Original Research Article

Study of various risk factors predisposing to hearing impairment in the new-born

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Abstract

Background: Within the general population, the prevalence of permanent hearing impairment (congenital, progressive and acquired) in infants and young children in early studies from the 1980s and 1990s ranged from 0.1% to 0.2%. More recent studies have confirmed that this incidence has remained stable. However, there has been a decrease in the incidence of sensorineural hearing loss among NICU graduates when rates published in more recent reports (0.7–1.5%)are compared with those from previous decades (2.1–17.5%).**Aim and objectives:** To study of various risk factors predisposing to hearing impairment in the newborn. **Materials and Methods:** In the present study all NICU graduates who complied with the follow up in the neuro developmental clinic during the Aug 2000 to July 2010 were included in the study. The period of follow up was variable, ranging from 4 months to 18 months. Thus the duration of study was 10 years. A prestructured proforma was used to enter the details of selected NICU graduate. All the NICU graduates in the study population were screened for the presence of hearing impairment at the first follow up after discharge from NICU. The screening method used was Brainstem Evoked Response Audiometry. **Results:** Out of total 421 neonates Hearing impairment was observed in 44(10.45%) neonates. It was observed that Gender was not a significant risk factor in the present study (p=1.0000). It was observed that 25% neonates with hearing impairment were having birth weight less than 1500gms and 36.36% were having birth weight between 1500 to 2500gms. **Conclusion:** Thus with reference to above mentioned results and discussion we conclude that Very low birth weight was a statistically significant risk factor for hearing impairment. Perinatal asphyxia, Craniofacial anomalies, Mechanical ventilation >5days, Hyperbilirubinemia requiring exchange transfusion and PPHN were also associated with hearing impairment.
Key words: hearing impairment, risk factors, NICU graduates

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Received Date: 02/05/2019 Revised Date: 27/05/2019 Accepted Date: 14/07/2019
DOI: https://doi.org/10.26611/101411110

Access this article online

Quick Response Code:

Website: www.medpulse.in

Accessed Date: 10 July 2019

INTRODUCTION

Hearing impairment or deafness is an unforeseen misery. Helen Keller, a powerful symbol of triumph over adversity and a leader and legend of the blindness field said, " the problems of deafness are deeper and more complex, if not more important than those of blindness. Deafness is much worse misfortune, for it means, the most vital stimulus - the sound of voice - that brings speech and language, sets thoughts astir and keeps us in intellectual company of the man". Galambos and Despland (1980) identified the presence of hearing loss in NICU graduates with prematurity and low birth weight, low Apgar scores, low blood pH, ototoxic drugs, respiratory distress syndrome requiring ventilation for more than 11 days and congenital cardiac and facial malformations and possibly trisomy18.[1]Downs and silver[2] had produced a much simpler ABCDS of risk factors: A - affected family regardless of the claimed cause, B- serum bilirubin levels of 20 mg% or more, C- congenital rubella, D- Defects of ear , nose or throat at birth and S- small at birth (<1500 gm). High-risk indicators for hearing loss in children from birth to 24 months of age, as mentioned by 2000 position statement by JCIH are as shown below.[3]Within the general population, the prevalence of permanent hearing impairment (congenital, progressive and acquired) in infants and young children in early studies from the 1980s and 1990s ranged from 0.1% to 0.2%.More recent studies

How to cite this article: Swati Khot, Bhavesh Shah. Study of various risk factors predisposing to hearing impairment in the new-born. *MedPulse International Journal of Pediatrics.* July 2019; 11(1): 36-41. http://medpulse.in/Pediatrics/index.php

have confirmed that this incidence has remained stable. However, there has been a decrease in the incidence of sensorineural hearing loss among NICU graduates when rates published in more recent reports (0.7–1.5%)are compared with those from previous decades (2.1–17.5%).This may be due to the successful preventive management of hearing loss risk factors, including quieter technology used in NICUs, better infection control, improved monitoring of oxygen supplementation and the routine measurement of serum aminoglycoside concentrations.[4]

