant mortality rate in the country of Romania was 7.3 per live 1000 births in 2015. This rate was higher in rural areas (9.6 per 1000) compared to 6.0 per 1000 in urban areas (United Nations Statistics Division, 2016; National Institute of Statistics, 2017).

37.1.2. Neonatal hearing screening

In the country of Romania, neonatal hearing screening has been conducted locally from 2006-2019, where babies in only some hospitals have access to hearing screening. Neonatal hearing screening was first performed in Romania in 2006 and in 2016, the Ministry of Health approved national neonatal hearing screening guidelines. In December 2018, equipment was provided to maternity hospitals. Screening is not yet implemented across the country, but the goal is that there will be national coverage by 2020.

In places where neonatal hearing screening exists, it is embedded in the Preventive Child Health Care screening system. Screening is funded through parents, health insurance, and the state. It is not obligatory for parents.

There have previously been differences in how hospitals perform well-baby screening, where some hospitals may use DPOAEs and others may use TEOAEs. For at-risk infants, TEOAEs and aABR were performed. Since the release of the guidelines by the Ministry of Health, all hospitals should adhere to the protocol stipulated in the document.

37.1.3. Preschool hearing screening

In Romania, there is no regulated preschool hearing screening programme. School physicians perform a whisper test as part of school-entry testing.

Doctors began performing the whisper test as part of school control testing since the 1960s. The whisper test is performed at schools across the country and is funded by health insurance.

37.2. Guidelines & Quality Control

There are national guidelines for neonatal hearing screening in Romania. A national protocol was recently published by the Ministry of Health in 2016 (Ministerul Sănătății [Ministry of Health], 2016).

The content of the programme was decided on by the Ministry of Health, in collaboration with four ENT-Audiologist physicians invited by the Ministry of Health. The guideline was approved by the Romanian and Society of Audiology and Communication Pathology and the Romanian Society of Otorhinolaryngology, after which it became mandatory, enforced by the Ministry of Health.

The neonatal hearing screening protocols have not changed since screening started in 2006. In 2016, the hearing screening protocol was standardized across the country by the Ministry of Health (Ministerul Sănătății [Ministry of Health], 2016).

Quality assurance of hearing screening programmes is not yet imposed by the government (Ministerul Sănătății [Ministry of Health], 2016); however, outcome measures are collected. Since 2006, data have been sent to the Ministry of Health and monthly reports are generated; however, data on test performance is not monitored (Ministerul Sănătății [Ministry of Health], 2016). A National Electronic Registry for Hearing Screening (RENSA) has been developed; however, this database is not yet used. In the future, a National-level coordinator will analyse and evaluate the data collected into RENSA for quality assurance. Data collection will hopefully become mandatory from 2019 onwards.

Annual reports are not yet available, due to the current lack of data. Furthermore, neonatal hearing screening does not have national coverage, and therefore reporting on national data would reflect incomplete performance.

There has been one PhD thesis written on neonatal hearing screening in Romania. Other than this, there have not been any other studies performed on the effectiveness of neonatal hearing screening in Romania.

37.3. Process: Screening, Diagnosis, Intervention

37.3.1. Neonatal hearing screening

Well and at-risk babies are screened in the maternity hospital or a private clinic. Well-baby families and families of infants at-risk are invited for screening either directly in person in the hospital or via phone. It is calculated that 97.94% of births take place in the maternity hospital, where the average length of stay after delivery is 5 days. Only around 0.284% of births take place at home.

Hearing screening for well babies should be completed by 1 month. Hearing screening with OAE for at-risk infants should be completed by 1-month of age, but at-risk infants are also referred for ABR screening, which takes place by 6-months of age.

The target condition for screening for well- and at-risk babies is not defined in protocol, but is determined by the OAE screening method (i.e., bilateral or unilateral hearing loss of 30 dB HL).

There is no data available on the percentage of infants considered to be at risk. At-risk infants are defined in protocol as those admitted to the NICU or with a risk factor according to the list published by the Joint Committee on Infant Hearing (2007). Specifically, infants that are born premature and with birth weight <1500 g, hyperbilirubinemia, administration of ototoxic drugs, hypoxia at birth, genetic syndromes associated with hearing loss, craniofacial abnormalities, severe neurological disorders, congenital infections (specifically, TORCH), bacterial infections causing severe sepsis or meningitis, > 2 days mechanical ventilation, or a family history of congenital hearing loss (Joint Committee on Infant Hearing, 2007; Ministerul Sănătății [Ministry of Health], 2016).

The prevalence of CMV or meningitis in Romania is unknown.

Infants considered at-risk have a different screening protocol and also follow a schedule for surveillance at age 6, 12, and 18 months.

37.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests performed after neonatal hearing screening referral is OAE, ABR and ASSR. Diagnostic testing should be performed at 3 months and no later than 6 months of age for well and at-risk infants. At-risk infants that pass screening are rescreened at 6, 12, and 18 months of age.

37.3.3. Preschool hearing screening

The whisper test is performed in schools by school physicians. Children are tested directly in schools; families are not invited separately. There is no target condition for the whisper test.

37.3.4. Intervention approach

In Romania, treatment options available include hearing aids, bone conductive devices and cochlear implants. Infants are fitted with hearing aids from 6 months of age and cochlear implants from 12 months of age.

The hearing aid fitting criteria in Romania is a bilateral hearing loss (mild to profound), sensorineural or permanent conductive.

37.4. Protocols

Hearing screening protocols are described for neonatal hearing screening (well-baby 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

37.4.1. Neonatal hearing screening (well)

The neonatal hearing screening protocol in Romania is described below. From 2006 to 2019, the protocol involved a 3-step protocol OAE-OAE-aABR. The first OAE is performed in the maternity hospital and the second OAE is performed by the age of 1 month. If the second OAE fails, an aABR is performed directly after during the same session. Those that do not pass the aABR were referred for diagnostic assessment. The national guidelines indicated a 2 step OAE-OAE protocol The Ministry of Health has recently distributed OAE equipment to hospitals. The third step (aABR) performed in the previous protocol is not part of the national protocol, due the lack of aABR equipment at maternity hospitals across the country.

Table 66: Screening process for well babies in Romania

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location
OAE1*	24-72 hours	3/4 freqs	Interacoustics Sera	Yes	Maternity hospital / Private clinic
OAE2	1 month			Yes	Maternity hospital / Private clinic
aABR**	1 month (same session)	35 dB nHL		Yes	Maternity hospital / Private clinic

*OAE1 may be performed once or twice before discharge. It is recommended that a failed OAE be repeated before discharge, if possible. This repeat-OAE would still be included under OAE1. **From 2006-2019, the screening protocol included aABR for infants that did not pass the OAE at the 1-month rescreening. This is no longer the case according to the national protocol.

37.4.2. Neonatal hearing screening (at-risk)

From 2006 to 2019, OAE and aABR were performed before discharge from the maternity hospital. The protocol is described in Table 2.

Since the 2016 guidelines, the protocol has changed. Because maternity hospitals are only equipped with OAE devices, at-risk infants are screened with one OAE before discharge (Table 3); however, infants at-risk that pass neonatal hearing screening are monitored, including an ABR screening at 6-months of age. Follow-up screening is performed at age 6, 12, and 18 months.

Table 67: Screening process for at-risk babies in Romania (2006-2019)

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location
OAE+aABR1	24-72 hours	3/4 freqs / 35 dB nHL	EchoScreen	Yes	Maternity hospital / NICU / Private clinic
OAE+aABR2	1 month			Yes	Maternity hospital / Private clinic

Table 68: Screening process for at-risk babies in Romania (2019-present).

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location

OAE	24-72 hours / before discharge	3/4 freqs	Interacoustics Sera	Yes	Maternity hospital / NICU / Private clinic

37.4.3. Preschool hearing screening

Table 69: Screening process for school-age children in Romania.

Test	Age	Referral Criteria	Location
Whisper test	6 years	None (physician's discretion)	School

37.5. Professionals

37.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses, audiologists, and ENT physicians. Nurses performed screening in the maternity wards in public hospitals, and audiologists or ENT physicians perform screening private clinics in private hospitals.

Training is provided during implementation of screening within a hospital. It is typically 3-5 days, but depends on the number of nurses participating in the training session. Update to staff training is provided on request only. This training is not accredited or certified.

37.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by nurses, audiologists and ENT physicians, similar to well babies. See 7.1 for information on training.

37.5.3. Preschool hearing screening

The whisper test is performed by school physicians.

38. Russian Federation

***Hearing screening representative for the Russian Federation**: George Tavartkiladze, National Research Centre for Audiology and Hearing Rehabilitation, Department of Physiology and Pathology of Hearing.*

38.1. Background

In Russia, neonatal hearing screening is organized nationally.

The following report contains information corresponding to hearing screening in the entire country of Russia.

