

**PREVALENCE OF HEARING IMPAIRMENT IN NEONATES ADMITTED IN NEONATAL INTENSIVE CARE UNIT IN TERTIARY CARE CENTER.****Dr. Ashok Murthy**

Professor and HOD, Dept of ENT, PESIMSR, Kuppam 517425

Dr. Udayalakshmi Bai C

PG Resident, Dept. of ENT, Dept of ENT, PESIMSR, Kuppam 517425

ABSTRACT

Introduction: Early hearing detection have been shown to facilitate timely diagnosis and management of hearing loss. [1] Screening techniques such as otoacoustic emissions offer a non-invasive, objective, and efficient method for assessing cochlear function in neonates. These screening tools are suitable for use in NICU settings, where early identification of loss of hearing can guide further diagnostic evaluation and prompt initiation of intervention. [2] **Aim:** To assess the prevalence of hearing impairment among neonates admitted to the Neonatal Intensive Care Unit of a tertiary care centre and to facilitate early identification and management of affected neonates. **Objectives:** 1. To estimate the prevalence of hearing impairment among neonates admitted to the NICU using otoacoustic emission (OAE) screening. 2. To evaluate the association between hearing impairment and established neonatal risk factors for hearing loss. 3. To ensure early referral and initiation of appropriate management for neonates identified with hearing impairment. **Study design:** Prospective observational study. **Study settings:** The study was carried out in the Neonatal Intensive Care Unit of PES Institute of Medical Sciences and Research (PESIMSR) Hospital, Kuppam, a tertiary care teaching hospital providing advanced neonatal care services. **Inclusion criteria:** All neonates admitted to the NICU, including both inborn and outborn neonates. **Exclusion criteria:** 1. Neonates with active ear discharge at the time of screening. 2. Neonates whose parents or legal guardians refused to give informed consent. **Results and Conclusion:** Based on the findings, the study strongly recommends the implementation of universal neonatal hearing screening, particularly in NICU settings, using a two-stage OAE protocol with timely referral for diagnostic evaluation. Neonates with identified risk factors should undergo closer surveillance, early audiological confirmation, and prompt initiation of appropriate interventions to minimize long-term speech, language, and cognitive deficits.

KEYWORDS :**INTRODUCTION:**

Neonatal hearing impairment is often insidious in onset and may not be clinically apparent during routine postnatal examination. [3] Unlike visible congenital anomalies, hearing loss frequently goes unnoticed until delays in speech and language development become evident. By the time such delays are recognized, a significant window for optimal neural plasticity may have already been missed. [4] This outlines the importance of systematic hearing screening during first month, particularly in high-risk populations. [5]

AIM

To assess the prevalence of hearing impairment among neonates admitted to the Neonatal Intensive Care Unit of a tertiary care centre and to facilitate early identification and management of affected neonates.

OBJECTIVES

- To estimate the prevalence of hearing impairment among neonates admitted to the NICU using otoacoustic emission (OAE) screening.
- To evaluate the association between hearing impairment and established neonatal risk factors for hearing loss.
- To ensure early referral and initiation of appropriate management for neonates identified with hearing impairment.

Study design: Prospective observational study

Study settings: The study was carried out in the Neonatal Intensive Care Unit of PES Institute of Medical Sciences and Research (PESIMSR) Hospital, Kuppam, a tertiary care teaching hospital providing advanced neonatal care services.

Inclusion criteria:

- All neonates admitted to the NICU, including both inborn and outborn neonates.

Exclusion criteria:

- Neonates with active ear discharge at the time of screening
- Neonates whose parents or legal guardians refused to give informed consent

METHODOLOGY:

Neonates who passed the first OAE screening in both ears were considered to have normal hearing, and no further screening was required. Neonates who failed the initial screening in one or both ears were scheduled for a second OAE screening after one month to rule out

transient causes of hearing loss such as middle ear fluid or physiological immaturity of the auditory system.