MATERIALS AND METHODS

The present study was conducted in the NICU of Department of Paediatric of the tertiary care institute. The study institute is having Level III NICU which mean a unit that provides both specialty and subspecialty care including the provision of life support (mechanical ventilation).All NICU graduates who complied with the follow up in the neurodevelopmental clinic during the Aug 2000 to July 2010 were included in the study. The period of follow up was variable, ranging from 4 months to 18 months. Thus the duration of study was 10 years. For those patients born during August 2008 to July 2010, information details were collected from parents of NICU graduates in the neuro-development clinic and NICU discharge summary. Patients born during Aug 2000 to Jul 2008 were followed up retroprospectively with help of recorded data in neuro developmental clinic registers and NICU records. A prestructured proforma was used to enter the details of selected NICU graduate. All the NICU graduates in the study population were screened for the presence of hearing impairment at the first follow up after discharge from NICU. The screening method used was Brainstem Evoked Response Audiometry. BERA was performed in these babies in a separate room specially designed for this procedure. The machine used was a Oxford based Medelac Synergy machine. The stimulus used being Monoaural, Rarefaction Broad band clicks of 100ms duration with contralateral masking. The maximum intensity of stimulus was 105 dB. BERA was recorded in a single channel (ipsilateral mastoid Mi-Cz). Five waves of BERA were recorded; designated as waves I, II, III, IV and V. A detailed evaluation of the neurodevelopmental status was also done. Case data was recorded in a predetermined proforma. Information regarding presence of various risk factors was recorded and its association with the hearing impairment was studied and the findings were noted. Appropriate statistical tests were applied wherever necessary (Fisher exact test, Chi square test with or without Yate's correction)

RESULTS

Table 1: Incidence of Hearing Impairment in NICU Graduates

	No. of neonates	%
NICU graduates with hearing loss	44	10.45%
NICU graduates without hearing loss	377	89.55%
No. Of NICU graduates	421	100%

It was observed that out of total 421 neonates Hearing impairment was observed in 44(10.45%) neonates.

Table 2: Distribution of risk factors according to gender, birth weight and gestational age

		hearing impairment present	hearing impairment absent	total	p value
Gender	Male	25 (56.82%)	216 (57.29%)	241 (57.24%)	1.0000
	Female	19 (43.18%)	161 (42.71%)	180 (42.76%)	
Birth Weight	<1500 gm	17 (38.64%)	92 (24.40%)	109 (25.89%)	0.0467
	1500-2500 gm	11 (25.00%)	200 (53.05%)	211 (50.12%)	
	>2500 gm	16 (36.36%)	85 (22.55%)	101 (23.99%)	
Gestational Age	<28wks	2 (4.55%)	6 (1.59%)	8 (1.90%)	0.6697
	28to<34wks	16 (36.36%)	131 (34.75%)	147 (34.92%)	
	34 to<37wks	10 (22.73%)	115 (30.50%)	125 (29.69%)	
	≥37 wks	16 (36.36%)	125 (33.16%)	141 (33.49%)	

It was observed that Gender was not a significant risk factor in the present study (p=1.0000). It was observed that 25% neonates with hearing impairment were having birth weight less than 1500gms and 36.36% were having birth weight between 1500 to 2500gms. And the difference observed was statistically significant. No statistically significant difference was observed among the gestational age and hearing impairment.