38.1.1. General

The country of Russia has a total area of around 17 100 000 km^2 and a population of around 146 800 000 as of January 2017 (Federal State Statistics Service, 2018). In Russia, each birth is registered. The number of live births in Russia was 1 888 729 in 2016 (Federal State Statistics Service, 2018).

The World Bank income classification categorizes Russia as an upper-middle-income country (The World Bank, 2018). The gross domestic product (GDP) was € 9 470 per capita in 2017 (The World Bank Group, 2019).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Russia in 2015 was 502 USD or €442 per capita (World Health Organization, 2018).

Infant mortality rate in the country of Russia was 8.6 per 1000 births in 2012 (United Nations Statistics Division, 2016). From the Federal State Statistics Service (2018), infant mortality rate was calculated to be 6.5 per 1000 in 2015.

38.1.2. Neonatal hearing screening

In Russia, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening. Screening is government-funded, and participation is obligatory for parents. There is no penalty for non-attendance nor is there a reward for attendance.

Neonatal hearing screening started in Russia in 1996 and universal screening started in 2008. It was fully implemented across the country in 2011. Neonatal hearing screening is not embedded in the Preventive Child Health Care screening system.

There are no differences in neonatal hearing screening procedures across regions, though coverage rates of well-babies differ across regions. Regional coverage rates are monitored to ensure staff training.

38.1.3. Preschool hearing screening

There is no preschool hearing screening in Russia.

38.2. Guidelines & Quality Control

National guidelines for child health care exist in Russia, including the national hearing screening guidelines (Moscow Health Department, 2011).

The content of general hearing screening programme was decided on by audiologists and the Ministry of Public Health. The content of the programme was revised in 2010 when the network of maternity hospitals was expanded, personnel were trained and hospitals were additionally equipped. The guidelines are revised by leading audiological centres once per 5 years, which are decided on by the ministry.

Data are unavailable on how these revisions are funded.

Quality assurance is of hearing screening programs is not imposed by the government though information is collected about hearing screening by the Ministry of Health and the National Research Centre for Audiology and Rehabilitation. Therefore, these institutions have the possibility to monitor the screening programme.

Annual reports are not available for Russia.

Studies have been performed on hearing screening in Russia, though not on the programme effectiveness.

38.3. Process: Screening, Diagnosis, Intervention

38.3.1. Neonatal hearing screening

In Russia, well-babies and at-risk babies are screened in the maternity hospital. Approximately 99% of infants are born in maternity hospitals, where the average length of stay after delivery is 3-4 days.

For well-babies, screening should be performed by 72-96 hours of life and before discharge from the hospital though 2% of infants are screened later in the pediatric outpatient clinics. For infants at-risk, screening should be completed by 1 month after birth.

The target condition for screening for well and at-risk babies is a bilateral hearing loss greater than 25 dB HL.

In Russia, at-risk infants are defined as those with a family history of permanent childhood hearing loss, syndromes associated with hearing loss, cranio-facial anomalies, intrauterine infections (CMV, rubella, toxoplasmosis, syphilis), severe hypoxia/ asphyxia requiring mechanical ventilation for more than 5 days, prematurity less than 32 weeks gestation or birthweight less than 1500 g, ototoxic medications during the perinatal period, hyperbilirubinaemia above exchange transfusion levels, neurodegenerative disorders, and meningitis. In Russia, all babies are screened with the same protocol. Infants with one or more of the listed risk factors are automatically referred for diagnostic assessment, regardless of the result of the initial screening test.

In Russia, the percentage of children admitted to the NICU is around 1% (Research Centre for Organization and Information of Public Health , 2017). The prevalence of CMV infections is roughly

estimated to be about 1.5% at birth (National guideline, 2014). The prevalence of meningitis is roughly estimated to be 7.3 per 100 000 at the age of 2 to 4 (National guideline, 2014)

38.3.2. Neonatal diagnostic assessment

In Russia, the national neonatal hearing screening programme for well babies includes both screening and diagnostics. The second stage of the screening programme is the diagnostic assessment. When referral to diagnostic assessment is warranted, families are provided a written referral after discharge from the maternity hospital.

The diagnostic assessment tests performed after referral from the first stage of neonatal hearing screening are ABR, TEOAE, DPOAE, tympanometry, and acoustic reflex testing.

As described, a specified target age for screening is not indicated by guidelines for well-infants; however, regulations indicate that the entire screening / diagnostic process should be completed before 3 months of age. For at-risk infants, the diagnostic test should also be performed by 3 months corrected age.

Those that do not attend the second stage of screening are contacted by phone.

38.3.3. Preschool hearing screening

Not applicable. Russia does not have a preschool hearing screening programme.

38.3.4. Intervention approach

In Russia, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. It is estimated that infants are fitted with hearing aids from less than 6 months of age and infants are fitted with cochlear implants from 6-12 months of age or older.

The estimated hearing aid fitting criteria in Russia is a bilateral hearing loss of >35 dB HL. Unilateral hearing loss is not currently within the criteria for fitting hearing aids.

38.4. 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.

38.4.1. Neonatal hearing screening (well)

The neonatal hearing screening protocol in Russia for well babies is described in Table 1. In Russia, the OAE may be performed multiple times under Step 1 before discharge from the maternity ward. The screening protocol in Russia also includes the diagnostic audiological assessment. The diagnostic assessment is the second phase of the protocol.

Table 70: Screening process for well babies in Russia.

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location
OAE	72-96 hours	4 dB SNR for 3/6 freq (Interacoustics, 2017)	OtoRead TEOAE screening	Yes	Maternity ward

38.4.2. Neonatal hearing screening (at-risk)

The at-risk screening protocol is indicated in Table 2. Note that the process for screening is similar to the process for well babies. However, all babies at-risk are automatically referred to the second phase of the screening programme (i.e., the diagnostic assessment), regardless of the OAE result at the initial screen.

Table 71: Screening process for at-risk babies in Russia.

Test	Age	Referral Criteria	Settings / Device	Unilateral Referrals?	Location
OAE	Before discharge	All infants are referred	OtoRead TEOAE screening	Yes	Maternity ward /NICU

38.4.3. Preschool hearing screening

Not applicable. There is no preschool hearing screening.

38.5. Professionals

38.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses, neonatologists and pediatricians. There is a 2-week accredited/certified course in newborn hearing screening. Updating or re-validating training occurs once every 5 years.

38.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by nurses and pediatricians, but also audiologists.

38.5.3. Preschool hearing screening

Not applicable.

39. Rwanda

***Hearing screening information acquired from answers by**: Lieke Gouma, Rwanda Charity Eye Hospital.*

***General information acquired from answers by**: Lieke Gouma, Rwanda Charity Eye Hospital.*

39.1. Background

In Rwanda, childhood hearing screening does not exist. The following report contains information with regards to childhood hearing screening across Rwanda.

39.1.1. General

The country of Rwanda has an area of 26 338 km^2 and with an estimated population of 11 839 420 in 2017 (National Institute of Statistics Rwanda, 2019).

In Rwanda, most children are registered to their parents' ID at birth; however, some are registered later when applying for health insurance. According to a published report, 51% of births are registered in Rwanda (National Institute of Statistics of Rwanda, 2016). The number of live births in Rwanda, by projection is an estimated 352 052 in 2017 (National Institute of Statistics Rwanda, 2019).

The World Bank income classification categorizes Rwanda as a low-income country (The World Bank, 2018). The gross domestic product (GDP) was €678 per capita in 2017 (National Institute of Statistics Rwanda, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Rwanda in 2015 was 46 USD or €40 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 31.4 per 1000 was reported in 2015 by the World Health Organization (World Health Organization, 2018).

39.1.2. Neonatal hearing screening

In Rwanda, neonatal hearing screening is not conducted. It is not offered in any hospitals in Rwanda.

39.1.3. Preschool hearing screening

There is no preschool hearing screening in Rwanda.

39.2. Guidelines & Quality Control

Not applicable. Hearing screening is not performed in Rwanda.

39.3. Process: Screening, Diagnosis, Intervention

39.3.1. Neonatal hearing screening

Not applicable. Hearing screening is not performed.

39.3.2. Neonatal diagnostic assessment

Not applicable.

39.3.3. Preschool hearing screening

Not applicable.

39.3.4. Intervention approach

In Rwanda, treatment options available include hearing aids. It is unknown at what age hearing aids are fitted on children

The hearing aid fitting recommendations are unknown.

39.4. Protocols

Hearing screening protocols are described for neonatal hearing screening (well-baby 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

39.4.1. Neonatal hearing screening (well)

Not applicable.

39.4.2. Neonatal hearing screening (at-risk)

Not applicable.

39.4.3. Preschool hearing screening

Not applicable.

