www.jpnim.com Open Access eISSN: 2281-0692
Journal of Pediatric and Neonatal Individualized Medicine 2015;4(1):e040110
doi: 10.7363/040110
Received: 2014 Oct 09; revised: 2014 Dec 16; accepted: 2014 Dec 21; published online: 2015 Feb 09

Original article

A quality improvement initiative project to evaluate a newborn hearing screening program in a Baby-Friendly Hospital Initiative setting

Stacey R. Lim[1], Sandra S. Newcomb[2]

[1]Central Michigan University, Department of Communication Disorders, Mount Pleasant, MI, USA
[2]Summa Health System, Communication Disorders Department, Akron, OH, USA

Abstract

Hearing loss present from birth can have a detrimental impact on later language and educational outcomes. Newborn hearing screening has allowed early identification and intervention of hearing loss, giving children the opportunity to develop age-appropriate language skills. The aim of this quality initiative study was to evaluate the quality of the newborn hearing screening program in the context of a newly implemented Baby-Friendly Hospital Initiative Program at Summa Health System Akron City Hospital. The goals were (1) to determine whether screening environment (mother's room vs. nursery) affected screening results, (2) to identify challenges and positive outcomes encountered by the audiologists, and (3) to ensure that Pass/Refer rates met state standards.

A Quest Technologies sound level meter (Model 1800; St. Paul, MN, USA) was used to measure noise levels in the nursery rooms where newborns were tested. The length of screening time was determined using a calibrated SP® Traceable® (ISO 17025) stopwatch (McGraw Park, IL, USA). Pass/Refer rates and observed challenges and benefits were noted. All well-baby infants born in the month of February 2013 (n = 101) were included, and Pass/Refer results were compared to those in years 2008-2012.

Noise levels in the mother's room did not appear to negatively affect the Pass/Refer rates. Some challenges were present, including interruptions and louder environmental noise. This protocol was considered appropriate for assessing a hearing screening program in a Baby-Friendly Hospital Initiative (BFHI) setting.

Benefits of performing hearing screening in the mother's room included test transparency for parents and the ability to immediately discuss the results. Results obtained in the mother's room were comparable to past results obtained in the nursery. Noise levels in the screening rooms and challenges should be noted, to ensure accuracy of screening results.

Keywords

Universal newborn hearing screening, Baby-Friendly Hospital Initiative, otoacoustic emissions, quality improvement, breastfeeding, rooming-in.

Corresponding author

Stacey R. Lim, AuD, PhD, Central Michigan University, Department of Communication Disorders, Health Professions Building 2172, Mt. Pleasant, MI 48859, USA; tel.: 989-774-1321; email: lim3s@cmich.edu.

How to cite

Lim SR, Newcomb SS. A quality improvement initiative project to evaluate a newborn hearing screening program in a Baby-Friendly Hospital Initiative setting. J Pediatr Neonat Individual Med. 2015;4(1):e040110. doi: 10.7363/040110.

Introduction

According to the Joint Committee on Infant Hearing [1], a goal of universal newborn hearing screening is to identify hearing loss early to maximize language development in the long term. Unidentified hearing loss at birth or in early childhood can have detrimental effects on a child's language and speech development, leading to later adverse effects on the individual's social, educational, cognitive, and emotional outcomes [1-5]. Newborn hearing screening ensures that hearing loss is confirmed by the age of 2-3 months rather than 24-30 months [6-8]. Prior to the implementation of universal newborn hearing screening, the average age of hearing loss identification was between the ages of 24-30 months. Earlier identification of hearing loss allows children to have an earlier opportunity to develop age-appropriate language skills [4, 9]. Newborn hearing screenings are typically completed using otoacoustic emissions (OAE) testing and/or auditory brainstem response (ABR) testing. OAE tests are administered by inserting a small probe tip in the infant's ear [10]. The stimulus is a soft sound or click, which travels through the outer ear and the middle ear to the cochlea. The OAE evaluation gives information about outer hair cell function [10]. If there is no deficit in the cochlea and no occlusion in the outer ear or middle ear, the cochlea will echo the sound (the OAE), which then travels back through the middle ear and outer ear and is recorded by the OAE equipment. OAE tests do not measure the neural components of the auditory system. An ABR test provides information about cochlear function, eighth nerve function, and auditory brainstem function [11]. Electrodes are placed on the infant's head, and sound is presented to the infant's ear through a probe or coupler. As in the OAE test, sound travels through the outer ear and middle ear to the cochlea. Electrical responses are recorded from the eighth nerve. Both OAE and ABR tests should be administered in quiet rooms. According to Hall [10], noise that is present while the neonate is being tested can affect the test results. Examples of unwanted noise include ambient environmental noise or physiologic noise.

