



Summary: Hearing Screening

The Netherlands

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1. Glossary of Terms: Hearing Screening

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



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



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

2. Abbreviations

ABR – auditory brainstem response

aABR – automatic auditory brainstem response

ANSD – auditory neuropathy spectrum disorder

ASSR – auditory steady-state response

CI – cochlear implant

CMV – cytomegalovirus

dB HL – decibel hearing level

dB nHL – decibel normalized hearing level

dB SNR – decibel signal-to-noise ratio

DPOAE – distortion product otoacoustic emissions

HA – hearing aid

NICU – neonatal intensive care unit

OAE – otoacoustic emissions

TEOAE – transient-evoked otoacoustic emissions

3. Background

In 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.

3.1. General

The country of the Netherlands has an area of 41 543 km² 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).

3.2. 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 programme.

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.

3.3. 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.

4. 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.



5. Process: Screening, Diagnosis, Intervention

5.1. 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).

5.2. 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.

5.3. 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.

5.4. 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.

6. Protocols

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

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

6.1. Neonatal hearing screening (well)

The 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 1: 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.

6.2. 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 2: 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-conceptual age)	35 dB nHL		Yes	Outpatient Clinic /NICU

*96.9% of infants were screened before 1 month of age (corrected) in 2014.

6.3. 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 3: 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.

7. Professionals

7.1. 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.

7.2. 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.

7.3. Preschool hearing screening

Hearing screening for school-aged children is performed by assistants or nurses from the Youth Health Care organizations.

8. Results: Neonatal Hearing Screening

8.1. Coverage and attendance rates

Coverage rate is defined as the number of infants screened out of all eligible infants. Attendance rate is defined as the number of infants screened out of all infants offered screening. In principle, all infants should be offered neonatal hearing screening through the Basic Registration Persons. Therefore, coverage and attendance rates should be about equal.

Based on the annually published report, attendance rates for 2015 are indicated for neonatal hearing screening of well babies for each step of the sequence. The combined attendance rate across all three steps for 2015 was 98.9%. A total of 219 parents refused screening for their infant in 2015, out of a total of 166 911 eligible infants (0.13%; Van Der Ploeg, Pot, & Verkerk, 2017).

Table 4: Attendance rates for neonatal hearing screening (well babies) in the Netherlands (Van Der Ploeg, Pot, & Verkerk, 2017).

Test	Attendance Rate
OAE1	99.6%
OAE2	99.5%
aABR	99.8%

For at-risk infants, all NICU infants are invited to participate in neonatal hearing screening. Similar to well infants, the coverage and attendance rates for NICU infants will be essentially identical given that all NICU infants are offered screening. A total of 17 families refused screening for their infants in 2014 out of a total of 3960 (0.43%; van Straaten, van Dommelen, & Verkerk, 2014).

Table 5: Attendance rates for neonatal hearing screening (NICU babies) in the Netherlands (Van Straaten, van Dommelen, & Verkerk, 2014).

Test	Attendance Rate
aABR1	>99.4%
aABR2	97.2%

8.2. Referral rates

Referral for each stage of the three-stage screening process for well babies is presented in Table 6.

Table 6: Referral rates for neonatal hearing screening (well babies) in the Netherlands (Van Der Ploeg, Pot, & Verkerk, 2017).

Test	Referral Rate
OAE1	4.3%
OAE2	34.1%*
aABR	18.3%*

Referral rates assume 100% attendance at each step.

*Referral rates are highly dependent on one another. For step 3, the referral rate is highly dependent on the results from steps 1 and 2. Similarly, the referral rate from step 2 depends on the results for step 1. These referral rate figures are not to be considered as independent data values but are only valid when considered in combination across all three steps.

In total, the referral rate to a diagnostic assessment after the three-stage screening process was 0.27% (2015) for well babies (Van Der Ploeg, Pot, & Verkerk, 2017).

The percentage of NICU babies that were referred for a diagnostic audiological evaluation after neonatal hearing screening was 5.2% in 2014 (205 of 3960 screened in test 1; van Straaten, van Dommelen, & Verkerk, 2014).

8.3. Diagnostic assessment attendance

In general, the rate of compliance with referral to diagnostic assessment is 95.7% to 98.4%. Of the infants referred from screening in 2015, 96.8% of families attended the audiological centre for a diagnostic audiological evaluation. Of the infants that attended an initial audiological assessment, 98.8% have a complete diagnosis (Van Der Ploeg, Pot, & Verkerk, 2017).

The compliance rate of NICU babies referred for a diagnostic audiological evaluation after neonatal hearing screening was 95.1% in 2014 (Van Straaten, van Dommelen, & Verkerk, 2014).

8.4. Prevalence / Diagnosis

The prevalence values of permanent hearing loss among neonates in the Netherlands are presented in Tables 7 and 8.

Table 7: Prevalence (per 1000) of permanent hearing impairment among well infants in the Netherlands (Van Der Ploeg, Pot, & Verkerk, 2017).

	Bilateral		Unilateral	
	≥ 40 dB HL	≥ 80 dB HL	≥ 40 dB HL	≥ 80 dB HL
Prevalence (per 1000) from Youth Health Care, 2015 (Van Der Ploeg, Pot, & Verkerk, 2017)	0.7		0.5	

Table 8: Prevalence (per 1000) of permanent hearing impairment among NICU infants in the Netherlands (Coenraad, Goedegebure, van Goudoever, & Hoeve, 2010)

	Bilateral		Unilateral	
	≥ 40 dB HL	≥ 80 dB HL	≥ 40 dB HL	≥ 80 dB HL
Prevalence (per 1000) from NICU, 2004-2009 (Coenraad, Goedegebure, van Goudoever, & Hoeve, 2010)	17			

Prevalence was calculated based on data acquired after neonatal hearing screening. Therefore, the percentage of infants with permanent hearing loss after neonatal hearing screening is the same as presented.