39.5. Professionals

39.5.1. Neonatal hearing screening (well)

Not applicable. Hearing screening is not performed in Rwanda.

39.5.2. Neonatal hearing screening (at-risk)

Not applicable. Hearing screening is not performed in Rwanda.

39.5.3. Preschool hearing screening

Not applicable. Hearing screening is not performed in Rwanda.

40. Serbia

Hearing screening representatives for Serbia: *Snežana Andrić Filipović, Clinical Centre of Serbia, Clinic of ENT and Maxillofacial Surgery.*

General information acquired from answers by*: Mirjana Zivkovic Sulovic, Head of Center for Analysis, Planning and Organization of Health Care in Institute of Public Health of Serbia.*

40.1. Background

In Serbia, hearing screening is performed regionally and organized by hospitals (locally). The following report contains information with regards to childhood hearing screening in the entire country of Serbia with information specific to the area of Belgrade.

40.1.1. General

Serbia has a total area of 88 361 km^2 with a population of 7 095 383 million in 2015 (Statistical Office of the Republic of Serbia, 2016).

In Serbia, all births are registered in the maternity ward by the community office, which then delivers data to the Statistical Office and the Institute of Public Health. The number of live births in Serbia in 2016 was 64587 (Statistical Office of the Republic of Serbia, 2018)

The World Bank income classification categorizes Serbia as an upper middle-income country (The World Bank, 2018). The gross domestic product (GDP) in 2016 was 640 558 RSD or €5412 per capita in Serbia (Statistical Office of the Republic of Serbia, 2018)

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Serbia in 2015 was 419 USD or €366 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 5.3 per 1000 is reported for Serbia (United Nations Statistics Division, 2016), with a higher mortality rate reported in urban areas (5.7 per 1000) compared to rural areas (4.4 per 1000; United Nations Statistics Division, 2016).

40.1.2. Neonatal hearing screening

In Serbia, the status of neonatal hearing screening is changing quickly. Currently, all maternity hospitals have the tools and capacity to implement a universal neonatal hearing screening programme, and organization is underway. However, screening may not yet be performed on all infants in the country. In Belgrade, all babies have access to hearing screening, though screening is not obligatory for parents. The year in which the universal program for well and at-risk babies was first implemented is not specified; however, an article was published in 2010 with the goal of establishing a neonatal hearing screening programme. It is roughly estimated that the screening for at-risk/ NICU infants began in 2012. Since 2017, all maternity hospitals in Serbia are equipped with screening devices, and national implementation is currently in progress.

Neonatal hearing screening is not embedded in the Preventive Child Health Care screening system. Screening for well and at-risk infants is funded by charity, company, council and the state.

National guidelines or a national screening protocol are not yet available in Serbia.

40.1.3. Preschool hearing screening

Preschool hearing screening is conducted universally in Serbia as part of the routine check-up prior to school entry. It is embedded in the Preventive Child Health Care screening system and is funded by the state. The exact date of when preschool hearing screening began is not known; however, it was prior to 1984.

40.2. Guidelines & Quality Control

National guidelines for hearing screening do not exist in Serbia.

A special board of ENT and speech-language pathologist professionals are selected by the Ministry of Health to develop the content of the hearing screening programme. In 2017, screening devices were provided to all maternity hospitals in Serbia, and staff education and training were organized. This organization for implementation was funded by the state/government.

Quality assurance of hearing screening programs is not imposed by the government. Information is collected locally by regional hospitals; however, the government does not yet collect screening data or publish annual reports.

40.3. Process: Screening, Diagnosis, Intervention

40.3.1. Neonatal hearing screening

Well-babies and at-risk babies are screened in the hospital or private clinic. In 2014, 98.3% of births took place in a maternity hospital (Statistical Office of the Republic of Serbia and UNICEF, 2014), where the average length of stay after delivery is estimated to be 3.98 days. It is roughly estimated that home deliveries account for 1.3% of births. Parents/caregivers of well and at-risk babies are invited to participate in neonatal hearing screening via a letter.

Neonatal hearing screening for well babies should be completed before 3 months of age. For at-risk babies, screening should be completed by 3 to 6 months of age (corrected), depending on the health and developmental status of the child.

At-risk infants are defined as those with a positive family history of hearing loss, admission to the NICU for more than 5 days, use of mechanical ventilation, prematurity, use of ototoxic medications, or with meningitis.

Data on the prevalence of CMV is not available in Serbia. The prevalence of meningitis was 137 cases (total) in 2015.

The target condition for screening for well- and at-risk babies is a unilateral or bilateral hearing loss of 30 dB HL or worse.

40.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral is described in the article by Babac, Đerić, & Ivanković (2007) as including OAEs, tympanometry and click-ABR. The diagnostic assessment should be completed by 3-6 months of age for well infants, and after 6 months of age for at-risk infants, depending on the general health and developmental status of the child. The diagnostic assessment may be scheduled after 6 months of age if delayed neurological maturation may be suspected.

40.3.3. Preschool hearing screening

Preschool hearing screening is performed at primary or secondary health care centres, depending on the availability of pure-tone audiometers. Children and parents are invited to participate via a letter. Testing is performed by a trained audiologist.

The target condition for preschool hearing screening is a unilateral or bilateral hearing loss of 25 dB or worse.

40.3.4. Intervention approach

In Serbia, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids and cochlear implants from 6 months of age or older.

The fitting criteria in Serbia for a hearing aid is bilateral hearing loss of at least 30 dB HL in the better ear or a unilateral hearing loss of at least 40 dB HL.

40.4. 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

40.4.1. 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 before discharge. If the infant fails the first test, rescreening occurs at 1 month of age. A subsequent fail at age 1-month would warrant a follow-up assessment at 3-6 months of age at a secondary referral centre (audiology department).

Table 72: Process for neonatal hearing screening for well, healthy infants in Serbia.

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location
OAE1	24-72 hours	Various	Otometrics, Fisher-Zoth Echo Screen, Maico	Yes	Maternity hospital
OAE2	1 month	Various	Otometrics, Fisher-Zoth Echo Screen, Maico	Yes	Maternity hospital

40.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk infants is described in Table 2. Infants in the NICU are mainly screened with TEOAE. In some hospitals, aABR may also be performed before discharge from the hospital, regardless of whether the infant passed or failed the OAE screen. If the aABR is a fail, the infant will be referred for further assessment. Additionally, infants that present additional risk factors for hearing loss (excluding NICU admission), may be referred for ENT follow-up at a later time by their pediatrician.

Table 73: Process for neonatal hearing screening for at-risk infants in Serbia.

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location
OAE1 (+aABR, some hospitals)	24-72 hours	Various	Various	Yes	Maternity hospital
OAE2	1 month	Various	Various	Yes	Maternity hospital

40.4.3. Preschool hearing screening

Hearing screening is performed prior to school entry during a routine childhood check-up at 6-7 years of age. Pure-tone audiometry, in addition to otoscopy, tympanometry, and a tuning-fork test is performed at the primary or secondary health center, depending on equipment availability. Referrals are made to ENT or to the audiology department depending on the suspected nature of the hearing loss (conductive or sensorineural).

Table 74: Process for preschool hearing screening in Serbia.

Test	Age	Referral criteria	Unilateral Referrals?	Location
Pure-tone audiometry + otoscopy + tympanometry + tuning fork test	6-7 years	25 dB HL	One or both	Primary or secondary health care centre

40.5. Professionals

40.5.1. Neonatal hearing screening (well)

Screening is performed by trained nurses or otolaryngologists.

There is no specific training for hearing screening staff or certified education. Training of the nurses involved in hearing screening is either performed by the manufacturers or companies providing the screening equipment or by a senior audiologist.

40.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by nurses (see 39.1 for training requirements).

40.5.3. Preschool hearing screening

Screening for preschool-age children is performed by trained audiologists.

41. Slovakia

Hearing screening representatives for Slovaka: *Irina Šebová, Children's ENT Department Medical Faculty of Comenius University and National Institute of Children Diseases.*

41.1. 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.

41.1.1. General

Slovakia has a total area of 49 035 km^2 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).

41.1.2. 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.

41.1.3. Preschool hearing screening

There is no preschool hearing screening programme in Slovakia.

41.2. 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.

41.3. Process: Screening, Diagnosis, Intervention

41.3.1. 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.

41.3.2. Neonatal diagnostic assessment

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

41.3.3. Preschool hearing screening

Not applicable.

41.3.4. 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.

41.4. 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

41.4.1. 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 75: 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

41.4.2. 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 76: 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

41.4.3. Preschool hearing screening

Not applicable.

41.5. Professionals

41.5.1. 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.

41.5.2. Neonatal hearing screening (at-risk)

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

41.5.3. Preschool hearing screening

Not applicable.