Ohio's recommended well-baby nursery protocol includes an initial hearing screening through the use of OAE testing or ABR testing. Should an infant not pass the initial hearing screening, an ABR evaluation must be completed before discharge from the hospital [12]. The performance standards of OAE and ABR testing equipment lack standardization, and the equipment used in newborn hearing screening lacks calibration standards [1, 13, 14]. As a result, it is audiologists who determine the normative data and protocols used in hearing screening.

The Baby-Friendly Hospital Initiative (BFHI) was established by the United Nations Children's Fund and the World Health Organization to encourage maternity hospitals to implement the 10 steps of breast-feeding to build a strong mother-baby relationship [15-17]. A goal of the BFHI is to allow the infant to stay with the mother 24 hours a day after birth [18, 19]. Goals include breast-feeding within a half hour after birth, teaching the mother breast-feeding techniques, rooming-in and breast-feeding on demand. To promote breast-feeding, all assessments, including the initial hearing screening, are completed in the mother's room.

Quality improvement projects in newborn hearing screening have generally focused on the Pass/Refer rates and the incidence of follow-up testing and intervention. Few studies have focused on the quality of OAE results obtained across different test environments in the first few days after birth. Examples of factors influencing test results have included the use of different construction materials in the hospital setting [20]. With the push toward promoting BFHI settings and the lack of standardization of noise levels in various environments, it becomes critical to ensure that Pass/Refer rates are consistent with data obtained in the well-baby nursery and comply

with state and/or national standards for referral rates. Quality initiative projects are important to ensure the highest level of health care quality is being provided [21]. A question asked by those interested in quality improvement is whether an initiative works [21, 22]. It is also important to assess the internal and external influences that impact the quality and success of a program [21], thus creating more positive outcomes for children and their families. Little research has focused on the influence of hospital environment on quality of newborn hearing screenings at individual hospital settings, with the goal of implementing high-quality screening programs and protocols that add to state aggregate data [23]. Given the interest in BFHI, the quality of the newborn hearing screening program should not only take into account the Pass/Refer rates, but also the potential influences of the test environment on test results and the screening process.

Methods

In August 2012, Summa Health System Akron City Hospital began the process toward becoming designated as a BFHI hospital; this process shifted various screening and testing programs from the well-baby nursery to the mother's room. The hospital's goal for rooming-in is to keep mothers and infants together 24 hours per day. As part of the changes in practice supporting the mother-child bonding relationship, all procedures (e.g., bathing and assessments) are now completed bedside.

Summa Health System Akron City Hospital has used the two-step newborn hearing screening described by Hall and colleagues [24] since 2008. Hearing screening can be completed either in the nursery or in the mother's room [25]. Before the changes involved in becoming a designated BFHI facility, the audiology department performed both screening OAE tests and ABR tests in the well-baby nursery. Since February 2013, OAE tests have been completed in the mother's room. The ABR tests continue to be administered in the well-baby nursery to minimize any potential interference from electrical equipment (e.g., computers, computer monitors, and other medical equipment). Data from this project are solely from the two separate well-baby Mother-Infant Units at Summa Health System Akron City Hospital.

