

# Hearing screening in newborns in the Central Denmark Region

Linda Busk Linnebjerg<sup>1</sup>, Anita Ekman Hansen<sup>2</sup> & Troels Reinholdt Møller<sup>2</sup>

## ABSTRACT

**INTRODUCTION:** In 2005, a nationwide programme on hearing screening in newborns was launched in Denmark. The purpose of the programme was to ensure early detection of hearing loss in newborns and to institute subsequent treatment. The aim of this study was to assess whether the Central Denmark Region observes the guidelines of the Danish Health and Medicines Authority (DHMA) for neonatal hearing. In addition, we wanted to identify factors that may influence screening density positively or negatively.

**METHODS:** Data were collected retrospectively from patient record forms completed in the 2006-2014 period. For selected periods, patient record forms were examined manually.

**RESULTS:** We recorded an annual increase in average screening density; from 88.6% in 2006 to 94.8% in 2013. Furthermore, in 2006, 89.5% had completed the hearing screening programme within 30 days and in 2014 this figure had increased to 99%. The average time to diagnosis decreased from 3.5 months in 2006 to 0.7 months in 2013. A strike among healthcare professionals in 2008 and the launch of electronic patient record (EPJ) forms in 2012 had a negative impact on screening density. Due to EPJ errors, the hearing screening density occasionally appeared to be lower than the actual number of newborns screened. In contrast, advanced training of primary screening staff, the establishment of close relations with the primary screening units in hospitals and the implementation of "Maternity packages" improved screening density.

**CONCLUSION:** Based on our results, our conclusion is that the Central Denmark Region observes the DHMA guidelines on neonatal hearing screening in Denmark.

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**TRIAL REGISTRATION:** not relevant.

In 2004-2005, a nationwide programme on hearing screening in newborns was launched in Denmark. The purpose was early detection of hearing loss in newborns [1] and subsequent institution of treatment to optimize the potential for developing cognitive, language and social skills [2]. All newborns in Denmark are offered neonatal hearing screening.

The Danish Health and Medicine Authority (DHMA) guidelines for neonatal hearing screening provide that:

- $\geq 90\%$  of all newborns must be screened.

- The full hearing screening programme must be completed no later than 30 days after birth (healthy newborns) or discharge from a neonatal unit.
- Infants with a hearing loss  $> 30$  dB must be fully diagnosed within three months of birth (healthy newborns) or discharge from a neonatal unit.

A study published in 2007 [3] recorded a screening density of 79.67% in 2006. Subsequently, the screening density was expected to increase to  $\geq 90\%$ .

In 2007, the DHMA published an evaluation of the neonatal screening programme in Denmark [4]. The conclusion of this report was that infants born with a permanent hearing loss were diagnosed at an earlier stage after the implementation of neonatal hearing screening. A follow-up evaluation of neonatal hearing screening in Denmark [5] was published by the DHMA in 2010, pointing out that Danish Regions do not fully comply with the objectives of the guidelines.

The data used in this study were extracted from the Danish National Patient Registry (NPR) by using the diagnosis codes for hearing screening: DZ135 and DZ135C. The objective of the present study was to assess whether the Central Denmark Region observes the DHMA guidelines for neonatal hearing screening. Furthermore, we wanted to identify factors that may have a positive or negative influence on the screening density and the diagnosis time with the objective of optimising neonatal hearing screening conditions in the Central Denmark Region. Data were collected from patient record forms. MidtEPJ is responsible for electronic patient record (EPJ) forms in the Central Denmark Region.

## METHODS

In the Central Denmark Region, primary hearing screening is performed in five hospitals:

- Aarhus University Hospital, Skejby (Aarhus)
- Randers Regional Hospital (Randers and Grenaa)
- Regional Hospital Central Jutland (Viborg and Skive)
- Regional Hospital West Jutland (Herning and Holstebro)
- Horsens Regional Hospital.

## ORIGINAL ARTICLE

1) ENT Department, Vejle Hospital  
2) Audiology Clinic, ENT Department H, Aarhus University Hospital, Denmark

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**FIGURE 1**

A. Hearing screening in a newborn. B. Newborn with automated auditory brainstem response patch attached to the forehead.



The test used in the Central Denmark Region is the Automated Auditory Brainstem Response (AABR) for healthy newborns not suspected of congenital hearing loss (Figure 1). If the infant is at an increased risk of congenital hearing loss, or if he/she is hospitalized in a neonatal unit for more than 48 hours, he/she is offered a new test in the primary screening unit. If the infant also does not pass this second test, he/she is referred to the Audiology Clinic at Aarhus University Hospital (AUH).

At the Audiology Clinic, further AABR and transiently evoked otoacoustic emissions (TEOAE) tests are performed, and if the infant still does not pass the test, he/she is offered an examination for congenital hearing loss with the Auditory Brainstem Response (ABR) test.