Table 3: Occurrence of Different Proposed Risk Factors in NICU Graduates

Proposed risk factor	Hearing impairment present	Hearing impairment absent	Total	P value
Perinatal asphyxia	14 (31.82%)	64 (16.98%)	78 (18.53%)	0.0050
Craniofacial anomalies	9 (20.45%)	24 (6.37%)	33 (7.84%)	0.001
Mechanical ventilation >5days	9 (20.45%)	34 (9.02%)	43 (10.21%)	0.0178
Ototoxic drugs >5days	21 (47.73%)	127 (33.69%)	148 (35.15%)	0.0649
Hyperbilirubinemia requiring exchange transfusion	8 (18.18%)	7 (1.86%)	15 (3.56%)	0.001
Sepsis	9 (20.45%)	54 (14.32%)	63 (14.96%)	0.2807
Intracranial haemorrhage	2 (4.55%)	3 (0.80%)	5 (1.19%)	0.1506
Metabolic/Electrolyte disturbances	6 (13.64%)	60 (15.92%)	66 (15.68%)	0.8616
PPHN	5 (11.36%)	9 (2.39%)	14 (3.33%)	0.0070
Family history of hearing loss	2 (4.55%)	2 (0.53%)	4 (0.95%)	0.0756

The most prevalent risk factors in NICU graduates are Use of ototoxic drugs, Very low birth weight, Perinatal asphyxia, Metabolic or electrolyte disturbances, Sepsis, Mechanical ventilation >5 days, Craniofacial anomalies, Hyperbilirubinemia requiring exchange transfusion, PPHN, Intracranial haemorrhage and family history of hearing loss, in that order.

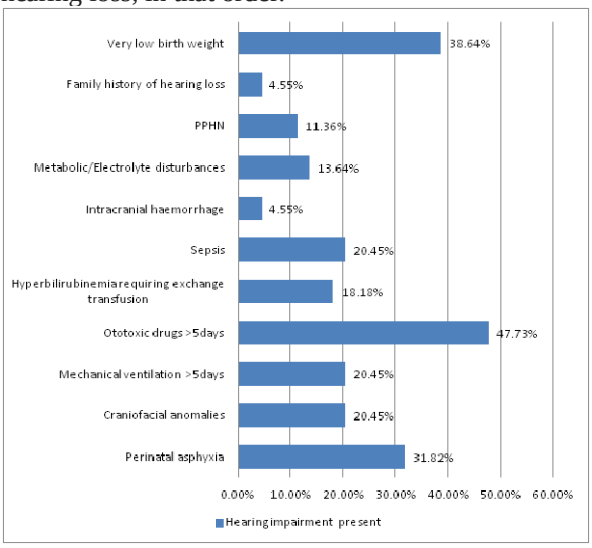

Figure: Occurrence of Different Proposed Risk Factors In Nicu Graduates

DISCUSSION

The present study as conducted with the aim to study the various risk factors predisposing to hearing impairment in the newborn. Among the 421 NICU graduates who were available for follow up, 44 showed some form of hearing impairment. Thus, the incidence of hearing impairment in our study population was 10.45%. Among the total 421 patients, 241 (57.24%) were males and rest 180 (42.76%)were females, with a male : female ratio of 1.34:1. It was seen that 25 male newborns developed hearing impairment while, among females19 developed hearing impairment but the difference was not statistically significant (p= 1.0000). This result is at par with other studies, including study by Zamani *et al*[5] who mentioned that there was no significant relationship between hearing loss and sex. We divided the study population into three categories based on weight for the purpose of comparison, babies with weight <1500 grams, between 1500 to 2500 grams and those with weight >2500 grams. 109 (25.89%) babies had weight <1500 grams, 211 (50.11%) had a weight between 1500 to 2500 grams and 101 (23.99%) babies weighed >2500 grams at birth. It was observed that 25% neonates with hearing impairment were having birth weight less than 1500gms and 36.36% were having birth weight between 1500 to 2500gms. And the difference observed was statistically significant