The protocol for newborn hearing screening is as follows: the audiologist places a sign on the mother's door to alert staff and visitors that a newborn hearing screening is being performed. The sign requests that visitors or staff enter the room quietly. Once in the room, audiologists explain to the parents that they will be performing a hearing screening and that it will be necessary for the room to be quiet. If the television is on, the audiologists ask the parents to mute the sound. The audiologist collects pertinent data (e.g., risk factors for hearing loss and follow-up pediatrician information). The infant is placed in a crib, where the audiologist administers the OAE test. On completion, the audiologist explains the test results to the parent or parents.

There is a paucity of data on the efficacy and feasibility of screening infants' hearing in the mother's room rather than the nursery; in fact, few data exist on the Pass/Refer rates, ambient noise levels, and test time for hearing screening in either the well-baby nursery or the mother's room. It has been suggested, however, that external environmental noise can affect screening results. Environmental noise such as talking and the sounds of equipment, fans, and vents can be recorded through the microphone of the OAE system, thereby negatively influencing the results [26, 27]. Grasso and colleagues [18] suggested that the well-baby nursery is a more ideal screening environment than the mother's room, but there is a general lack of data in the existing body of research to support this statement. With a shift toward a baby-friendly environment in maternity units, it is important to consider all aspects of any testing and screening, including test results and tester concerns and experiences. By considering all factors involved in a BFHI environment, staff and administration can determine the most effective way to ensure the accuracy and quality of newborn hearing screenings.

The goals of this quality improvement project were twofold. The primary goal was to determine whether screening infants' hearing in the nursery was equivalent to screening infants' hearing in the mother's room, thus ensuring the quality of care for patients at the facility. A secondary goal was to develop a systematic protocol that could be used to monitor the quality of hearing screenings in the mother's room in a baby-friendly environment. According to Summa Health System guidelines for research, this work met the criteria for a quality improvement activity and was exempt from institutional review board attention. No funding was received for this study and the authors have no conflict of interest to disclose.

Data for this quality improvement project were collected during a 1-month period using the Bio-logic® AuDX™ portable distortion product otoacoustic emissions (DPOAE) device (Mundelein, IL, USA). In addition to recording Pass/Refer results, the five staff audiologists collected descriptive data about the observed challenges and benefits they encountered during the hearing screening process. Using a calibrated SP® Traceable® (ISO 17025) stopwatch (McGraw Park, IL, USA), the audiologists determined the length of time required to complete an OAE test in the mother's room, from the moment they entered the room to charting the data to leaving the room. The audiologists noted whether there were visitors in the mother's room, interruptions, noise in the room, or any other unanticipated challenges. Audiologists also determined the length of time it took to perform a hearing screening in the well-baby nursery, including the time it took to enter the mother's room, take the infant to the nursery, complete the hearing screening and charting, and return the infant to the mother in her room. They measured sound levels in the nurseries in which the newborn hearing screenings were completed. Additional sound level measurements were taken in a sampling of occupied and unoccupied bedrooms in each maternity ward. Pass/Refer rates obtained in February 2013 were compared with the average Pass/Refer rates from February 2011 and February 2012. This same screening protocol continued throughout the remainder of the year, and the yearly Pass/Refer rate for 2013 was compared to yearly Pass/Refer rates obtained in 2008-2012.

Summa Health System Akron City Hospital has two Mother-Infant Units, which are on different floors. Mother Infant Unit 2 was renovated in 2012. Mother Infant Unit 1 had not been renovated at the time this project was completed. **Tab. 1** describes the rooms designated for newborn hearing screening in each unit.

Table 1. Rooms used for newborn hearing screening at Summa Health System Akron City Hospital.

Room used for newborn hearing screening	Description
Mother Infant Unit 1 patient rooms	Each room has a bed, nightstand, wheeled table, sofa, rocking chair, sink, bathroom, and linoleum flooring.
Mother Infant Unit 1 conference room	This carpeted conference room adjacent to the nursery has a large conference table with chairs, several counters, cabinets, and a sink. The room may be used to store extra cribs, chairs, and other equipment.
Mother Infant Unit 1 circumcision room	This room has a counter on which circumcisions are performed, a sink, and linoleum flooring.
Mother Infant Unit 2 patient rooms	Each room has a bed, nightstand, wheeled table, sofa, rocking chair, sink, bathroom, and wood laminate flooring.
Mother Infant Unit 2 circumcision room	This room has two counters on which circumcisions are performed, a sink, another counter with a sink, a sliding glass door, and wood laminate flooring.