Data for neonatal hearing screening were collected retrospectively from patient record forms. Our search included the diagnosis code DZ135\*, procedure codes for AABR (ZZ1450\*), TEOAE (ZZ7306\*) and DPOAE (ZZ7307\*) and additional codes for results: not passed (refer) (ZPR00\*) and passed (pass) (ZPR01A). We excluded from the data pool all infants who were not residents of the Central Denmark Region at the time of birth and infants who were deceased at the time of discharge.

The fairly large amount of data was entered into pivot tables for subsequent data extraction. We analysed data in relation to DHMA guidelines on neonatal hearing screening in Denmark. The results were compared with DHMA figures from evaluation reports generated in 2007 and 2010 [4, 5].

*Trial registration:* not relevant.

## RESULTS

Screening density data were gathered from patient record forms for the 2006-2014 period. The density remained at a constant 90% level, except for 2006 and 2008. In 2006, the hearing screening programme was still in its infancy, and 2008 saw a nationwide strike among healthcare professionals from mid-April to mid-

June. Figure 2 shows the effect of the latter on hearing screening in the Central Denmark Region. In a few hospitals, screening density was as low as 29% in this period. Through manual examination of patient record forms, we found that the hearing screenings had, in fact, been performed, but they had not been registered. During the remaining months of 2008, the screening density was  $\geq 90\%$ .

As of 2012, an EPJ system was implemented at hospitals in the Central Denmark Region. In several hospitals, a drop in the hearing screening density was observed for a period of three months after the implementation. Through manual examination of patient record forms, we found that hearing screening had, in fact, been performed, but in most cases had not been registered correctly.

Furthermore, after the implementation of the EPJ in 2012, screening density incorrectly appeared lower than actual figures despite correct registration. For example, screening density in one hospital suddenly seemed to drop from 97.4% in February to 65.9% in September, when searching for data in EPJ. Through manual examination of patient record forms, we discovered that the actual screening density was considerably higher than that shown in the data extracted from the EPJ (Figure 3). This was seen in several hospitals with a variety in duration and intensity. Consequently, we manually examined all 800 patient record forms of infants who – according to the EPJ – had not been screened. Efforts were made to determine common characteristics of the screened infants that were automatically eliminated from the EPJ search, but without any result.

The percentage of screening programmes completed within 30 days rose from 89 in 2006 to 99 in 2014. The average time consumption for a completed programme is shown in Figure 4. In 2006, the mean time for completion of the programme was 39 days. Subsequently, this figure has decreased annually (2008 being the only exception) to reach an all-time low of seven days in 2013. Preliminary data for 2014 show a further drop to an average of two days.

In 2006, it took an average of 3.5 months (range: 0-11 months) after birth/discharge from a neonatal unit to diagnose congenital permanent hearing loss. In 2013, this period had been reduced to an average of 0.7 months (range: 0-2 months). Among the reasons for delayed diagnosis were referral to a local hearing clinic rather than to the Audiology Clinic at the AUH, diagnosis delayed by parents, waiting time for diagnosis and death.

Ten patients had their diagnosis of hearing loss delayed due to postponement of further examination by the patient's parents.

A total of 14 patients had their diagnosis of hearing

loss delayed because they were referred to the local hearing clinic in the Central Denmark Region rather than directly to the Audiology Clinic at the AUH. The diagnosis of these patients had been made to varying degrees at the time of their referral.

Six infants were delayed in the diagnosis of hearing loss due to serious illness. Three have since died.

## DISCUSSION

According to patient record form data, the hearing screening unit in the Central Denmark Region has performed at  $\geq 90\%$  since 2006, with a few exceptions. In 2006, the hearing screening was still in its infancy – screening was new to the general population and to healthcare professionals. In 2008, the strike among healthcare professionals had a negative impact on screening density.

In 2012, the “Maternity package” was introduced in the Central Denmark Region. This package includes neonatal hearing screening and a heel prick test for phenylketonuria (PKU) and other serious congenital diseases. The neonatal heel prick test has been performed in Denmark since 1965, it is well-known among parents, and it has a high screening density. An integration of the two tests increases the probability of neonatal hearing screening being performed. Since the introduction of neonatal hearing screening in Denmark, healthcare professionals have drawn parents’ attention to the screening and encouraged them to accept the offer to have their infants screened for hearing loss.

The Hearing Screening Coordinator at the Audiology Clinic of the AUH performs monthly checks of the screening density of hearing screening units. Regular visits or phone calls are made to individual units. Furthermore, primary screening unit staff receive advanced training in screening methods. These factors all have a positive impact on the screening density.