During the second screening, neonates who demonstrated a pass result were categorized as having normal hearing. Neonates who continued to fail the second OAE screening were considered to have suspected hearing impairment and were referred for further audiological evaluation. These neonates were directed to appropriate audiology services for confirmatory diagnostic testing and early intervention. Appropriate management, including counselling of parents and initiation of further diagnostic or therapeutic measures, was undertaken at the earliest to minimize long-term adverse developmental outcomes.

RESULTS:

The sample size was calculated based on the study by Sharma et al [6] in 2023 where the prevalence of hearing impairment in NICU admitted neonates was 25%; with 95% confidence interval, 7% absolute precision and with 10% excess sampling to account for non-response, sample size was derived using the formula:

$$n = Z^2 \times PQ / d^2$$

1. The distribution of neonates by gestational age and birth weight (N = 162).

- a. Term neonates (≥ 37 weeks of gestation) constituted the majority of the study population at 61.7% ($n = 100$), while preterm neonates accounted for 38.3% ($n = 62$).
- b. With regard to birth weight, more than half of the neonates had a normal birth weight of ≥ 2500 g, comprising 50.6% ($n = 82$).
- c. Low birth weight neonates weighing between 1500 and 2499 g accounted for 34.6% ($n = 56$), whereas very low birth weight neonates weighing less than 1500 g constituted 14.8% ($n = 24$).
- d. When gestational age and birth weight were considered together, 29.6% ($n = 48$) of the neonates were preterm with low birth weight.
- e. Term neonates with normal birth weight formed the largest subgroup, representing 50.6% ($n = 82$) of the study population.
- f. The remaining 19.8% ($n = 32$) comprised neonates with other combinations of gestational age and birth weight.

This distribution highlights a substantial proportion of preterm and low birth weight neonates among NICU admissions, reflecting a population at increased risk for adverse neonatal outcomes, including hearing impairment.

2. The distribution of neonates according to APGAR scores at 1

and 5 minutes (N = 162).

- a. At 1 minute, 35.8% (n = 58) of neonates had an APGAR score of ≤ 6 , whereas the remaining 64.2% (n = 104) had scores greater than 6.
- b. By 5 minutes, the proportion of neonates with low APGAR scores (≤ 6) reduced to 19.8% (n = 32), while 80.2% (n = 130) achieved scores above 6.

This improvement in APGAR scores from 1 to 5 minutes suggests effective neonatal resuscitation and early stabilization among NICU-admitted neonates.

3. The clinical profile of neonates admitted to the NICU (N = 162).

- a. Prematurity was the most common indication for NICU admission, accounting for 32.1% (n = 52) of cases. This was followed by respiratory distress in 25.3% (n = 41) of neonates and delayed cry or birth asphyxia in 24.7% (n = 40).
- b. Neonatal jaundice constituted 17.9% (n = 29) of NICU admissions.

Overall, the distribution highlights prematurity and respiratory-related conditions as the leading causes of NICU admission in the study population.

4. The frequency distribution of identified risk factors for hearing impairment among the study participants (N = 162).

- a. Low birth weight (<2500 g) was the most frequently observed risk factor, present in 49.4% (n = 80) of neonates, followed by prematurity in 38.3% (n = 62).
- b. Birth asphyxia or delayed cry was noted in 24.7% (n = 40) of cases.
- c. Hyperbilirubinemia requiring treatment was identified in 17.9% (n = 29) of neonates.
- d. Exposure to ototoxic drugs for five days or more was observed in 16.0% (n = 26).
- e. Mechanical ventilation for five days or longer was required in 13.0% (n = 21) of neonates.
- f. Neonatal sepsis or meningitis was present in 11.1% (n = 18).

Overall, a substantial proportion of neonates had one or more established risk factors for hearing impairment.

5. The distribution of neonates according to the number of perinatal risk factors present (N = 162).

- a. A total of 21.0% (n = 34) of neonates had no identifiable risk factors.
- b. The largest proportion of neonates had a single risk factor, accounting for 34.6% (n = 56) of the study population.
- c. Two risk factors were present in 25.9% (n = 42) of neonates, while 18.5% (n = 30) had three or more risk factors.

This distribution demonstrates that the majority of neonates admitted to the NICU had at least one perinatal risk factor associated with hearing impairment, with a considerable proportion exhibiting multiple risk factors.