Results

Data collection yielded results from 101 babies who were screened bedside. The results included the time for hearing screening and charting to be completed in the mother's room, which averaged 7:29 minutes (range, 2:00-30:08 min) from start to finish. In contrast, it took an average of 8:19 minutes (range, 3:21-13:00 min) to complete a hearing screening in the nursery, including the time to transport the baby to the nursery and back to the mother's room. The difference of 50 seconds is negligible.

Sound levels were measured using a Model 1800 Quest Technologies sound level meter (St. Paul, MN, USA). The measurements were taken across a sample of occupied and unoccupied rooms where newborn hearing screenings were completed. These included mothers' rooms and the circumcision rooms on each floor, and the Mother Infant Unit 1 conference room. The average intensity levels of noise were measured in A-weighted decibels (dBA) and are shown in **Tab. 2** for each test environment.

There was no statistically significant difference between the average dBA levels obtained in the patient rooms and the other rooms on the Mother Infant Units (circumcision rooms and conference room), $t(1) = -5.05$, $p = 0.124$ or the mean of the average dBA and peak dBA, $t(1) = -1.81$, $p = 0.321$. However, the peak dBA obtained in the patient rooms was significantly different than the peak dBA obtained in the other Mother Infant Unit rooms, $t(1) = 63$, $p = 0.010$. An alpha level of 0.05 was used to determine statistical significance. A review of the obtained data showed that the peak dBA of patient rooms were 9.18 dBA higher than the other rooms where hearing screenings were

Table 2. Sound level measurements of test environments.

Test environment	Sound level, dBA		
	Average	Peak	Mean of Average and Peak
Mother Infant Unit 1 patient rooms (occupied)	38.4	74.3	56.35
Mother Infant Unit 1 patient rooms (unoccupied)	43.4	45	44.2
Mother Infant Unit 1 conference room (occupied)	46.1	68.1	57.1
Mother Infant Unit 1 conference room (unoccupied)	47.5	49.7	48.6
Mother Infant Unit 1 circumcision room (occupied)	54.3	68.8	61.6
Mother Infant Unit 1 circumcision room (unoccupied)	34.8	47.5	41.2
Mother Infant Unit 2 patient rooms (occupied)	42.8	75.2	59
Mother Infant Unit 2 patient rooms (unoccupied)	35.6	43.9	39.8
Mother Infant Unit 2 circumcision room (occupied)	38.8	59.8	49.3
Mother Infant Unit 2 circumcision room (unoccupied)	50.6	62.2	56.4

Occupied patient rooms included the infant, audiologist, and parent or parents. Occupied conference rooms and circumcision rooms included the infant and audiologist.
dBA: A-weighted decibels.

completed (i.e., circumcision rooms or conference room).

One of the concerns about completing newborn hearing screenings in the mother's room was a possible increase in referral rates. A one-way ANOVA indicated that there was no difference in referral rates on Refer Day 1, $F(5,6) = .030$, $p = .999$. See **Tab. 3** for the Pass/Refer rates from years 2008 through 2013. The audiologists, however, noted the following challenges while testing in the nursery: visitors; interruptions by staff (e.g., housekeeping, physicians, nurses, food service, medical residents, and lactation specialists); parents interfering with the test (asking audiologists questions during screening or trying to soothe the baby); parents making or receiving telephone calls; noise from a television; parents in the bathroom; parents getting the baby dressed; parents making noise (e.g., snoring loudly or talking); the baby fussing, crying, and making noise; dropping a container of probe tips on the floor when transporting OAE equipment to another patient room; and loud medical equipment in the room. The audiology staff at Summa Health System Akron City Hospital found that the sign indicating that hearing screening was being performed in the room was ignored at times, often by physicians and medical residents.

Table 3. Pass/Refer rates for 2008-2013.