From 2006 to 2008, six diagnosis programmes were delayed due to waiting time at the Audiology Clinic at the AUH for ABR tests in spontaneous sleep. Following optimisation of the use of electrophysiological equipment used for ABR assessments and introduction of melatonin for infants who are expected to have trouble falling asleep [6], the waiting time for the examination has been reduced significantly.

Authorities inform parents of the importance of neonatal hearing screening and subsequent follow-up if the infant does not pass the screening test, and the primary hearing screening unit has been made aware that they must refer patients directly to the Audiology Clinic at the AUH to reduce the time to diagnosis.

There is some discrepancy between DHMA data from the NPR and EPJ data from patient record forms for neonatal hearing screening. The NPR search was per-

formed for diagnosis codes DZ135 and DZ135C only. However, the search for the present study was performed on diagnosis as well as procedure and result codes. This detailed search provides a more realistic result for the neonatal hearing screening density. Since the introduction of EPJ, code registration has been optimized, and the future will hopefully see a higher degree of congruity between data from the NPR and the EPJ.

FIGURE 2

Hearing screening density in the Central Region Denmark, 2008.

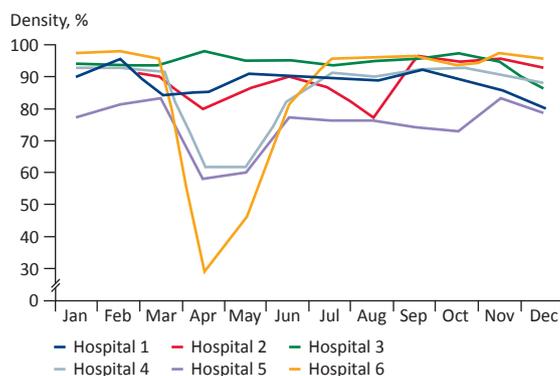


FIGURE 3

Hearing screening density in the Central Region Denmark in 2012. Electronic patient record (EPJ) data versus manual count.

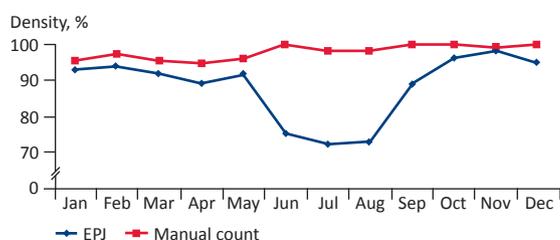
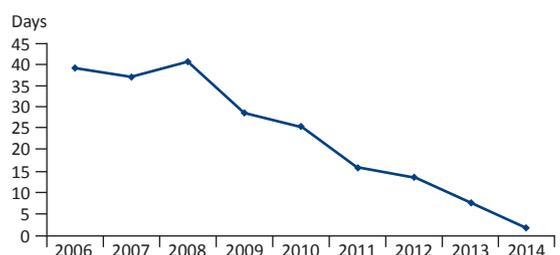


FIGURE 4

Average time to conclusion of hearing screening in the Central Denmark Region.



Since the introduction of the EPJ in the Central Denmark Region, inexplicable sporadic drops in the screening density have occurred. All patients are hearing screened, and the eliminated infants share no evident characteristics that might explain the incorrect elimination. The provider of the EPJ MidtEPJ is working to pinpoint the error. Unit management of the Main Neuro Centre has contacted the Medical Director of Quality and Health Data and efforts are being made to explain this phenomenon, but no conclusion and/or solution has been reached yet.

### CONCLUSIONS

Through systematic examination of MidtEPJ patient record forms we have established that in general, the hearing screening of newborns in Central Denmark Region observes the DHMA guidelines:

- The screening density is high:  $\geq 90\%$  since 2007.
- Time to completion of screening programmes for newborns decreased from an average of 39 days in 2006 to an average of two days in 2013.
- The diagnosis time for infants suspected of congenital hearing loss decreased from 3.5 months in 2006 to 0.7 months in 2013.

The strike among healthcare professionals in 2008 had no real impact on hearing screening density. Nor did the implementation of the EPJ in the Central Denmark Region. "Maternity packages" have been implemented with a combination of the PKU test, neonatal hearing screening and screening for other serious health issues. Diagnosis conditions for infants with congenital permanent hearing loss at the Audiology Clinic at the AUH have been optimised and infants are referred to the correct clinic if they do not pass the hearing screening test. EPJ challenges remain, but MidtEPJ are striving to overcome these challenges.

**CORRESPONDENCE:** *Linda Busk Linnebjerg*. E-mail: [linda@linnebjerg.com](mailto:linda@linnebjerg.com)

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**CONFLICTS OF INTEREST:** Disclosure forms provided by the authors are available with the full text of this article at [www.danmedj.dk](http://www.danmedj.dk)

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