(p=0.0467). Low birth weight is a well known risk factor since long. It was one of the 'ABCDS' of risk factors of hearing loss described by Downs and Silver in 1972.[2]One NIH sponsored large multicentered study in 1994-96 reported Very low birth weight as the second commonest risk factor in NICU population.[6]Van Naarden Decoufle P[7] have reported a prevalence of 4.1 per 10000 in babies with birth weight 4000 grams or more, 3.7 per 10000 in babies with birth weights ranging between 3000 and 3999 grams, 6.6 per 10000 in babies with birth weight between 2500 to 2999 grams, 12.7 per 10000 among babies between 1500 to 2499 grams and 51 per 10000 in babies with weight <1500 grams. The overall percentage of moderate to profound congenital bilateral sensorineural hearing loss in the entire study population that was attributable to children weighing <2500 g or <1500 g was estimated to be 18.9% and 9.4%, respectively. Out of total 421 NICU graduates followed, 8(1.9%) were <28 wks by gestational age at birth, 147 (34.92%) were born at gestational age of 28 wk to< 34 wk, 125 babies (29.69%) were 'late preterms' i.e. born at Gestational age 34 wks to <37wk completed and 141 newborns were term i.e.37 wks or more by gestational age. The difference observed in the gestational age and hearing impairment was not statistically significant. Berg *et al*[8] and Rance *et al*[9] have also shown in their studies that hearing impairment was not related to gestational age.In the present study 78(18.53%) babies out of total 421 had a history of significant perinatal asphyxia i.e. Apgar score of 0-4 at 1 min or 0-6 at 5 min. it was observed that perinatal asphyxia was present among 31.82% neonates with hearing impairment. And perinatal asphyxia (low apgar scores) was a statistically significant risk factor for hearing impairment in NICU graduates. (p = 0.0095). Salamy and colleagues[10] strongly support the direct association between hypoxia and hearing loss, as do studies conducted by Borradori *et al* [11] and Savic and colleagues.[12]Moster *et al* was 5.9%[13] and Roth *et al*[14]also observed similar findings in their study. Over 10 years of study period we found total 33 newborns (i.e.7.84%) with some or the other form of craniofacial abnormality. This included 5 babies with Down's syndrome (with mongoloid slant, low set ears, epicanthal folds etc.), 8 cases with preauricular tags, 3 with cleft lip and/or cleft palate. One baby was found to have craniofacial abnormalities (low set ears, microphthalmos, high arched palate) associated with bilateral absent thumbs, horseshoe kidney, ASD who was later diagnosed as a case of Fanconi's anemia. One case had external auditory canal atresia, One had Prune belly syndrome and imperforate anus with facial dysmorphic features. One had corneal clouding and cataracts with posteriorly placed ears and coarse facies. Two had micrognathia as a predominant feature along with High arched narrow palate and low set ears, remaining had variable dysmorphic facial features which were not diagnosed as a part of any defined syndrome. Total 9 of these babies developed some form of hearing impairment, as shown below and the association between craniofacial abnormalities and hearing impairment was statistically significant (p=0.0037).Zamani *et al*[5]also reported a significant statistical relation of craniofacial anomalies with hearing loss (*P* <0.000001). Hayes[15] analyzed results of auditory brainstem response (ABR) evaluation of 145 infants, ages 6 months and younger with craniofacial anomalies (CFA). Approximately 50% of infants demonstrated at least mild bilateral hearing loss. Presence and degree of hearing loss varied with occurrence of craniofacial anomalies. All infants with bilateral aural atresia exhibited at least a moderate bilateral hearing loss; less than 20% of infants with isolated external ear anomalies (ear tags, isolated microtia) exhibited any degree of hearing loss.

