



Summary: Hearing Screening Switzerland

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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 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.

3.1. General

The country of Switzerland has a total area of 41 285 km² 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).

3.2. 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.

3.3. 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.



4. 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).



5. Process: Screening, Diagnosis, Intervention

5.1. 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.

5.2. 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 otoscopy is also performed at the tertiary screening appointment.

5.3. 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.

5.4. 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.

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 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 1: 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

6.2. 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 2: 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

6.3. 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 3: 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		

7. Professionals

7.1. 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.

7.2. Neonatal hearing screening (at-risk)

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

7.3. Preschool hearing screening

Preschool screening is performed by physicians or paediatricians.



8. Results: Neonatal Hearing Screening

8.1. Coverage and attendance rates

Data are not regularly collected on a national level on Switzerland. The information provided is sourced from an article describing survey data collected in 2012 (Metzger, Pezier, & Veraguth, 2013).

Survey data indicated that 92.7% of maternity clinics regularly performed neonatal hearing screening in 2012. Assuming that each clinic that regularly performed screening tested 100% of all infants born in 2012, a coverage rate of 97.9% can be estimated via a weighted calculation. However, this figure is likely an overestimation, as clinics may not screen 100% of infants born. Furthermore, infants born at home or outside of the maternity hospital are not included in this calculation.

8.2. Referral rates

The pass rates for neonatal hearing screening of all infants are presented below in Table 3. Rates are presented from data collected via a pilot study in Switzerland from 2000-2007 (Veraguth, 2018).

Table 4: Referral rates for neonatal hearing screening (all babies) from a pilot study of data from 2000-2007 (Veraguth, 2018).

Test	Referral Rate
OAE1	1.8%
OAE2	98.7%

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

The final referral rate to a diagnostic assessment for all babies was 2.1% of babies born in University Hospital Zurich from 2000-2007 (Metzger, Pezier, & Veraguth, 2013). Data are inconsistent with stepwise referral rates due to data coming from different sources.

8.3. Diagnostic assessment attendance

Out of the infants referred from neonatal hearing screening in University Hospital Zurich from 2000-2007, 13% were lost to follow-up. Therefore, the compliance rate can be calculated to be 87% (Metzger, Pezier, & Veraguth, 2013).

8.4. Prevalence / Diagnosis

According to Metzger, Pezier, & Veraguth (2013), 1.2 per 1000 infants (n=15) who were screened in University Hospital Zurich from 2000-2007 were diagnosed with permanent bilateral hearing loss ≥ 40 dB HL.

Other prevalence data are not available. Data are also not available regarding the prevalence of auditory neuropathy in Switzerland.

8.5. Treatment success

Data are unavailable on the number of children fitted with hearing aids in Switzerland.

In 2017, 50 children age 0-3 and 27 children age 3-12 were fitted with cochlear implants. An additional 5 cochlear implants were fitted on children age 12-18.

8.6. Screening evaluation



Data are unavailable on the evaluation of neonatal hearing screening in Switzerland.



9. Results: Preschool Hearing Screening

9.1. Coverage and attendance rates

Data are unavailable regarding the coverage/attendance rates of preschool hearing screening in Switzerland, though 100% of 4-year olds are invited for screening.

9.2. Referral rates

Data are unavailable regarding the referral rates of preschool hearing screening in Switzerland.

9.3. Diagnostic assessment attendance

Data are not available.

9.4. Screening evaluation

Data are not available.



10. Costs: Neonatal Hearing Screening

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

10.1. Screening costs

The costs for neonatal hearing screening in Switzerland are 30 CHF or €27 per child according to the University Hospital Zurich (University Hospital Zurich, 2004)

10.2. Equipment costs

(Information extracted to protect commercially sensitive data)

Costs for maintenance is 200 CHF or €178 per year for calibration. Devices are only replaced when broken. Costs for disposables are not known.

10.3. Staff costs

Data on the number of screening staff in Switzerland are unavailable. The annual salary for a nurse in Switzerland is the 50 400 CHF or €44 766. The hourly salary (for those with irregular or reduced working hours) is 25.20 CHF or €22.38 (Aerztgesellschaft des Kantons Zuerich, 2018).

10.4. Diagnostic costs

Diagnostic costs are not indicated.

10.5. Amplification costs

In Switzerland, all children are treated.

The cost for hearing aid intervention is approximately 2200 CHF or €1954 for each ear. The cost for cochlear implant device and surgery in Switzerland is approximately 50 000 CHF or €44 752.

For intervention services, the cost for an audiogram is 44 CHF (€39) and hearing aid fitting consultation is 83 CHF (€74). A child with hearing aids can be expected to have around 4 visits (audiogram plus fitting consultation) per year.

For cochlear implants, the cost for initial cochlear implant fitting is 502 CHF (€446) per side, and further adjustments cost 388 CHF (€345 per side). Additionally, a speech language pathologist consultation costs 300 CHF per consultation (€266), and costs for therapy when needed cost 200 CHF per hour (€178). A child with cochlear implants can be expected to have 4 visits per year (including 4 cochlear implant adjustments, 2 audiograms, and 1 speech-language pathologist consultation).

Children that require therapy can be expected to require 1-hour of therapy per week for 39 weeks per year (excluding school holiday weeks).

Costs are covered by health insurance.

10.6. Social costs



Summary Hearing Screening: Switzerland

In the German part of Switzerland, there are 3 schools for the deaf and hard-of-hearing. Two schools function in sign language and one school functions in spoken German without sign language. It is not indicated how many children attend one of these specialized schools.

In mainstreams schools, there is special support provided to children with hearing impairment. "Audiopädagogischer Dienst" or audiological education service provides support inside and outside the educational environment.

Costs of covered by the state. Data on costs are unavailable.



11. Costs: Preschool Hearing Screening

11.1. Screening costs

Data on costs of preschool hearing screening are not known.

11.2. Equipment costs

Data are unknown.

11.3. Staff costs

Data are unknown.



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