42. Slovenia

Hearing screening representative for Slovenia: *Saba Battelino, University Medical Centre Ljubljana, University of Ljubljana, Faculty of Medicine.*

General information provided by: *Mojca Juricic, University of Ljubljana, Faculty of Medicine, Dep of Public Health.*

42.1. Background

In Slovenia, neonatal hearing screening is organized nationally through the National Institute for Health and implemented across all 14 maternity hospitals.

The following report contains information with regards to hearing screening in the entire country of Slovenia.

42.1.1. General

The country of Slovenia has a total area of 20 273 km^2 and a population of 2 065 895 as of January 2017 (Statistical Office of the Republic of Slovenia, 2018). In Slovenia, each birth is registered. The number of live births in Slovenia was 20 641 in 2015.

The World Bank income classification categorizes Slovenia as a high-income country (The World Bank, 2018). The gross domestic product (GDP) was €19 262 per capita in 2015 (Statistical Office of the Republic of Slovenia, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in Slovenia in 2015 was 1 772 USD or €1 528 per capita (World Health Organization, 2018).

Infant mortality rate in the country of Slovenia was 1.8 and 1.6 per 1000 in 2014 and 2015, respectively (United Nations Statistics Division, 2016; Statistical Office of the Republic of Slovenia, 2018).

42.1.2. Neonatal hearing screening

In Slovenia, neonatal hearing screening is conducted universally, with all babies in the country having access to hearing screening, though participation is not obligatory for parents. Neonatal hearing screening for well babies started and was fully implemented on in Slovenia in 2005 and was fully implemented in 2006. For infants at risk, screening was implemented in 2009, but it is unknown when it was implemented across the country. Neonatal hearing screening is funded through health insurance and is embedded in the Preventive Child Health Care screening system.

Neonatal hearing screening is organized by the Ministry of Health, who distributes funding. Each maternity hospital is responsible for training staff, managing equipment, and sending data to the National Institute of Health.

National guidelines are not available, nor is an official screening protocol across the country. Across Slovenia, maternity hospitals use the same protocol for performing TEOAEs and reporting results: however, there may be differences in rescreening and follow-up. Family physicians responsible for referring infants may refer to primary or secondary ENT clinics for rescreening before referral to audiological (tertiary) centres. However, in Ljublana or Maribor, family physicians may refer directly

to the audiological centre without intermediate rescreening at the ENT centre. It is unclear whether there are differences in protocol across NICUs in Slovenia.

42.1.3. Preschool hearing screening

In Slovenia, preschool hearing screening is not universally performed. Depending on the region, some type of test may be performed on preschool children. In Ljubljana, group audiometry is performed; in Celje, pure-tone audiometry is performed; and in the other 12 regions a whisper test may be performed. While early accounts of screening preschool-aged children in Ljubljana dates back to the 1960s, screening is not performed across the entire country.

42.2. Guidelines & Quality Control

As indicated, official national guidelines for hearing screening and screening protocol do not exist in Slovenia.

The content of the general hearing screening programme was decided on by the Ministry for Health, and has not been changed since implementation.

Quality assurance of hearing screening programmes is not imposed by the government; however, pass/refer information from maternity hospitals is collected by the National Institute for Health. Maternity hospitals are obligated to release the results of their individual neonatal data, including figures such as weight, APGAR scores, and neonatal hearing screening results. Data are automatically sent to the National Institute of Health. Other data collection is not systematically performed, but only when hospitals or the university are interested in collecting their own data.

Annual reports are not available. There have not been any studies on hearing screening programmes in Slovenia, nor has there been research performed on the effectiveness of screening in Slovenia.

42.3. Process: Screening, Diagnosis, Intervention

42.3.1. Neonatal hearing screening

In Slovenia, infants are screened in the hospital. It is estimated that 99% of infants are born in hospitals each year and 0.3% are born at home. The average length of stay in the maternity hospital after birth is 2 days. Families are invited to participate in screening directly in person at the hospital. For at-risk infants, its estimated that a doctor invites families to participate.

The target condition for screening is not documented in guidelines; however, the common target for neonatal screening is a bilateral hearing loss of at least 30 dB as defined by both automatic screening instruments and by hearing aid fitting protocols in Slovenia.

There is no set age in protocol by which neonatal hearing screening for well infants and infants at risk should be completed. Screening is performed in the hospital for all infants.

At-risk infants are defined as those admitted to the NICU, are premature, or have hypoxia, hypoglycemia, or sepsis.

Data are unavailable on the childhood/infant prevalence of CMV infections or meningitis in Slovenia.

42.3.2. Neonatal diagnostic assessment

The diagnostic assessment for well infants should be completed by 3-6 months of age (ideally by 3 months), and for at-risk infants should be completed before 4-12 weeks of age. Continued monitoring may be performed, depending on the case.

42.3.3. Preschool hearing screening

The target condition is a hearing loss of at least 30 dB HL.

42.3.4. Intervention approach

In Slovenia, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Children are fitted with hearing aids from < 6 months of age and with cochlear implants from 6-12 months of age.

According to insurance regulation, fitting guidelines for hearing aids in Slovenia is at least a 30-dB pure-tone average at 500, 1000, 2000 and 4000 Hz.

42.4. 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

42.4.1. Neonatal hearing screening (well)

The screening protocol for well infants in Slovenia is described in Table 1. As described previously, after referral from the maternity ward, infants may first be rescreened in a general ENT clinic before being referred further to the tertiary audiological centre. In Ljubljana or Maribor, family physicians may refer infants directly to the tertiary audiological centre.

Table 77: Process for neonatal hearing screening for well, healthy infants in Slovenia.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location

OAE1	24-72 hrs	4 dB SNR for 3/6 freq (Maico, 2017)	Maico Screener	Yes	Maternity ward
optional OAE rescreen				Yes	General ENT centre
OAE2/3 (+ Tymp)	>10 days			Yes	Audiological centre

42.4.2. Neonatal hearing screening (at-risk)

Infants at-risk are screened with aABR. This protocol has been in effect for the last 2 years.

Table 78: Process for neonatal hearing screening at-risk infants in Slovenia.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
aABR	< 2 weeks after birth (36-42 weeks); before discharge	35-45 dB	Maico Screener	Yes	NICU

42.4.3. Preschool hearing screening

Hearing screening protocol for preschool-age children is not universal and differs across region in Slovenia. Screening generally takes place around the age of 5 to 6 years.

In some regions, group audiometry or pure-tone audiometry is performed. In other regions, the whisper test is performed. Testing occurs at the Child Health Care Centre and is performed by a pediatrician or a nurse. The referral criteria differ, depending on the test performed, and may be 25-30 dB for audiometry and a distance of 5 meters for the whisper test.

42.5. Professionals

42.5.1. Neonatal hearing screening (well)

Screening for well-babies is performed by nurses. There is no specific training programme for screening professionals. Nurses are trained by more experience nurses in the maternity ward or NICU.

42.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is performed by specialist nurses or pediatricians. Some specialized nurses are trained in the audiological centre in Ljubljana. However, no specific training is officially required.

42.5.3. Preschool hearing screening

Preschool-age screening is performed by a pediatrician or nurse.

43. Spain (Autonomous Community of Valencia)

Hearing screening representative for Spain (Valencian Community): *Jose Miguel Sequi-Canet, Pediatrics, Hospital Francesc de Borja Gandia..*

43.1. Background

In Spain, hearing screening is performed nationally, yet organized regionally. The following report contains information with regards to hearing screening in the Autonomous Community of Valencia (Comunitat Valenciana), hereafter, the Valencian Community, which includes the provinces of Castellon, Valencia, and Alicante.

43.1.1. General

The Valencian Community has a total area of 23 255 km^2 with a population of 4 959 968. The birthrate in the Valencian Community is 43 450 per year (Generalitat Valenciana, 2016).

The World Bank income classification categorizes Spain as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2015 was €20 586 per capita in the Valencian Community and €23 300 per capita in Spain (Datosmacros.com, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for all of Spain in 2015 was 2 354 USD or €2 026 per capita (World Health Organization (WHO), 2018).

In the Valencian Community, each birth is registered with the law office. Data from the Generalitat Valenciana (2016) indicates an infant mortality rate of 3.18 per 1000 for the Valencian Community in 2015. Data acquired from the 2016 United Nations Demographic Yearbook indicates an infant mortality rate of 2.7 per 1000 for the country of Spain in 2015 (United Nations Statistical Division, 2016).

43.1.2. Neonatal hearing screening

In the Valencian Community, neonatal hearing screening is conducted universally, with all babies in the region 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 2000, and by 2008/2009, neonatal hearing screening was implemented across the region. Neonatal hearing screening is embedded in the Preventive Child Health Care screening system. Screening is funded through the state and organized through the regional government via an auditory screening committee within Public Health entitled “salud publica: cribado auditivo” containing a group of experts.

