



Summary: Hearing Screening

Belgium (Flanders)

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Disclaimer: This is a summary report representing the responses from a screening 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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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 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. General

The Flanders region of Belgium has a total area of 13 683 km² 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).

3.2. 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.

3.3. 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.



4. 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, Boudewyns, Declau, Van de Heyning, & Wuyts, 2012; Stappaerts & Hoppenbrouwers, 2018).



5. Process: Screening, Diagnosis, Intervention

5.1. 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.

5.2. Neonatal diagnostic assessment

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

5.3. 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.

5.4. 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.



6. Protocols

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

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

6.1. Neonatal hearing screening (well)

The process for neonatal hearing screening for well babies is 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 1: 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,
aABR2	48 hrs after first test	35 dB nHL	MAICO 11MB Classic	Yes	home, district houses, Houses for the Child

6.2. 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 2: 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

6.3. 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 3: 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 4: 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



7. Professionals

7.1. 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.

7.2. 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.

7.3. Preschool hearing screening

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



8. Results: Neonatal Hearing Screening

8.1. Coverage and attendance rates

The coverage rate for Flanders for 2016 was 96% (Kind en Gezin, 2018), and is defined as the percentage of eligible infants born who were screened with at least one screening test. This includes 91.5% screened by Kind en Gezin and 4.5% screened in the maternity hospital. The remaining percentage may be infants who could not be reached for screening, whose parents refused screening, or who missed being offered. This figure includes all children born in Flanders, including well and at-risk infants. In Brussels region, the coverage rate is more difficult to determine based on the fact that some infants are screened under the programme organized within Wallonia-Brussels Federation.

The number of children missed being *offered* screening is not indicated, and therefore, the attendance rate cannot be calculated for the initial screen.

8.2. Referral rates

Referral rates for well babies and NICU babies are presented in Tables 4 and 5 for 2016 data. Data from Flanders exclude data from Brussels capital region; however, results for Brussels-capital region are similar.

Table 5: Referral rates for neonatal hearing screening (well babies) in Flanders and Brussels capital region (Kind en Gezin, 2018).

Test	Referral Rate (Flanders)	Referral rate (Brussels capital region)
aABR1	3.8%	5.2%
aABR2	39.5%	46.2%

Pass rates assume a 100% attendance rate at each step.

Table 6: Referral rates for neonatal hearing screening (NICU babies) in Flanders and Brussels capital region (Kind en Gezin, 2018).

Test	Referral Rate (Flanders)	Referral rate (Brussels capital region)
aABR1	7.5%	8.1%
aABR2	54.7%	42.0%

Pass rates assume a 100% attendance rate at each step.

The final referral rates to a diagnostic assessment after the 2-step aABR procedure for well infants was 1.4% and 2.4% for Flanders and Brussels-capital region, respectively (Kind en Gezin, 2018). For internal data from within Kind en Gezin, the final referral rate for 2017 was 1.25% (Kind en Gezin, 2018).

The final referral rate to a diagnostic assessment for NICU babies was 4% and 3.3% for Flanders and Brussels-capital region, respectively (Kind en Gezin, 2018). From Kind en Gezin's internal database, the final referral rate for NICU babies tested by Kind en Gezin was 1% in 2017 (Kind en Gezin, 2018).

8.3. Diagnostic assessment attendance

Data on the compliance and attendance to a diagnostic assessment are difficult to acquire due to new laws on data sharing. Not all infants screened or tested are being reported and shared. Therefore, Kind en Gezin can only report on data as far as the screening process performed internally (i.e., by staff of Kind en Gezin).



8.4. Prevalence / Diagnosis

Prevalence rates are presented in Table 6 and calculated from the Kind en Gezin database. However, due to the fact that not all children with hearing loss who were locally screened are reported due to new regulations on data sharing, the reliability of these data is not high.

Table 7: Prevalence rate (per 1000) of permanent hearing loss among neonates in Flanders and Brussels capital region (Kind en Gezin, 2018).