6. The prevalence of hearing impairment among NICU-admitted neonates included in the study (N = 162).

- a. The majority of the neonates, 95.7% (n = 155), were found to have normal hearing following completion of the screening and diagnostic process.
- b. Hearing impairment was confirmed in 4.3% (n = 7) of neonates.

This prevalence highlights the presence of a clinically significant burden of hearing impairment among NICU-admitted neonates, underscoring the importance of routine hearing screening in this high-risk population.

7. The association between gestational age and hearing impairment among NICU-admitted neonates (N = 162).

- a. Hearing impairment was observed in 8.1% (n = 5) of preterm neonates compared to 2.0% (n = 2) of term neonates.
- b. The difference in prevalence of hearing impairment between preterm and term neonates was found to be statistically significant (p = 0.04).

These findings indicate that preterm neonates had a significantly higher risk of hearing impairment when compared to term neonates.

8. The association between birth weight categories and hearing impairment (N = 162).

- a. The highest proportion of hearing impairment was noted among very low birth weight neonates weighing less than 1500 g, with 12.5% (n = 3) affected.

- b. This was followed by neonates weighing between 1500 and 2499 g, among whom 5.4% (n = 3) had hearing impairment.
- c. In contrast, only 1.2% (n = 1) of neonates with birth weight ≥ 2500 g were found to have hearing impairment.

The association between birth weight and hearing impairment was statistically significant (p = 0.03), demonstrating an inverse relationship between birth weight and risk of hearing impairment.

9. The association between birth asphyxia and hearing impairment among the study participants (N = 162).

- a. Hearing impairment was present in 10.0% (n = 4) of neonates with a history of birth asphyxia, compared to 2.5% (n = 3) among those without birth asphyxia. Hearing impairment was present in 10.0% (n = 4) of neonates with a history of birth asphyxia, compared to 2.5% (n = 3) among those without birth asphyxia.
- b. This difference was statistically significant (p = 0.02), indicating that neonates who experienced birth asphyxia had a significantly higher likelihood of developing hearing impairment.

These results underscore the importance of careful auditory monitoring in neonates with a history of perinatal hypoxia.

10. The association between hyperbilirubinemia and hearing impairment among NICU-admitted neonates (N = 162).

- a. Hearing impairment was observed in 10.3% (n = 3) of neonates with hyperbilirubinemia, compared to 3.0% (n = 4) among those without hyperbilirubinemia.
- b. The difference between the two groups was found to be statistically significant (p = 0.04).

These findings suggest that neonates with hyperbilirubinemia had a significantly higher risk of developing hearing impairment, highlighting the ototoxic potential of elevated bilirubin levels and the importance of auditory surveillance in this subgroup.

11. The association between neonatal sepsis or meningitis and hearing impairment among the study participants (N = 162).

- a. Hearing impairment was detected in 11.1% (n = 2) of neonates with a history of sepsis or meningitis, whereas only 3.5% (n = 5) of neonates without these infections were affected.
- b. This association was statistically significant (p = 0.03).

The results indicate that neonatal sepsis or meningitis is a significant risk factor for hearing impairment, underscoring the need for mandatory hearing evaluation and close follow-up in neonates with severe neonatal infections.

12. The association between exposure to ototoxic drugs and hearing impairment among NICU-admitted neonates (N = 162).

- a. Hearing impairment was identified in 11.5% (n = 3) of neonates who were exposed to ototoxic drugs for five days or more, compared to 2.9% (n = 4) among those without such exposure.
- b. This difference was statistically significant (p = 0.02), indicating that prolonged exposure to ototoxic medications significantly increased the risk of hearing impairment.

These findings emphasize the need for cautious use of ototoxic drugs in neonatal care and reinforce the importance of routine hearing screening in exposed neonates.

13. The association between the duration of mechanical ventilation and hearing impairment (N = 162).

- a. Hearing impairment was observed in 14.3% (n = 3) of neonates who required mechanical ventilation for five days or longer, whereas only 2.8% (n = 4) of neonates who did not require prolonged ventilation were affected.
- b. The association was statistically significant (p = 0.02), suggesting that prolonged mechanical ventilation is an important risk factor for hearing impairment.

