



Summary: Hearing Screening Czechia (East Bohemia)

Produced as part of Work Package 4

Date: 2019-02-14

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 733352

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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	<p>A pre-determined cut-off boundary for when an infant/child should be re-tested or seen for a diagnostic assessment.</p> <p>For example, referral criteria may be “no response” at 35 dB nHL.</p>
Risk babies / Babies at-risk	<p>All infants that are considered to be at-risk or have risk-factors for hearing loss according to the screening programme.</p> <p>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.</p>
Sensitivity	<p>The percentage of infants/children with hearing loss that are identified via the screening program.</p> <p>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%.</p>
Specificity	<p>The percentage of infants/children with normal hearing that pass the screening.</p> <p>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%.</p>
Target condition	<p>The hearing loss condition you are aiming to detect via your screening programme. This includes:</p> <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	<p>Infants who are <i>not</i> admitted into the NICU or born prematurely.</p> <p>Well, healthy babies may or may not have additional risk factors for hearing loss, according to the procedures indicated in the specific screening programme.</p>



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 Czechia, hearing screening is organized by region or area. There are 14 political regions of Czechia 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.

3.1. 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 km² with mid-2017 populations of 550 848 and 517 243, respectively (total: 1 068 091). In Czechia, 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 Czechia 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 Czechia 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 Czechia 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).

3.2. 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. Czechia 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.

3.3. Preschool hearing screening

In Czechia, 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.

4. 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 Czechia 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 Czechia to disseminate on the status of screening across the country (Havlíková, Zeleník, & Komínek, 2015). Currently, universal screening is not yet performed nationwide in Czechia (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.



5. Process: Screening, Diagnosis, Intervention

5.1. 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.

5.2. 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).

5.3. Preschool hearing screening

Not applicable.

5.4. 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.



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 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 1: 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.

6.2. 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 2: 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

6.3. Preschool hearing screening

Not applicable.



7. Professionals

7.1. 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.

7.2. 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.

7.3. Preschool hearing screening

Not applicable.



8. Results: Neonatal Hearing Screening

8.1. Coverage and attendance rates

In East Bohemia, coverage rates were calculated based on the total number of infants screened and the total number of infants born during that time period. From the period 2014-2016, the coverage rate for neonatal hearing screening for babies is approximately 95% (Regional Screening Database, 2014-2016).

It is estimated that 99% of at-risk infants are invited for neonatal screening (Regional Screening Database).

Attendance rate for the second step of screening is reported from 2018, whereby 97.02% of infants who were referred from the first screening step attended the second step of screening (Regional Screening Database, 2018).

8.2. Referral rates

Referral rates for the two-step neonatal screening protocol in East Bohemia are described in Table 3.

Table 3: Referral rates for neonatal hearing screening (all babies) in East Bohemia (Regional Screening Database, 2018).

Test	Referral Rate
Step 1*	5.76%
Step 2	26.21%

Referral rates assume 100% attendance. Rates reflect the number of infants referred out of the number of infants screened at each step.

*The referral rate for step 1 includes all infants that either failed or when the screening was not performed. These infants are invited to the ENT department for step 2 screening.

From 2018 data, a final referral rate of 1.5% can be calculated for all babies in East Bohemia (Regional Screening Database, 2018). The referral rate for at-risk infants to a diagnostic assessment is estimated to be approximately 2%.

8.3. Diagnostic assessment attendance

The compliance rate for a diagnostic assessment after neonatal hearing screening is low. According to 2018 figures, a high loss-to-follow-up is reported to the diagnostic assessment. From the 86 referrals after step 2, 16 (18.6%) have completed a diagnostic assessment on file (Regional Screening Database, 2018).

Individual case-by-case investigations of infants born January to March 2018 has shown that many children have actually been retested showing normal results and others have refused assessment (especially in cases of unilateral referrals). More investigation will pursue in East Bohemia to identify the other lost cases.