	Bilateral		Unilateral	
	≥ 40 dB HL	≥ 80 dB HL	≥ 40 dB HL	≥ 71 dB HL
Kind en Gezin (2018)	1.19	0.42	0.64	0.31

Data are not available regarding the prevalence of auditory neuropathy in Flanders.

8.5. Treatment success

Data are not available regarding the number of children fitted with hearing aids or cochlear implants each year in Flanders.

8.6. Screening evaluation

Data on screening evaluation have been calculated from the Kind en Gezin database (Kind en Gezin, 2018). The percentage of false negatives for all infants after the 2-step aABR screening is 0.0007% (i.e., only 1 in 153 204 babies). The percentage of false positives for all infants 3.21% (984 in 306 408 babies). The positive predictive value of a refer result in one or two ears for well babies born from 2013 to 2017 is 64.95% (Kind en Gezin, 2018).

The sensitivity of neonatal hearing screening for well babies with birth years 2013-2017 is 99.9% and the specificity of neonatal hearing screening for well babies with birth years 2013-2017 is 99.7% (Kind en Gezin, 2018).



9. Results: Preschool Hearing Screening

9.1. Coverage and attendance rates

Data are not available.

9.2. Referral rates

Data are not available.

9.3. Diagnostic assessment attendance

Data are not available.

9.4. Screening evaluation

Data are not available.



10. Costs: Neonatal Hearing Screening

In Flanders, screening is free of charge for parents. There is no financial reward when parents attend hearing screening, nor is there a penalty for those who do not attend hearing screening.

There has not been cost-effectiveness analysis performed in Flanders.

10.1. Screening costs

The total screening cost for neonatal hearing screening, according to the new contract (starting 2019), is €4 880 084.88 for a 5-year period. These costs will cover the total funds for neonatal hearing screening only. The costs per child for both well and NICU infants is €21.08 euro as of 2018.

10.2. Equipment costs

(Information extracted to protect commercially sensitive data)

The maintenance cost for an aABR device (calibration, etc.) is €200 plus taxes. The device is replaced after 5 years but prolonged service for 1 additional year is an option. The costs for disposables are €7.3 plus taxes and an estimated 375 000 tests are conducted across 5 years.

10.3. Staff costs

A total of 550 nurses work for Kind en Gezin's neonatal hearing screening programme in Flanders region and Brussels capital region. The annual salary of a nurse with 10 years of employment within Kind en Gezin ranges from €50 230.32 (limited contract) to €57 590.48 (permanent employment).

There is no extra cost for Kind en Gezin training, as this is part of the job contract. The cost of two-hours of training can be estimated from calculation of a nurse's hourly salary (i.e., around €94.85).

10.4. Diagnostic costs

The total cost of diagnostic confirmation is not indicated.

10.5. Amplification costs

All eligible children with hearing loss are not treated in Flanders. Deaf parents sometimes decline treatment/rehabilitation/early home guidance

The actual cost of bilateral amplification ranges significantly; however, children are eligible for reimbursement for the cost of hearing aids up to €1180.75 for one hearing and €2338.79 for bilateral hearing aids. This is renewable every 3 years.

10.6. Social costs

There are 8 schools in Flanders region for deaf children at different levels (e.g., primary, secondary, and high school). The cost for a normal hearing child in a regular primary school is reportedly €45 per year.

Deaf children who attend regular primary school have special support, including sign language support and/or a speech therapist for 2 hours per week.



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.