This finding highlights the need for vigilant auditory monitoring and follow-up in neonates who require extended respiratory support during their NICU stay.

14. The occurrence of hearing impairment among neonates based on the number of associated perinatal risk factors (N = 162).

- a. Hearing impairment was identified in only 1.8% (n = 1) of neonates with a single risk factor, whereas a markedly higher proportion of 8.3% (n = 6) was observed among neonates with multiple (two or more) risk factors.
- b. Notably, none of the neonates without any identified risk factors were found to have hearing impairment.
- c. The difference in the prevalence of hearing impairment across these groups was statistically significant (p = 0.01), indicating a

clear association between the accumulation of perinatal risk factors and the likelihood of hearing impairment.

These findings demonstrate a dose–response relationship, wherein the risk of hearing impairment increases with the number of risk factors present, underscoring the importance of comprehensive risk assessment and targeted auditory screening in neonates with multiple perinatal risk factors.

DISCUSSION

1. Gestational Age as a Determinant of Hearing Impairment in Neonates

In the present study, preterm neonates demonstrated a significantly higher prevalence of hearing impairment compared to term neonates, a finding that is consistent with Pourarian et al., who reported a statistically significant association between gestational age less than 36 weeks and hearing loss among NICU-admitted neonates [3]. A similar association was noted by Fakhim et al., who identified prematurity as one of the significant risk factors for sensorineural hearing loss in high-risk neonates, with prevalence markedly higher among preterm infants compared to low-risk term neonates [7]. The role of prematurity as a determinant of hearing impairment is further supported by Nair et al. (2018), who reported that a majority of neonates with hearing loss had prematurity as a contributing risk factor, often in combination with other neonatal morbidities [8].

2. Influence of Birth Weight on the Prevalence of Neonatal Hearing Impairment

The present study demonstrated a significantly higher prevalence of hearing impairment among very low birth weight neonates (<1500 g), which is consistent with the findings of Fakhim et al., who reported a strong association between birth weight below 1500 g and sensorineural hearing loss in high-risk neonates [7]. A similar trend was observed by Nair et al. (2018), where very low birth weight was identified as one of the most significant contributors to hearing impairment among NICU-admitted newborns [8].

3. Association between Birth Asphyxia and Hearing Impairment

The present study demonstrated a significantly higher prevalence of hearing impairment among neonates with a history of birth asphyxia, which is comparable to the findings of Pradhan et al., who reported a strong association between birth asphyxia and failed OAE/BERA outcomes in NICU-admitted neonates [9]. A similar association was observed by Nair et al. (2018), where birth asphyxia emerged as an important contributing risk factor for hearing impairment, particularly among neonates with multiple coexisting risk factors [8].

4. Impact of APGAR Scores on Neonatal Auditory Outcomes

In the present study, neonates with low APGAR scores (≤ 6) at 1 and 5 minutes exhibited a higher likelihood of hearing impairment, a finding that aligns with Shameem et al., who identified an APGAR score ≤ 6 at 5 minutes as an independent and significant risk factor for neonatal hearing impairment [10]. A comparable observation was reported by Pradhan et al., where low APGAR scores were significantly associated with abnormal hearing screening results and confirmed hearing loss on diagnostic evaluation [9].

5. Role of Hyperbilirubinemia in Neonatal Hearing Impairment

The present study found a statistically significant association between hyperbilirubinemia and hearing impairment, which is in agreement with Fakhim et al., who reported a strong link between hyperbilirubinemia requiring exchange transfusion and sensorineural hearing loss in high-risk neonates [7]. A similar association was observed by Pradhan et al., who demonstrated that neonates with hyperbilirubinemia requiring intensive treatment had a significantly higher prevalence of hearing impairment on follow-up evaluation [9].