In our study, total 43 newborns (10.21%) required mechanical ventilation for more than 5 days, out of which 9 developed hearing impairment. The mechanical ventilation for >5days was a statistically significant risk factor for hearing impairment in NICU graduates (p = 0.0307). Our study is at par with the results of various other studies like that by Zamani *et al*[5]who reports a significant association between mechanical ventilation>5 days and hearing impairment. Eavey *et al*[16]and Hille *et al*[17] also observed similar findings. In this study, out of total 421 patients, 148 received treatment with some ototoxic drug for more than 5 days during their NICU stay. Among the list of ototoxic drugs the most commonly used group was aminoglycosides, most commonly Amikacin which was administered in appropriate doses as per drug guidelines in newborns, taking into consideration their gestational age, day of life and renal status. The duration of administration varied from 5 days to 14 days in most of the cases. The other drugs used commonly were Furosemide, though not as commonly as previous one. The list included other aminoglycosides, Vancomycin, Quinine, etc drugs which are commonly given and are thought to be ototoxic.It was observed that out of 44 neonates with hearing impairment 21 (47.73) had received ototoxic drugs but the difference was not statistically significant (p = 0.0688). Our result is at par with the study by Zamani *et al*[5] who has shown that use of aminoglycosides alone is not an independent risk factor for hearing loss. But when associated with other risk factors, it is a significant risk factor. Hyperbilirubinemia requiring exchange transfusion was found to be an extremely significant risk factor for hearing impairment in NICU graduates. (p <0.0001).Our

result was at par with JCIH 2000 position statement which mentions hyperbilirubinemia requiring exchange transfusion as a risk factor.[3]Zamani *et al*[5]and Downs and silver[2]also observed similar findings in their study. In our study total 63 babies (i.e. 14.96%) had either culture proven or clinically suspected sepsis, including both early and late onset sepsis. Of all these cases, total 9 patients showed hearing impairment i.e. 14.29% but the difference was not statistically significant. In contrary Meyer *et al*[19] found out sepsis as a significant risk factor for hearing impairment in NICU graduates. Paul V K and Radhika S[20] have suggested an association between neonatal sepsis and adverse neurodevelopmental sequelae. These studies evaluated postnatal sepsis in neonates. We found total 5 babies (1.19%) with proven intracranial haemorrhage, all of which were cases of intraventricular haemorrhage out of which 2 developed hearing impairment. The association between these two was not found to be statistically significant (p = 0.0871).Our study was at par with Harbi *et al* who found ten babies had IVH grade 3 or 4 in their study, nine out of whom had pathological ABR. Hence they found an initial significant association. We assessed role of metabolic and electrolyte imbalances including hypoglycaemia (most common), Hyponatremia, Hypocalcemia, acidosis etc. Total 66 babies i.e.(15.68%) from our study group manifested some form of these imbalances during their NICU stay. Out of these babies 6 developed hearing impairment.But, the association was not found to be statistically significant (p = 0.8284). Out of total study population of 421 NICU graduates, 14 (3.33%) had shown manifestations of PPHN during NICU stay and survived. Out of these 5 developed hearing impairment. The effect of Extracorporeal membrane oxygenation could not be assessed due to non availability of this treatment modality at our institute.PPHN was found to be a significant risk factor for hearing impairment in NICU graduates (p = 0.0097). Our study was at par with various studies including Marlow *et al*[21], Lipkin *et al*[22], Lasky *et al*[23], Kawashiro *et al*[24] who all found PPHN as a significant risk factor and incidence varied from 17 to 30%. In our study, only 4 patients had a family history of hearing loss, out of which 2 showed hearing impairmentandthe association was not found to be statistically significant (p= 0.0756). Our report was at par with study by Zamani *et al*[5] who reported p value of 0.43 and concluded that there was no significant association between two. However, many studies have found a significant association, including study by Wenying *et al*[25], who reported it as an independent risk factor. Joan D Mello[26] reported an incidence of 5.6% while Savic *et al* found 12.3% incidence.[12]The contradictory result in our study might be due to very few cases in this group.

CONCLUSION

Thus with reference to above mentioned results and discussion we conclude that Very low birth weight was a statistically significant risk factor for hearing impairment. Perinatal asphyxia, Craniofacial anomalies, Mechanical ventilation >5days, Hyperbilirubinemia requiring exchange transfusion and PPHN were also associated with hearing impairment.

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Source of Support: None Declared
Conflict of Interest: None Declared