The prevalence of bilateral auditory neuropathy for well-babies is unknown. The prevalence of bilateral auditory neuropathy among NICU-babies is presented in Table 9 based on data collected by Coenraad et al. (2010).

Table 9: Prevalence (per 1000) of ANSD among NICU infants in the Netherlands (Coenraad, Goedegebure, van Goudoever, & Hoeve, 2011).

	Bilateral		Unilateral	
	≥ 40 dB HL	≥ 80 dB HL	≥ 40 dB HL	≥ 80 dB HL
Prevalence (per 1000) from NICU, 2004-2009 (Coenraad, Goedegebure, van Goudoever, & Hoeve, 2011)	0.6		2.1	

8.5. Treatment success

In the Netherlands, 118 infants were fitted with a hearing aid after neonatal hearing screening in 2015 and 19 infants were placed on the CI trajectory. However, hearing aids are often an initial step of the CI trajectory, and only 1-2 audiological centres will indicate a CI trajectory in the initial diagnosis. Eventually, more than 18 infants from the 2015 birth cohort will be implanted with CIs.

8.6. Screening evaluation

Data are unavailable regarding the percentage of false negatives or sensitivity of neonatal hearing screening, as it cannot be determined whether late identification of hearing loss is due to progressive or acquired loss or due to the hearing impairment being missed at the time of screening. False positive and specificity is difficult to determine due to the reasoning that a transient hearing loss may not be considered a true false positive.

For well babies, the positive predictive value of a refer result was documented to be 45% from the 2014 cohort and 39% from the 2015 cohort. For NICU infants, the positive predictive value of a refer result in one or two ears after neonatal hearing screening was 64.6% in 2014 (Van Straaten, van Dommelen, & Verkerk, 2014).

These figures must be interpreted with the known condition that the target condition is a permanent hearing impairment, and therefore, a temporary conductive hearing impairment in this case is considered to be a false positive.

9. Results: Preschool Hearing Screening

9.1. Coverage and attendance rates

There is no national data available for school-age hearing screening.

9.2. Referral rates

There is no national data available for school-age hearing screening.

9.3. Diagnostic assessment attendance

There is no national data available for school-age hearing screening.

9.4. Screening evaluation

There is no national data available for school-age hearing screening.

10. Costs: Neonatal Hearing Screening

Neonatal hearing screening in the Netherlands is free of charge for parents. There is no financial reward when parents attend hearing screening or penalty for refusal.

There has not been a cost effectiveness analysis completed in the Netherlands.

10.1. Screening costs

In the Netherlands, screening costs for the well-baby programme are unknown as the funding is part of the general Basic Package for child health care.

For NICU infants, the cost of screening is incorporated in to the add-on rate for the NICU. The average cost per child is €102.68 for a NICU stay. When calculated from the average number of NICU nursing days per child, the cost for neonatal hearing screening may be converted to a rate surcharge of €9.93 per NICU nursing day (price level 2016). Given the high percentage and the relatively small amount for the hearing screen, it is concluded that the effect on the cost homogeneity of the NICU treatment day is negligible. When calculated from the cost for aABR screening among well babies, the cost for NICU screening is roughly estimated to be €20-30 per child (around €100 000 per year).

10.2. Equipment costs

(Information extracted to protect data if commercially sensitive)

Devices are scheduled to be replaced every 5 years. OAE disposable tips cost €0.65-0.87 per tip. For aABR, the cost of an earphone/electrode set for one infant is €10.80.

10.3. Staff costs

In total, there are approximately 400-500 hearing screening professionals in the Netherlands for the first two well-baby stages (OAE screening). For well-baby aABR screening, there are approximately 30 regional coordinators that perform this third stage. For NICU babies, it is roughly estimated that there are 20-25 nurses performing screening.

The salary of a professional performing well-baby hearing screening is would not be uniform across screeners. For NICU hearing screening, the salary of an intensive care nurse is €500 per month (gross income).

The educational costs would include basic background education, as well as the cost of training. It is roughly estimated that the training costs would be around €1500.

10.4. Diagnostic costs

Screening costs for neonatal hearing screening are unknown.

10.5. Amplification costs

In the Netherlands, all children are treated for hearing loss.

The cost of each hearing aid device is €500 to €1200 each for the age of 3 months to 6 years. The costs of habilitation associated with hearing aid amplification is not indicated.

The initial cost of a cochlear implant is, on average, €40 465. With the implant, testing, surgery and rehabilitation, the cost is €55 000 to €75 000.

10.6. Social costs

In the Netherlands, hearing impaired students can attend mainstream schools or one of the special schools available. There are 10 Auris primary schools and 3 Auris secondary schools, and 24 Kentalis schools in the Netherlands for hearing-impaired students.

Support funding provided to schools by the Ministry of Education. The amount of funding depends on the severity of the impairment. The funding for the 'middle' category, which includes physical impairment, is approximately €15 700. In total, including the basic funding of €100 provided for each student admitted to schools in the Netherlands, this amount combines to €15 800. The funding for the 'low' category, which includes learning difficulties, is €15 200 per student in total. Mainstream schools may also apply for this support funding.

Data are not available for how many children with hearing impairment attend special education schooling in the Netherlands.

11.Costs: Preschool Hearing Screening

11.1. Screening costs

Data are not available.

11.2. Equipment costs

Data are not available.

11.3. Staff costs

Data are not available.

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