Refer Day[a]	2008	2009	2010	2011	2012	2013
1, % referred	17	17	21	25.5	20.9	22
2, % referred	4	3.1	3.08	3.2	2.8	3.125

Otoacoustic emissions tests were completed in the well-baby nursery, not in the mother's room, before 2013.
[a]Refer Day 1 is the first day after birth. Refer Day 2 is the second day after birth.

Discussion

Hearing screening results obtained in the mother's room were comparable to the results obtained in the well-baby nursery. The Pass/Refer rates of the first-day screening in the mother's room were similar to the Pass/Refer rates of OAE tests administered in the nursery. However, noise levels in the screening rooms must be acceptably quiet in either location. Again, there is no standardized noise level for the test environment, whether in the well-baby nursery or the mother's room. One of the concerns of the audiology department at Summa Health System Akron City Hospital in regard to the implementation of the BFHI initiative was that ambient noise present in the mother's room could negatively affect the test results. Based on the results, the average noise levels in the mother's room were generally comparable to the levels in the well-baby nursery. The peak dBA, which is the highest intensity level, was significantly different, with the peak intensity being 9.18 dBA higher in the patient rooms than in the nursery. Although this did not appear to affect the overall Pass/Refer rates, this increased intensity level does suggest that there are differences in the noise levels in some of these rooms where newborn hearing screening is completed. Thus, audiologists and nursing staff should take these differences into consideration and determine whether these do impact overall Pass/Refer rates.

Even though the Pass/Refer rates were comparable to past years, the staff audiologists encountered situations that made it more challenging to complete hearing screenings bedside. These challenges included staff and visitor interruptions, telephone calls made and received by the parents, conversations in the room, television and radio noise, electronic and medical equipment noise in the room, and noise from infants. Louder conversations and floor noise were disruptive to the test and at times aroused the infants. These could very well be reflected in the increased peak dBA levels that were measured. The disruptions the audiologists encountered were similar to those described in past research [26, 27]. Some infants who heard their mother's voice had a rooting response or began to fuss or move, making it more difficult for the audiologist to maintain the position of the OAE equipment in the infant's ear. In some cases, the audiologist was able to request that the parents, visitors, or staff members keep noise to a minimum. In other cases, the audiologist determined that it would be more efficient to complete the hearing screening in the nursery instead or to come back later to finish the newborn hearing screening.

Based on the subjective comments made by the staff audiologists, it is highly recommended that other maternity staff such as nurses, nursing students, physicians (pediatricians and obstetricians-gynecologists), medical residents, and support staff be informed about newborn hearing screening and the effects of additional noise in the mother's room. These could potentially be integrated into medical or nursing student coursework or in staff meetings. However, the authors believe it will be a challenge to educate physicians and medical students performing rounds, as there is a large number of them and not all hold permanent positions on the Mother-Infant Units.

Although there were documented challenges in the administration of OAE tests in the mothers' rooms, this testing procedure had some positive aspects. The audiologists noted that some parents were able to observe and understand that hearing screening was noninvasive. Weichbold and Welzl-Mueller [28] observed that parents who were not present during newborn hearing screening generally reported greater levels of anxiety than parents who were present. Allowing parents to watch the audiologist administer the OAE test might reduce some of their anxiety. We found that some parents who watched the hearing screening appeared to view it positively, but others appeared to be more anxious, particularly if they thought the hearing screening was taking a long time. This observation is consistent with past research [16, 29, 30]. Staff audiologists also commented that they were able to immediately explain the results of the hearing screening to the parents. Thus, audiologists were able to alleviate parents' anxiety and answer questions about the hearing screening and its results.

For the most part, parents and visitors understood the need to keep the environment quiet. At times, however, the audiologists determined that it would be more appropriate to complete the hearing screening in the nursery, such as when there were many visitors present or many telephone calls being received. Thus, BFHI programs should also support the audiologists' decisions to administer hearing screenings in the nursery or another designated quiet room when doing so will affect the results (e.g., when noisy equipment or many visitors are present or the baby is extremely fussy).