Each region across Spain is responsible for organizing its own protocol, though a national committee (CODEPEH) publishes recommended guidelines. Regions use the different protocols for screening well and at-risk babies, though for at-risk infants nearly all regions use aABR. Within the Valencian Community, all public hospitals follow the same protocol.

43.1.3. Preschool hearing screening

The well child control programme contains some indications about hearing. There is a current mandate that pediatricians ask the family about hearing status and a tuning fork test is occasionally performed. However, preschool hearing screening is not performed universally in the Valencian Community. Further sections in this report will state “not applicable” with regards to information about preschool hearing screening.

43.2. Guidelines & Quality Control

National recommended guidelines for hearing screening exist in Spain, published by CODEPEH (Comisión para la Detección Precoz de la Hipoacusia Infantil (CODEPEH), 1999; Trinidad-Ramos, de Aguilar, Jaudenes-Casaubon, Nunez-Batalla, & Sequi-Canet, 2010). These recommendations may be used for the development of regional protocols.

The content of the hearing screening programme was decided on by the Valencian Community government through a panel of experts and has not been changed since its implementation. The revision process is performed when needed through a meeting of experts and is funded by the state.

Quality assurance of hearing screening programmes is not imposed by the government; however, information is collected about hearing screening outcomes through a database specific to the Valencian Community.

Annual reports are available, but with some delays. The most recent data from 2013 were published in 2015 (Dirección General de Salud Pública, 2015). Other research has been performed on hearing screening in the Valencian Community apart from auditing (e.g. Sequi-Canet, Sala-Langa, & Collar del Castillo, 2016; Sequi-Canet, Sala-Langa, & Collar del Castillo, 2014).

43.3. Process: Screening, Diagnosis, Intervention

43.3.1. Neonatal hearing screening

Well-babies and at-risk babies are screened in the hospital. Well-baby and at-risk families are invited to participate in neonatal screening directly in person in the hospital by pediatricians, nurses and sometimes ENT physicians. It is estimated that 90% of infants are born in a hospital or maternity clinic in the Valencian Community and 10% of births take place at home. The average stay in the maternity hospital after birth is estimated to be 48 hours (2 days).

Neonatal hearing screening for both well- and at-risk babies should be completed before 1 month of age.

In the Valencian Community, approximately 3% of infants are screened differently than well-babies. The definition of at-risk infants is obtained from the 2007 publication by the Joint Committee of Infant Hearing (Joint Committee on Infant Hearing, 2007). Infants with risk factors are screened at least once with aABR, with or without TEOAE screening. The exception is infants with a family history of hearing loss in the well-baby nursery who are screened with TEOAE.

The prevalence of CMV infections among neonates is estimated to be <1%. The prevalence of meningitis (all cases) is estimated to be <3 cases per 10000.

The target condition for screening for well- and at-risk babies is a hearing loss of >40 dB HL.

43.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests performed after neonatal hearing screening referral are tympanometry, clinical ABR, TEOAE/DPOAE, and ASSR. Testing should be performed by 3 months of age.

43.3.3. Preschool hearing screening

Not applicable.

43.3.4. Intervention approach

In the Valencian Community, treatment options available include grommets, hearing aids, bone conductive devices and cochlear implants. Infants are fitted with hearing aids from 6-12 months of age and cochlear implants from 1-2 years of age.

The hearing aid fitting criteria in the Valencian Community is a bilateral hearing loss of >40 dB HL.

43.4. 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

43.4.1. Neonatal hearing screening (well)

The protocol for neonatal hearing screening for well babies is described in Table 1. A two-step OAE screening programme is in effect, whereby the first step of OAE screening takes place in the maternity ward and the second step occurs before the infant is 1 month of age. The first OAE step may include one or two OAE tests depending on when the first test occurred and when the infant is discharged. If two OAE tests are performed, these would both be included under OAE1.

Table 79: Screening protocol for well babies in the Valencian Community.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1*	24-72 hours	Base program†	Otodynamics ILO	Yes	Maternity hospital
OAE2	<30 days	Base program	Otodynamics ILO	Yes	Hospital (outpatient)

*Step 1 (OAE1) takes place before hospital discharge. If OAE1 fails and time allows, a repeat screening will be performed before discharge. This rescreen is still included under Step 1 (OAE1).
†Default referral criteria according to the Otodynamics EchoPort EZScreen Manual (Otodynamics, 2017) is 3 out of 5 bands with a criteria of 6 dB SNR, and confirmed in Sequi-Canet, Sala-Langa & Collar del Castillo (2016).

43.4.2. Neonatal hearing screening (at-risk)

The screening protocol for at-risk infants is described in Table 2. As indicated previously, infants that undergo screening with the at-risk protocol are those with risk indicators defined by the Joint Committee on Infant Hearing (2007). These infants may or may not also undergo OAE screening in addition to aABR screening. The exception is infants in the well-baby unit with a family history of hearing loss who are screened according to the well-baby protocol.

Table 80: Screening protocol for at-risk babies in the Valencian Community.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
aABR	2-8 weeks (36-42 weeks gestation)	35 dB nHL	Various	Yes	NICU

43.4.3. Preschool hearing screening

Not applicable.

43.5. Professionals

43.5.1. Neonatal hearing screening (well)

Screening for well babies is predominantly performed by pediatric nurses. In a few hospitals, pediatricians or ENT physicians also perform screening. All screening staff (including nurses, pedatricians and ENT physicians) undergo training for a few days. The head of the nursing staff typically performs the in-house training, except in large hospitals where there is a dedicated team for training new staff.

43.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by nurses, pediatricians, or ENT physicians, and training is similar to that for well-baby screening.

43.5.3. Preschool hearing screening

Not applicable.

44. Spain (Principality of Asturias)

Hearing screening representative for Spain (Principality of Asturias): *Faustino Nunez-Batalla, Hospital Universitario Central de Asturias, Principado de Asturias, Spain.*

44.1. Background

In Spain, hearing screening is performed nationally, yet organized regionally. The following report contains information with regards to childhood hearing screening in the Autonomous Community or Principality of Asturias.

44.1.1. General

The Principality of Asturias has a total area of 10 604 km^2 with a population of 1 034 960 in 2016. The birthrate in the Principality of Asturias is 6600 per year, from 2015 data (Asturian Society of Economic and Industrial Studies, 2017).

The World Bank income classification categorizes Spain as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2015 was €21 595 per capita in the Principality of Asturias (Asturian Society of Economic and Industrial Studies, 2017) and €23 300 per capita in Spain (Datosmacros.com, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for all of Spain in 2015 was 2 354 USD or €2 026 per capita (World Health Organization (WHO), 2018).

In the Principality of Asturias, each birth is registered. Data from the Asturian Society of Economic and Industrial Studies indicate an infant mortality rate of 1.86 per 1000 for the Principality of Asturias in 2015 (2017). Data acquired from the 2016 United Nations Demographic Yearbook indicates an infant mortality rate of 2.7 per 1000 for the country of Spain in 2015 (United Nations Statistical Division, 2016).

44.1.2. Neonatal hearing screening

In the Principality of Asturias, neonatal hearing screening is conducted universally, with all babies in the region 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 2002 across the entire region. Neonatal hearing screening is not embedded in the Preventive Child Health Care screening system. Screening is funded by the region.

Each region across Spain is responsible for organizing its own protocol, though a national committee (CODEPEH) publishes recommended guidelines. Regions use the different protocols for screening well and at-risk babies, though for at-risk infants nearly all regions use aABR. There are no differences in neonatal hearing screening protocols across the Principality of Asturias for either well babies or at-risk babies.

44.1.3. Preschool hearing screening

In the Principality of Asturias, preschool hearing screening is not performed.

44.2. Guidelines & Quality Control

National recommended guidelines for hearing screening exist in Spain, published by CODEPEH (Comisión para la Detección Precoz de la Hipoacusia Infantil (CODEPEH), 1999; Trinidad-Ramos, de Aguilar, Jaudenes-Casaubon, Nunez-Batalla, & Sequi-Canet, 2010). These recommendations may be used for the development of regional protocols.

Regional guidelines and a protocol for hearing screening exist in the Principality of Asturias. The content of the hearing screening programme was decided on by the public health organization.

Quality assurance of hearing screening programs is not imposed by the government; however, information is collected about hearing screening outcomes. Hospitals regularly send hearing screening information via email to a generalized database of all hospitals in the Principality of Asturias. Neonatal hearing screening outcomes collected from maternity hospitals are reviewed annually. It is unknown how the review and revision process is funded. The content of the programme has not been changed since its start.

Annual reports are available based on data collected from maternity hospitals. It is unknown if other research has been performed in the Principality of Asturias apart from this annual auditing.