6. Neonatal Sepsis and Meningitis as Risk Factors for Hearing Loss

The present study demonstrated a statistically significant association between neonatal sepsis or meningitis and hearing impairment, which is consistent with the findings of Pehlajani et al., who reported meningitis as a significant risk factor for hearing impairment among NICU graduates [11]. Choi et al. also identified a history of sepsis as a significant contributor to hearing loss in NICU-admitted infants, emphasizing the role of systemic infection and inflammatory insult on auditory pathways [12]. In addition,

7. Effect of Ototoxic Drug Exposure on Hearing Impairment in NICU Neonates

In the present study, exposure to ototoxic drugs for five days or more was significantly associated with hearing impairment, a finding comparable to Pehlajani et al., who identified prolonged ototoxic medication use as a statistically significant risk factor for hearing loss [11].

Consistent with these findings, Gohari et al. reported a statistically significant association between antibiotic therapy and hearing loss in NICU infants, supporting the need for cautious use and close auditory monitoring during treatment [13].

8. Mechanical Ventilation and Its Association With Neonatal Hearing Loss

The present study identified prolonged mechanical ventilation (≥ 5 days) as a significant risk factor for hearing impairment, which aligns with the findings of Pradhan et al., who reported a strong association between mechanical ventilation and hearing loss in NICU neonates [9]. In contrast, Pourarian et al. did not find a statistically significant association between mechanical ventilation and hearing loss, highlighting variability across studies and suggesting that the effect of ventilation may be influenced by duration, severity of illness, and associated comorbidities [3].

9. Prevalence and Pattern of Hearing Impairment among NICU-Admitted Neonates

The prevalence of hearing impairment in the present study was 4.3%, which is comparable to the prevalence reported by Fakhim et al., who observed a prevalence of 4.2% among high-risk neonates, markedly higher than that seen in low-risk populations [7]. Pehlajani et al. reported a lower incidence of hearing impairment (13 per 1,000 NICU graduates), which may be attributed to differences in inclusion criteria, population characteristics, and restriction to full-term NICU graduates [11]. In contrast, Nair et al. (2021) documented a higher prevalence of permanent childhood hearing impairment (6.3%) among NICU-admitted infants compared to the general population, reinforcing the consistently elevated burden of hearing loss in NICU cohorts [4].

10. Cumulative Effect of Multiple Perinatal Risk Factors on Hearing Impairment

In the present study, neonates with multiple (two or more) perinatal risk factors exhibited a significantly higher prevalence of hearing impairment compared to those with a single or no risk factor, demonstrating a clear dose–response relationship. A similar cumulative risk effect was described by Fakhim et al., where hearing loss was predominantly observed in neonates with multiple coexisting risk factors such as prematurity, low birth weight, sepsis, and ototoxic drug exposure [7]. Siddique et al. also noted that neonates diagnosed with severe bilateral sensorineural hearing loss commonly had multiple high-risk conditions, highlighting the compounded effect of concurrent neonatal morbidities [14].

11. Clinical implications and Recommendations for Management

The findings of the present study have important clinical implications for neonatal care, particularly in the early identification and management of hearing impairment among NICU-admitted neonates. Given the significant association between hearing impairment and factors such as prematurity, low birth weight, birth asphyxia, hyperbilirubinemia, neonatal sepsis, and exposure to ototoxic medications, clinicians should maintain a high index of suspicion in neonates with these risk profiles. Routine auditory surveillance should be integrated into the standard care of high-risk neonates, ensuring that hearing assessment is not delayed until overt clinical signs become apparent. Early recognition of auditory dysfunction allows timely initiation of rehabilitative measures, thereby minimizing long-term deficits in speech, language, and cognitive development.

CONCLUSION

Several perinatal and neonatal factors demonstrated a statistically significant association with hearing impairment. Prematurity, very low birth weight, birth asphyxia, low APGAR scores, hyperbilirubinemia requiring treatment, neonatal sepsis or meningitis, exposure to ototoxic medications, prolonged mechanical ventilation, and a positive family history of hearing loss were identified as important determinants of adverse auditory outcomes. Additionally, neonates with multiple concurrent risk factors had a markedly higher prevalence of hearing impairment compared to those with a single or no identified risk factor, highlighting the cumulative effect of perinatal insults on the developing auditory system.

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