A limitation of this project is that the results are not generalizable across all hospital systems that perform newborn hearing screening. Rooms and nurseries vary in construction, so each room may have different acoustic parameters and noise levels. Even within the Summa Health System Akron City Hospital building, the two well-baby nurseries are on two separate floors and are different. One floor was renovated in 2012 and has wood laminate floors, as well as a different layout and different furniture in the rooms than the other well-baby nursery and rooms. Based on the characteristics of these environments, it can be assumed that other buildings will have differences in the structure of the rooms and nurseries. Headley et al. [20] indicated that testing in nurseries in different hospital facilities built at different times, resulting in different construction, can affect the Pass/Refer results. Thus, the audiology staff at hospitals considering bedside newborn hearing screenings should evaluate their own maternity rooms using a calibrated sound level meter to determine whether newborn hearing screening can be effectively completed in the mother's room. A larger multi-center study should be completed to determine whether these results, as well as subjective observation by newborn hearing screening staff, are similar across different birth hospitals. This would then provide

greater information about the types of expected noise levels in the mothers' room, thus allowing Mother-Infant Units to continue to provide high levels of care. Audiology staff should also work with the Mother-Infant Unit employees to educate them about newborn hearing screening protocols. Future research could investigate the efficacy of employing different strategies to counsel parents and staff about the importance of minimizing the level of background noise and develop strategies to minimize interruptions and noise.

Given the support for, and generally wide acceptance of, newborn hearing screening programs, the lack of standardization across newborn hearing screening protocols is surprising. Because testing environments differ across locations and even within a single location, it is important to have a general guideline for the appropriate levels of noise and acceptable screening conditions. Audiologists, nursing staff, physicians, and families then could be certain that newborn hearing screenings are completed under the best possible conditions.

Acknowledgements

The Authors of this article would like to acknowledge Lori Seaman, Dyana Rossi, Monica Mason, and Ashley Dainton for their help with data for this project. We also would like to thank Ann Wargo, Susan Sorboro, and Jennifer Foster for their support on this project and their thoughtful editorial comments.

Declaration of interest

The Authors have no conflict of interest to disclose. No funding was secured for this study. The Authors have no financial associations relevant to this article.