44.3. Process: Screening, Diagnosis, Intervention

44.3.1. Neonatal hearing screening

Well-babies and at-risk babies are screened in the hospital. Well-babies are invited to participate in neonatal hearing screening via a letter, and at-risk families are invited to participate in neonatal screening directly in person in the hospital by pediatricians, nurses and sometimes ENT physicians. It is roughly estimated that 99% of infants are born in maternity hospitals, where the average length of stay is 2 days after delivery.

Neonatal hearing screening for both well and at-risk babies should be completed before 3-months of age.

In the Principality of Asturias, 1.4% of infants have an increased risk of auditory neuropathy and are screened differently than well-babies. At-risk infants are defined as those with hypoxia, family history of hearing loss, and hyperbilirubinemia.

The prevalence of CMV infections or meningitis among neonates is unknown.

The target condition for screening for well- and at-risk babies is a bilateral hearing loss of 35 dB HL or worse.

44.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral, including clinical ABR, should be performed before 6 months of age.

44.3.3. Preschool hearing screening

Not applicable.

44.3.4. Intervention approach

In the Principality of Asturias, treatment options available include grommets, hearing aids, bone conductive devices and cochlear implants. The average age infants are fitted with hearing aids is 8.42 months of age. Infants are fitted with cochlear implants from 1-2 years of age.

The hearing aid fitting criteria in the Principality of Asturias is a hearing loss > 40 dB HL.

44.4. 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

44.4.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies is described in Table 1. A 3-step OAE protocol is in effect, whereby the first OAE is performed in the maternity hospital before discharge. If the infant fails the first OAE, rescreening occurs at 15 days after birth and again by 3 months.

Table 81: Screening protocol for well babies in the Principality of Asturias.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	24-72 hours	Bimodial statistical probability	Echo-screen	Yes	Maternity hospital
OAE2	15 days			Yes	Maternity hospital
OAE3	<3 months			Yes	Maternity hospital

44.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk infants is described in Table 2. As indicated, infants with hypoxia, family history of deafness, or hyperbilirubinemia undergo the at-risk protocol. These infants are initially screened with OAE. In cases where the OAE is a pass, an aABR is performed.

In cases where OAE is a fail, a second OAE is performed at 15 days and a third OAE is performed at 3 months.

After at-risk infants pass neonatal hearing screening, a follow-up process is then initiated until the child is 3-years of age.

Table 82: Screening process for at-risk babies in the Principality of Asturias.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE+ aABR	2-8 weeks (36-42 weeks gestation)	Bimodial statistical probability / 35 dB nHL	Echo-screen	Yes	Hospital
OAE2	15 days			Yes	Hospital
OAE3	3 months			Yes	Hospital

44.4.3. Preschool hearing screening

Not applicable.

44.5. Professionals

44.5.1. Neonatal hearing screening (well)

Screening for well and at-risk babies is performed by nurses. Nurses undergo a specific one-week training on hearing screening, which is not accredited or certified. The training is not updated, monitored or revalidated.

44.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by nurses.

44.5.3. Preschool hearing screening

Not applicable.

45. Sweden (Stockholm Region)

Hearing screening representative for Sweden (Stockholm Region): *Inger Uhlén, Department of Clinical Science, Intervention and Technology (CLINTEC), Karolinska Institutet.*

45.1. Background

In Sweden, neonatal hearing screening and preschool hearing screening are organized regionally, though both screening programmes are nationally implemented. There are 27 regions of Sweden and each is responsible for organizing components of its own health care, including hearing screening.

The following report contains information with regards to hearing screening in the region of Stockholm. While all regions provide hearing screening and hearing screening programmes are quite similar, results are not reported nationally and protocols may differ slightly between regions.

45.1.1. General

Stockholm region, including the capital city of Stockholm and surround area, has a total area of 6524 km^2 with a population count of 2 303 417 in 2017. In the Stockholm region and in Sweden, each birth is registered. The number of births is 28 805 per year in Stockholm region and 115 416 per year in Sweden, acquired from 2017 national statistical data (Statistics Sweden, 2018)

The World Bank income classification categorizes Sweden as a high-income country (The World Bank, 2018). The gross domestic product (GDP) in 2015 was 627 000 SEK or approximately €60 000 per capita for Stockholm region and 444 000 SEK or €42 000 per capita for all of Sweden in 2016 (Statistics Sweden, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for all of Sweden in 2015 was 5 600 USD or €4 839 per capita (World Health Organization (WHO), 2018).

Data acquired from the 2016 United Nations Demographic Yearbook indicates an infant mortality rate of 2.5 per 1000 for the country of Sweden in 2015 (United Nations Statistical Division, 2016), and data from Statistics Sweden indicates an infant mortality rate of 2.4 per 1000 for 2017 (Statistics Sweden, 2018).

45.1.2. Neonatal hearing screening

In Stockholm region, neonatal hearing screening is conducted universally, with all babies in the region having access to hearing screening. Screening is not obligatory for parents. The universal programme for well and at-risk babies was first implemented in 1998. By 2008, neonatal hearing screening was implemented across the country (Swedish Agency for Health Technology Assessment and Assessment of Social Services (SBU), 2004; Socialstyrelsen, 2014). Neonatal hearing screening is not embedded in the Preventive Child Health Care screening system. Regions in Sweden provide funding for well-baby screening, while hospitals provide the funding for screening infants at risk.

Regions may use different protocols for neonatal screening for both well babies at at-risk babies, and therefore tests performed and referral criteria may differ regionally. For example, regions may use aABR, OAE or both methods for screening.

45.1.3. Preschool hearing screening

In Sweden, preschool hearing screening exists regionally and is embedded in the general Preventive Child Health Care system. Similar to neonatal hearing screening, there are differences in preschool hearing screening across regions, as some regions may not screen hearing at age 4 years, though it is recommended in the guidelines for child health care.

45.2. Guidelines & Quality Control

National guidelines for child health care exist in Sweden, including guidelines for childhood hearing screening (Socialstyrelsen, 2014). While national guidelines exist for Sweden, protocols for hearing screening are decided regionally. A protocol exists for neonatal hearing screening in Stockholm region (Riktlinjer för screeningpersonal vid hörselscreening för nyfödda, 2008 or Gudielines for staff performing newborn hearing screening, 2008)

The content of hearing screening programme was decided on by the public health organization, paediatricians and ENT specialists. The content of the programme was revised in 1998-2005 when neonatal hearing screening was implemented in Stockholm region and behavioural observational audiometry screening at 7-8 months, previously provided by child health care centres, was abandoned. Furthermore, the neonatal hearing screening protocol in Stockholm region was revised in 2016 when aABR screening was added to the protocol.

It is unknown who decides on the revisions, how revisions take place or how revisions are funded.

Quality assurance is of hearing screening programmes is not imposed by the government, though information is collected about hearing screening outcomes in Stockholm region.

Annual reports are available for Stockholm region (e.g., Karolinska University Hospital, 2018).

Studies have been performed on hearing screening in Stockholm region, including its effectiveness (e.g., Berninger & Westling, 2011).

45.3. Process: Screening, Diagnosis, Intervention

45.3.1. Neonatal hearing screening

In Stockholm region, well-babies and at-risk babies are screened in the in the hospital where the average length of stay after deliver is 1.8 days. Approximately 99.8 % of infants in Stockholm region are born in maternity hospitals and 70-80 infants per year (0.25%) are born at home. Staff in the maternity ward invite well-baby families directly to participate in neonatal hearing screening as part of routine care after delivery. For at-risk babies, invitation is by staff in the NICU or from the ENT/Audiology unit. Information about hearing screening is also provided to families prior to delivery.

In Stockholm region, at risk infants are defined as those with congenital infections (CMR, toxoplasmosis), taking ototoxic medications, meningitis, craniofacial malformations, and syndromes, in addition to infants admitted to the NICU and who are extremely premature. Babies who meet these

conditions are screened using a different protocol because of the increased risk of auditory neuropathy and other retrocochlear hearing impairment. It is estimated that approximately 5% of infants are screened with the at-risk protocol.

The prevalence of CMV infections and meningitis among neonates is not known.

Neonatal hearing screening for well babies should be completed before 4 weeks of age. For infants at-risk, screening should also be completed by 4 weeks of age or by discharge.

The target condition for screening for well and at-risk babies is a unilateral or bilateral hearing loss greater than 30 dB HL. For at-risk babies, the target condition also includes auditory neuropathy.

45.3.2. Neonatal diagnostic assessment

The diagnostic assessment tests performed after neonatal hearing screening referral are clinical ABR and ASSR.

The diagnostic assessment of well-babies should be performed before 3 months of age. For at-risk infants, there is no recommended maximum age, but the test should be performed as soon as possible depending on the child's medical condition.

45.3.3. Preschool hearing screening

Preschool-age hearing screening takes place at child health care centres when children are 4 years old and at school when the children are 6 years old.