12. References

- Belgian Federal Government. (2017). *Stabel: Belgium in figures*. Retrieved from https://statbel.fgov.be/nl/modules/publications/statistiques/bevolking/population_-_naissances_et_fecondite_2010.jsp
- Belgian Federal Public Services. (2019). *Official Information and Services*. Retrieved from Belgium.be: <https://www.belgium.be/>
- Hardonk, S., Desnerck, G., Loots, G., Van Hove, G., Van Kerschaver, E., Sigurionsdottir, H. B., . . . Louckx, F. (2011). Congenital deaf children's care trajectories in the context of universal neonatal hearing screening: a qualitative study of the parental experiences. *Journal of Deaf Student Education*, 16, 30524.
- Kind en Gezin. (2018). *Database Newborn Hearing Screening, 1998 - October 2018*. Saint-Gilles: Kind en Gezin.
- Kind en Gezin. (2018). *Gehoor: Vlaams, Brussels en provinciaal niveau*. Retrieved from Kind en Gezin: <https://www.kindengezin.be/cijfers-en-rapporten/cijfers/gehoor/vlaams-brussels-en-provinciaal-niveau/>
- Stappaerts, L., & Hoppenbrouwers, K. (2018). Neonatale gehoorscreening in Vlaanderen, een overzicht van 20 jaar ervaring . *Tijdschr. Jeugdgezondheid*, 50, 106-111.
- Statistics Flanders. (2018). *Statistiek Vlaanderen*. Retrieved from <https://www.statistiekvlaanderen.be/>
- Trading Economics. (2017). *Belgium GDP per capita*. Retrieved from Trading Economics: <https://tradingeconomics.com/belgium/gdp-per-capita>
- United Nations Statistics Division. (2016). *Demographic Yearbook – 2016*. Department of Economic and Social Affairs. New York: United Nations.
- Van Hoeck, K. (2015). *Werkwijze Audiometrie*. Retrieved from Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg: https://www.vwvj.be/sites/default/files/horen/horen_-_standaard/werkwijze_audiometrie_2_10_2015.pdf
- Van Kerschaver, E., & Stappaerts, L. (2012). *Jaarrapport Gehoor 2009-2010-2011. Universele gehoorscreening in Vlaanderen. Doelgroepbereik, testresultaten en resultaten van de verwijzingen*. Retrieved from Kind en Gezin: <https://www.kindengezin.be/img/rapportGehoor2009-2010-2011.pdf>
- Van Kerschaver, E., Boudewyns, A., Declau, F., Van de Heyning, P., & Wuyts, F. (2012). Socio-demographic determinants of hearing impairment studied in 103 835 term babies. . *European Journal of Public Health*, 23(1), 55-60.
- Van Kerschaver, E., Boudewyns, A. N., Stappaerts, L., Wuyts, F. L., & Van de Heyning, P. H. (2007). Organisation of a universal newborn hearing screening programme in Flanders,. *B-ENT*, 3, 185-190.
- Verhaert, N., Willems, M., Van Kerschaver, E., & Desloovere, C. (2008). Impact of early hearing screening and treatment on language development and education level: evaluation of 6 years



of universal newborn hearing screening (ALGO) in Flanders, Belgium . *International Journal of Pediatric Otorhinolaryngology*, 72, 599-608.

Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg. (2015). *Neonatale gehoorscreening in vlaanderen en wallonie maico11b classic - info*. Retrieved from Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg:

https://www.vwvj.be/sites/default/files/horen/horen_-_faq/neonatale_gehoorscreening_in_vlaanderen_en_wallonie_maico_11b_classic_info_0.pdf

Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg. (2016). *Integrale tekst richtlijn 'horen'*. Retrieved from Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg:

<https://www.vwvj.be/integrale-tekst-richtlijn-horen>

Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg. (2016). *Ontwikkeling van de standaard 'gehoor'*. Retrieved from Vlaamse Wetenschappelijke Vereniging voor

Jeugdgezondheidszorg: https://www.vwvj.be/sites/default/files/horen/horen_-_standaard/totstandkoming_standaard_gehoor_v3.pdf

Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg. (2017). *DE NIEUWE RICHTLIJNEN VOOR GEHOORSCREENING IN DE CLB*. Retrieved from Vlaamse Wetenschappelijke Vereniging voor Jeugdgezondheidszorg:

https://www.vwvj.be/sites/default/files/horen/horen_-_communicatiematerialen/communicatie_standaard_gehoor_-_domus_-_vvk-_20maart2017-cg-met_bijlage.pdf

World Health Organization. (2015, 01). *Belgium: WHO statistical profile*. Retrieved from Country statistics and global health estimates by WHO and UN partners:

<http://www.who.int/gho/countries/bel.pdf?ua=1>

World Health Organization. (2018). *Global Health Expenditure Database*. Retrieved 08 01, 2018, from NHA Indicators: <http://apps.who.int/nha/database/DataExplorerRegime.aspx>