References

1. Joint Committee on Infant Hearing. Year 2007 position statement: principles and guidelines for early hearing detection and intervention programs. Pediatrics. 2007;120(4):898-21.
2. National Institutes of Health, Office of Medical Applications of Research, National Institute on Deafness and Other Communication Disorders. Consensus Development Conference on Early Identification of Hearing Impairment in Infants and Young Children. NIH Consensus Development Conference; March 1-3, 1993; Bethesda, MD.
3. Tharpe AM. Unilateral and mild bilateral hearing loss in children: past and current perspectives. Trends Amplif. 2008;12(1):7-15.
4. Yoshinaga-Itano C, Sedey AL, Coulter DK, Mehl AL. Language of early- and later-identified children with hearing loss. Pediatrics. 1998;102(5):1161-71.
5. Yoshinaga-Itano C. Early intervention after universal neonatal hearing screening: impact on outcomes. Ment Retard Dev Disabil Res Rev. 2003;9(4):252-66.
6. Harrison M, Roush J, Wallace J. Trends in age of identification and intervention in infants with hearing loss. Ear Hear. 2003;24(1):89-95.
7. Nelson HD, Bougatsos C, Nygren P. Universal newborn hearing screening: Systematic review to update the 2001 US preventive task force recommendation. Pediatrics. 2008;122(1):e266-76.
8. Fitzpatrick E, Durieux-Smith A, Eriks-Brophy A, Olds J, Gaines R. The impact of newborn hearing screening on communication development. J Med Screen. 2007;14(3):123-31.
9. Russ SA, White K, Dougherty D, Forsman I. Preface: newborn hearing screening in the United States: Historical perspective and future directions. Pediatrics. 2010;126(Suppl 1):S3-6.
10. Hall JW III. Handbook of Otoacoustic Emissions. San Diego, CA: Singular Thomson Learning, 2000.
11. Atcherson SR, Stoody TM. Auditory Electrophysiology: A Clinical Guide. New York, NY: Thieme Medical Publishers, 2012.
12. Ohio hearing screening requirements for newborns and school-aged children. American Speech-Language Hearing Association Web site. Available at: http://www.asha.org/Advocacy/state/info/OH/Ohio-Hearing-Screening-Requirements.htm, last access: August 17, 2013.
13. Gravel JS, White KR, Johnson JL, Widen JE, Vohr BR, James M, Kennalley T, Maxon AB, Spivak L, Sullivan-Mahoney M, Weirather Y, Meyer S. A multisite study to examine the efficacy of the otoacoustic emission/automated auditory brainstem response newborn hearing screening protocol: recommendations for policy, practice, and research. Am J Audiol. 2005;14(2):S217-28.
14. Natus Medical Inc. The ABaer and AOAE Hearing Screening System: User's and Service Manual. Mundelein, IL: Natus Medical Inc., 2011.
15. World Health Organization. Evidence for the Ten Steps to Successful Breastfeeding. Geneva, Switzerland: WHO, 1989.
16. World Health Organization. Protecting, Promoting and Supporting Breastfeeding: the Special Role of Maternity Services. Geneva, Switzerland: WHO, 1992.
17. World Health Organization. Protecting, Promoting and Supporting Breast-feeding: the Special Role of Maternity Services. Geneva, Switzerland: WHO, 1994.
18. Grasso DL, Hatzopulos S, Cossu P, Ciarafoni F, Rossi M, Martini A, Zocconi E. Role of the "rooming-in" on efficacy of universal neonatal hearing screening programmes. Acta Otorhinolaryngol Ital. 2008;28(5):243-6.
19. World Health Organization, UNICEF. Baby-Friendly Hospital Initiative: Revised, Updated and Expanded for Integrated Care. Geneva, Switzerland: WHO, 2009.
20. Headley GM, Campbell DE, Gravel JS. Effect of neonatal test environment on recording transient-evoked otoacoustic emissions. Pediatrics. 2000;105(6):1279-85.
21. Homer C. A tall order: Improve child health. Acad Pediatr. 2013:13(6 Suppl):S5-6.

22. Parry GJ, Carson-Stevens A, Luff DF, McPherson ME, Goldmann DA. Recommendations for evaluation of health care improvement initiatives. Acad Pediatr. 2013;13(6 Suppl): S23-30.
23. Deem KC, Diaz-Ordaz EA, Shiner B. Identifying quality improvement opportunities in a universal newborn hearing screening program. Pediatrics. 2012:129(1);157-64.
24. Hall JW, Smith SD, Popelka GR. Newborn hearing screening with combined otoacoustic emissions and auditory brainstem responses. J Am Acad Audiol. 2004;15(6):414-25.
25. Winston R, Ditty KM. Newborn hearing screening. In: Schmeltz L (Ed.). A Resource Guide for Early Hearing Detection and Intervention. Logan, UT: Utah State University, 2013, pp. 1-14. Available at: http://www.infanthearing.org/ehdi-ebook/index.html, last access: September 14, 2013.
26. Jacobson JT, Jacobson CA. The effects of noise in transient EOAE newborn hearing screening. Int J Pediatric Otorhinolaryngol. 1994;29(3):235-48.
27. Popelka GR, Karzon RK, Clary RA. Identification of noise sources that influence distortion product otoacoustic emission measurements in human neonates. Ear Hear. 1998;19(4):319-28.
28. Weichbold V, Welzl-Mueller K. Maternal concern about positive test results in universal newborn hearing screening. Pediatrics. 2001;108(5):1111-6.
29. Hergils L, Hergils Å. Universal neonatal hearing screening – parental attitudes and concerns. Br J Audiol. 2000;34(6):321-8.
30. Papacharalampous GX, Nikolopoulos TP, Davilis DI, Xenellis IE, Korres SG. Universal newborn hearing screening, a revolutionary diagnosis of deafness: Real benefits and limitations. Eur Arch Otorhinolaryngol. 2011;268:1399-406.