Children are invited to participate in hearing screening by the child health care centres through a letter.

The target condition for preschool-age screening is a bilateral or unilateral hearing loss of >25 dB HL from 500 to 4000 Hz. For school-age screening, the target condition is a bilateral or unilateral hearing loss of >20 dB HL from 500 to 6000 Hz.

45.3.4. Intervention approach

In Stockholm region, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids from less than 6 months of age and infants are fitted with cochlear implants from 6-12 months of age or older.

The hearing aid fitting criteria in Stockholm region is a bilateral hearing loss of >25 dB HL or a unilateral hearing loss of >40 dB HL.

45.4. 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

45.4.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies is described in Table 1. A 3-step OAE and aABR protocol is in effect. The first OAE is performed in the maternity hospital typically before discharge. Infants that do not pass the initial OAE are rescreened in the maternity hospital. If the infant fails the second OAE, a third rescreening of OAE takes place in the audiology department before the age of 4 weeks. Infants that do not pass the third OAE screen are directly screened with aABR in the same appointment.

Table 83: Screening protocol for well babies in Stockholm region, Sweden.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
OAE1	24-72 hours	4 dB SNR, 3/4 freqs & 70% reproducibility	Otodynamics	Yes	Maternity ward
OAE2	2 weeks			Yes	Maternity ward
OAE3	< 4 weeks			Yes	Audiology dept
aABR	< 4 weeks	30 dB nHL	Accuscreen	Yes	Audiology dept

45.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk infants is described in Table 2. These infants are screened with both OAE and aABR. At-risk infants that fail aABR are referred directly for a diagnostic assessment. At-risk infants that fail OAE but pass aABR are called back at one year of age.

Table 84: Screening protocol for at-risk babies in Stockholm region, Sweden.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
aABR + OAE	ASAP after 35 weeks gest.	30 dB nHL (aABR), 4 dB SNR at 3/4 freqs & 70% reproducibility (OAE)	Accuscreen, Otodynamics	Yes	NICU or Audiology dept

45.4.3. Preschool hearing screening

The screening procedure for preschool-age hearing screening is described in Table 3. If the child meets the referral criteria, they are rescreened before being referred for a diagnostic assessment.

Table 85: Screening process for preschool-age children in Stockholm region, Sweden.

Test	Age	Referral criteria	Location
Pure-tone audiometry1 Pure-tone audiometry2	4 years	30 dB HL or worse at 2 frequencies or 40 dB HL or worse at 1 frequency (0.5, 1, 2, and 4 kHz)	Child health care centers

45.5. Professionals

45.5.1. Neonatal hearing screening (well)

Screening for well babies is performed by nurses, midwives, assistant nurses or audiologists. When screening was first implemented, a training session was held including a full day of lectures, followed by practical training. Theoretical and clinical training of professional staff is also held when a new device is added to the protocol.

Today there is no specific training programme or certification requirement for new staff, but new screeners are trained on the job by experienced staff. On-the-job training takes approximately 4 weeks. Screening results (specifically referral rates) are assessed for each screener to monitor inexperienced staff. Furthermore, a yearly seminar is held where screeners are invited to attend to hear about updated methodology as well as yearly performance results and feedback.

45.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by nurses, midwives, assistant nurses or audiologists. Training is the same as for staff performing well-baby screening (see section 5.1, above).

45.5.3. Preschool hearing screening

Preschool hearing screening is performed by nurses with special training. Training on hearing screening for these nurses is not indicated.

46. Switzerland

Hearing screening representative for Switzerland: *Nora Buser, ENT department, Zurich University Hospital in collaboration with Dorothe Veraguth, Head of Audiology, Zurich University Hospital.*

General information provided by: *Nora Buser, ENT department, Zurich University Hospital.*

46.1. Background

In Switzerland, hearing screening is organized regionally, though neonatal hearing screening is implemented across the entire country and offered universally to all babies. A national hearing screening protocol is followed across all hospitals in Switzerland, though organization of screening is provided by the larger ENT centres where diagnostic follow-up occurs. Preschool hearing screening is also organized via pediatricians.

The following report contains information with regards to hearing screening for the entire country of Switzerland.

46.1.1. General

The country of Switzerland has a total area of 41 285 km^2 and a population of 8 419 550 as of 2017 (Bundesamt für Statistik [Federal Statistical Office], 2018). In Switzerland, each birth is registered. The number of live births in Switzerland was 87 381 in 2017 (Bundesamt für Statistik [Federal Statistical Office], 2018).

The World Bank income classification categorizes Switzerland as a high-income country (The World Bank, 2018). The gross domestic product (GDP) was €70 258 per capita in 2017 (Bundesamt für Statistik [Federal Statistical Office], 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure in 2015 was 9808 USD or €8575 per capita (World Health Organization, 2018).

Infant mortality rate in the country of Switzerland was 3.9 per 1000 in 2015 (United Nations Statistics Division, 2016) and 3.5 per 1000 in 2017 (Bundesamt für Statistik [Federal Statistical Office], 2018).

46.1.2. Neonatal hearing screening

In Switzerland, 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 for all babies started in Switzerland in 1999 and was also fully implemented across the country in the years following. Neonatal hearing screening is funded by health insurance, but and is embedded into the Preventive Child Health Care screening system.

Neonatal hearing screening is organized by the ENT centres responsible for follow-up, though all screeners comply with the national guidance document and protocol. The same protocol was used for screening well and at-risk infants until 2017.

46.1.3. Preschool hearing screening

In Switzerland, preschool hearing screening is universally performed. It was fully implemented across the country prior to 2000. Cao-Nguyen, Kos and Guyot (2007) indicate that screening preschool-age

children even started prior to 1957. It is funded by health insurance and is part of the Preventive Child Health Care screening system.

46.2. Guidelines & Quality Control

National guidelines for childhood hearing screening exist in Switzerland, decided on by professional societies consisting of ENTs, pediatricians and neonatologists. The guidelines were originally published in 1999, and were recently updated in 2017 to include bilateral screening, narrowed the target condition, and added aABR screening for at-risk infants. Prior 2017, only one ear was tested.

Updates and revisions are also made by the professional societies, though funding is not provided for these revisions.

Quality assurance of hearing screening programmes is not imposed by the government, and data collection is not performed nationally. Any data collection is only performed on a local level. Annually reports are not available.

There have been a couple studies performed on the neonatal hearing screening programme in Switzerland (Cao-Nguyen, Kos, & Guyot, 2007; Metzger, Pezier, & Veraguth, 2013).

46.3. Process: Screening, Diagnosis, Intervention

46.3.1. Neonatal hearing screening

In Switzerland, infants are screened in the hospital maternity ward. Data are unavailable regarding the percentage of neonates born in maternity hospitals in Switzerland or the percentage of neonates born at home. However, the average length of stay in the maternity hospital after birth is roughly estimated to be 3 days (5 days in cases of caesarean section). Invitation to screening is performed directly at the hospital by screening staff.

The target condition for screening both well- and at-risk infants is currently a bilateral or unilateral hearing loss of ≥ 25 dB HL; however, this recently changed. New guidelines published in 2017 altered the target condition for the neonatal hearing screening programme.

Initial screening is performed in the maternity hospital. All screening should be completed by 1 month of age for both well and at-risk infants.

Until 2017, all infants (both well and at-risk) undergo the same screening protocol. There was no difference in screening protocol between groups of infants and no specific protocol for at-risk infants.

The prevalence of CMV infections or meningitis in Switzerland is unknown.

46.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral should be completed by 3 months of age for both well, healthy infants and at-risk infants when possible. According to the document provided, tests performed for the confirmation of hearing loss include DPOAE/TEOAE, frequency-specific ABR, and behavioural audiometry. Tympanometry and otosocopy is also performed at the tertiary screening appointment.

46.3.3. Preschool hearing screening

In Switzerland, preschool screening takes place in the paediatrician or general practitioners office and is performed by a paediatrician or physician. Children are invited to participate in screening directly in person in the clinic.

The target condition for preschool hearing screening is a unilateral or bilateral hearing loss of at least 30 dB HL.

46.3.4. Intervention approach

In Switzerland, treatment options available include grommets, hearing aids, bone conductive devices, and cochlear implants. Children are fitted with hearing aids from < 6 months of age and with cochlear implants from 6-12 months of age or older.

The fitting criteria for hearing aids in Switzerland is a hearing loss of ≥ 30 dB HL in at least two frequencies.

46.4. 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

46.4.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies in Switzerland is summarized in Table 1, whereby a 2-step OAE protocol is in effect. Both OAEs are performed in the maternity hospital before discharge. The first OAE is performed 24-72 hours after birth. If the infant does not pass the first OAE, one rescreening attempt may be completed the following day or before discharge.