8.4. Prevalence / Diagnosis

The prevalence values of permanent hearing loss among neonates in East Bohemia is presented in Table 4 based on calculated estimates.

**Table 4:** Prevalence of permanent hearing loss among neonates in East Bohemia (Regional Screening Database).

Prevalence (per 1000) (Regional Screening Database)	Bilateral		Unilateral	
	≥ 40 dB HL	≥ 80 dB HL	≥ 40 dB HL	≥ 80 dB HL
	1.8	0.2		

The prevalence values of infants diagnosed with permanent hearing loss in East Bohemia is determined from the screening database; therefore, the percentage of infants diagnosed with hearing loss after neonatal screening is not provided separately.

It is roughly estimate that the prevalence of bilateral auditory neuropathy is 0.20% of infants at-risk for hearing loss.

The prevalence values of permanent hearing loss among preschool-age children (5-year olds) in East Bohemia are presented in Table 5.

Table 5: Prevalence of permanent hearing loss among preschool-age children in East Bohemia (Školoudík, et al., 2018).

Prevalence (per 1000) (Školoudík, et al., 2018)	Bilateral			Unilateral		
	≥ 25 dB HL	≥ 40 dB HL	≥ 80 dB HL	≥ 25 dB HL	≥ 40 dB HL	≥ 80 dB HL
	20	4				

8.5. Treatment success

Approximately 90% of children with hearing loss are fitted with hearing aids in East Bohemia (Regional Screening Database, 2014-2017). Data are unavailable on how many children are fitted with cochlear implants per year.

8.6. Screening evaluation

The percentage of false negatives is unknown, but there are “individual cases.”

The percentage of false positives after neonatal hearing screening is roughly estimated to be around 5%.

For well babies, the positive predictive value of a refer result is around 10% (Regional Screening Database, 2014-2017). Sensitivity is roughly estimated to be 80%. Specificity is unknown.

For at-risk infants, positive predictive value of a refer result is unknown. The sensitivity is and specificity is unknown.



9. Results: Preschool Hearing Screening

9.1. Coverage and attendance rates

Not applicable

9.2. Referral rates

Not applicable

9.3. Diagnostic assessment attendance

Not applicable.

9.4. Prevalence / Diagnosis

Not applicable

9.5. Treatment success

Not applicable

9.6. Screening evaluation

Not applicable

10. Costs: Neonatal Hearing Screening

Neonatal hearing screening in East Bohemia 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 a cost effectiveness analysis completed in East Bohemia.

10.1. Screening costs

Screening costs for well and at-risk babies are unknown.

10.2. Equipment costs

An OAE screening device costs roughly around 80 000 CZK and is expected to be replaced every 10 years. The cost for performing ABR is indicated to cost roughly 50 CZK per test. Maintenance costs are covered by insurance.

10.3. Staff costs

It is roughly estimated that there are 50 hearing screening professionals per 1 million individuals, though salary and education costs for these professionals are unknown.

10.4. Diagnostic costs

The cost for a diagnostic assessment is not indicated.

10.5. Amplification costs

In East Bohemia, children may not be fitted with cochlear implants if deaf parents refuse this type of intervention.

The total cost for hearing aids, including the device and associated services for the first or subsequent years is unknown.

For cochlear implants, the cost of the first year of treatment is roughly estimated to be 2 million CZK for the first year. The cost of cochlear implant treatment after the first year is unavailable.

10.6. Social costs

There are 10 specialized schools in all of Czechia from primary school to university. The number of children attending these schools and cost information are unknown

In mainstream schools, school assistants are available to support children who are deaf or hard of hearing.

The cost of special support in mainstream schools for deaf and hard of hearing students is not indicated.

11. Costs: Preschool Hearing Screening

11.1. Screening costs

Not applicable.

11.2. Equipment costs

Not applicable.

11.3. Staff costs

Not applicable.



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