Table 86: Process for neonatal hearing screening of well babies in Switzerland.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location

OAE1	24-72 hours	EchoScreen	Yes	Maternity ward
OAE2	1 month	EchoScreen	Yes	ENT department / Paediatrician office

46.4.2. Neonatal hearing screening (at-risk)

Prior to 2017, there was no difference in screening protocol for well or at-risk infants. In the 2017 revision, aABR was the recommended procedure among infants with risk factors.

Table 87: Process for neonatal hearing screening at-risk babies in Switzerland.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
aABR1	24-72 hours	35 dB nHL		Yes	Maternity ward

46.4.3. Preschool hearing screening

In Switzerland, hearing screening is performed in private clinics at 4 years of age. Pure-tone audiometry screening is performed. If one or more thresholds are worse than 30 dB HL for a 3-month period a referral is made to an ENT for a diagnostic assessment.

Table 88: Process for preschool hearing screening in Switzerland

Test	Age	Referral criteria	Location
Pure-tone screening	4 years	30 dB HL	Physician / Paediatrician Office
Pure-tone screening	3 months after first screen		

46.5. Professionals

46.5.1. Neonatal hearing screening (well)

Screening for well-babies is performed by nurses in the maternity clinics.

There is no specific training programme for nurses to learn screening. Instead, on-the-job instruction is provided by colleagues or by ENT physicians.

46.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by nurses. See 7.1 for details.

46.5.3. Preschool hearing screening

Preschool screening is performed by physicians or paediatricians.

47. Turkey

Hearing screening representatives for Turkey: *Mine Baydan, Department of Audiology, Ankara University.*

General information acquired from answers by*: Ciler Tezcaner, Otorhinolaryngology Department, Ankara University School of Medicine.*

47.1. Background

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

47.1.1. General

Turkey has a total area of 783 562 km^2 with a population of 79 814 871 in 2016 (TurkStat, 2018).

In Turkey, all births are registered through the Ministry of Health. The number of live births in Turkey in 2016 was 1 309 771 (TurkStat, 2018).

The World Bank income classification categorizes Turkey as an upper middle-income country (The World Bank, 2018). The gross domestic product (GDP) in 2016 was 10883 USD or €9 616 per capita (TurkStat, 2018).

From the World Health Organization (WHO) Global Health Expenditure Database, health expenditure for Turkey in 2015 was 455 USD or €402 per capita (World Health Organization (WHO), 2018).

An infant mortality rate of 10.7 per 1000 live births is reported for Turkey (United Nations Statistics Division, 2016; TurkStat, 2018).

47.1.2. Neonatal hearing screening

In Turkey, neonatal hearing screening is conducted universally. All babies in Turkey have access to hearing screening, and screening is obligatory for parents. Neonatal hearing screening for well and at-risk babies was first implemented in 2000 and became available nationally in 2004. Neonatal hearing screening is embedded in the Preventive Child Health Care screening system and is funded by health insurance.

Neonatal hearing screening is organized by the Turkish Public Health Institution through the Ministry of Health. Each maternity hospital is responsible for training staff, managing equipment, and sending data to the National Institute of Health.

National guidelines and a national neonatal hearing screening protocol are available. Maternity hospitals use the same protocol for performing screening and reporting data across all regions of Turkey. The only protocol difference across regions is with regards to the referral centre for at-risk infants. For regions without a primary health care centre, at-risk infants are then referred to another region.

47.1.3. Preschool hearing screening

There is currently no preschool hearing screening programme in Turkey.

47.2. Guidelines & Quality Control

There are national hearing screening guidelines and a protocol for neonatal hearing screening in Turkey (Ministry of Health; Ministry of Health).

The neonatal hearing screening programme was created by the Turkish Public Heath Institution. In 2013, the hearing screening programme was changed; however, information regarding the extent of this change is not indicated. It is unknown how often the programme is revised or how these revisions are funded.

Quality assurance of hearing screening programme is imposed by the government. Data are collected through the National Neonatal Hearing Screening Database, which is managed through the Ministry of Heath, Health Information Systems. Maternity centres are responsible for entering the screening results into the national database. The national database is owned and operated by the Ministry who is responsible for analysis if data. It is unknown how these data are used for monitoring the effectiveness of the screening programme or how annual reporting is performed within the Ministry; however, some results (coverage rate, referral rate and detection rates) are published in Turkey's Health Yearbook. Only authorized persons have access to these data or reports.

Research performed on the neonatal hearing screening programme in Turkey (e.g., Bolat, Bebitoglu, Ozbas, Altunsu, & Kose, 2009; Kemaloglu, et al., 2016; Konukseven, et al., 2010; Konukseven, et al., 2017).

47.3. Screening – Diagnosis – Intervention process

47.3.1. Neonatal hearing screening

Well-babies and at-risk babies are screened in the hospital or private clinic. It is roughly estimated that 99% of births take place in maternity hospitals, where the average length of stay is roughly estimated to be 2 days. Parents/caregivers of well and at-risk babies are invited to participate in neonatal hearing screening directly in the hospital.

It is recommended that screening should be completed within the first 72 hours, and ideally before discharge. However, there is no set maximum time by which screening should be completed; instead, guidelines stipulate a criterion age for the diagnosis of hearing impairment.

At-risk infants are defined as those who were born with assistance of forceps or suction, are premature <35 weeks, weigh less than 1500 kg at birth, have a NICU stay (undefined duration), have atresia or microtia, bacterial meningitis, hyperbilirubinemia, or if the mother had fever-invoking illness during pregnancy.

Data on the prevalence of CMV or meningitis is unknown; though the prevalence rate of CMV is roughly estimated in 0.2 to 2.2 per 1000.

The target condition for screening for well- and at-risk babies is all types and severities of hearing loss, including both unilateral and bilateral. No set target is defined in protocol.

47.3.2. Neonatal diagnostic assessment

The diagnostic assessment after neonatal hearing screening referral is described in the article by Kemaloglu, et al. (2016) as including OAEs, clinical ABR and behavioural audiometry. The diagnostic assessment should be completed by 3 months of age for well and at-risk infants.

47.3.3. Preschool hearing screening

Not applicable.

47.3.4. Intervention approach

In Turkey, treatment options available include hearing aids, bone conductive devices, and cochlear implants. Infants are fitted with hearing aids from less than 6 months of age or older. Intervention should be implemented prior to 6 months of age, according to the national protocol. The fitting criteria in Turkey for a hearing aid is a unilateral or bilateral sensorineural hearing loss of 25 dB HL or 30 dB eHL or worse. Cochlear implants are provided by 9-10 months of age when the infant is mature enough to undergo imaging (MRI and CT).

47.4. 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

47.4.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies is described in Table 1. A 3-step OAE-aABR protocol is in effect, whereby the first OAE is performed in the maternity hospital. If the infant fails the first test, rescreening occurs either before discharge or 3-5 days later when the return to the birth hospital for dried bloodspot screening. A subsequent fail would warrant a third screening with aABR. This may be performed also prior to discharge during the follow-up visit (if the hospital has adequate equipment), or at a secondary implementation unit with both aABR and OAE screening equipment as well as a qualified ENT or audiologist on staff.

Table 89: Process for neonatal hearing screening for well, healthy infants in Turkey.

Test	Age	Referral Criteria	Device	Unilateral Referrals?	Location
OAE1*	24-72 hours	Various	Various	Yes	Maternity hospital
OAE2	1 week / Before discharge	Various		Yes	Maternity hospital
aABR	1 week / Before discharge	35 dB nHL		Yes	Maternity hospital / Secondary unit

*A minimum of two attempts is suggested before referral to rescreening.

47.4.2. Neonatal hearing screening (at-risk)

The screening process for at-risk infants is described in Table 2. For these infants, aABR is performed in the hospital, as well as OAE when possible. After two attempts, if the aABR shows a failed result, infants are referred directly to an audiological centre for diagnostic assessment.

Table 90: Process for neonatal hearing screening for at-risk infants in Turkey.

Test	Age	Referral criteria	Device	Unilateral Referrals?	Location
aABR* (+OAE)	24-72 hours (< 2 weeks if premature)	35 dB nHL	Various	Yes	Hospital

*A minimum of two attempts is suggested before referral to rescreening.

47.4.3. Preschool hearing screening

Not applicable.

47.5. Professionals

47.5.1. Neonatal hearing screening (well)

Screening is performed by trained nurses, audiometrists, or audiologists. There is a specific training (Newborn Hearing Screening Course) within the national neonatal hearing screening programme. Training is performed at the diagnostic assessment centre and consists of a full day course. A certificate is provided to screening staff that have completed the training.

47.5.2. Neonatal hearing screening (at-risk)

Screening for at-risk infants is also performed by nurses audiometrists, or audiologists (see 7.1 for training requirements).

47.5.3. Preschool hearing screening

Not applicable.