HEARING STATUS OF PREMATURE CHILDREN AT HASAN SADIKIN GENERAL HOSPITAL ON 2018-2020

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Abstract

Introduction. Hearing disorder is one of the most common disorder in children causing negative effect in their development. This might be caused by several factors including prematurity, low birth weight, asphyxia, hyperbilirubinemia, and medication. Therefore, children with known risk factors as mentioned earlier should be screened for their hearing function in order to detect and treat hearing disorder as soon as possible for their better outcome.

Objective. This study aims to describe hearing status in premature children in Hasan Sadikin General Hospital in Bandung, Indonesia

Method. A descriptive retrospective study was conducted in Hasan Sadikin General Hospital using medical record of children with history of prematurity that have been performed hearing examination on 2018-2020 with Brainstem Response Evoke Audiometry (BERA).

Result. There were 406 children included in the study. It was shown that 40,4% children had normal hearing while 59,6% children had hearing disorder with 58,1% sensorineural hearing loss and the most common degree of hearing disorder is very severe (93,3%). Hearing disorder in subject with history of low birth weight, asphyxia and hyperbilirubinemia were higher, with 63.3%, 75.4%, and 64.78% consecutively.

Conclusion. The incidence of hearing loss occurs in more than half of children with history of prematurity. Early detection and treatment of hearing disorder are important to be conducted in children with history of prematurity so they can have better outcome and quality of life.

Keywords: Hearing Loss, Premature, Brainstem Response Evoke Audiometry (BERA)

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INTRODUCTION

Hearing disorder is one of the most common disorder in children causing negative effect in their development. Global statistic estimate about 5 from 1000 children had hearing disorder during their first days of life causing hearing disorder become the most cause of morbidities in the world.[1] In Indonesia, hearing disorder has a prevalence of 4.2% in general population and 0.1% in children age 24-59 months old.[2,3]

Hearing disorder in children can be caused by genetic, infection, birth-related condition like prematurity, birth wright, asphyxia, hyperbilirubinemia, and medication. World Health Organization stated that about 60% of the causes of hearing disorder in children are preventable and this preventable causes are more common in middle- and low-income countries. [4] Therefore, prevention strategy is needed to lowered the number of hearing disorder in children and increase their quality of life. One of the prevention strategies is early detection and early management.

Joint Committee on Infant Hearing promotes the Early Hearing Detection and Intervention program to increase ability in language and communication, literation, and their psychosocial aspect in children with hearing disorder.[5] One of the program is Infant Hearing Screening (IHS). In this program, physician observed children behavior and examine their hearing function using Oto-acoustic Emission (OAE) dan Brainstem Response Evoke Audiometry (BERA).[6]

There is a limited data about hearing status of premature children in Indonesia. This study aims to describe hearing status in premature children in Hasan Sadikin General Hospital in Bandung, Indonesia.

METHOD

A descriptive retrospective study is conducted in Hasan Sadikin General Hospital. All medical record of premature children screened for hearing function using BERA from 2018 to 2020 is reviewed. Those who had non-completed medical record are excluded from the study.

The data is obtained from medical record consisting of sex, current age at examination, gestational age, birth weight, history of asphyxia, mechanical ventilator, hyperbilirubinemia. type of hearing disorder and degree of hearing disorder. According to their gestational age, children are grouped into extremely preterm, very preterm, dan moderate to late preterm. According to their birth weight, children are grouped into low birth weight and normal birth weight with cut off point 2380 grams. According to their history of hyperbilirubinemia, children are grouped into no hyperbilirubinemia (normal), hyperbilirubinemia with exchange transfusion and without exchange transfusion.

The result of BERA examination consist of type and degree of hearing loss in right and left ear individually. Types of hearing loss are sensorineural hearing loss, conductive hearing loss, and mixed hearing loss. Conductive hearing loss is considered if there is an absolute prolonged latency with normal inter-wave latency and other morphology and parameter. Sensorineural hearing loss is considered when there is normal or absence with prolonged absolute latency in other wave and poor morphology.[7] The degree of hearing loss is divided into four category where mild for having hearing loss within 20-40 decibel (dB), moderate within 41-60 dB, severe within 61-80 dB, and very severe for having hearing loss more than 81 dB. Data is then analyzed and is described in frequency and percentage.

RESULT

From 2018-2020, 450 children were screened for hearing disorder. Among them, 11 had non-completed medical record and therefore excluded from the study leaving 406 children left in the study.

Most of the children were boy with age ranging from 1-3 years old. About 74.4% of the children was born within 28-32 gestational week and 63.3% of them had low birth weight. Among all participants, those who has history of asphyxia, mechanical ventilator use, and hyperbilirubinemia without exchange transfusion were more frequent.

Table 1. Participant Characteristic

Characteristic		T	
Sex	Boy	2	5
	Girls	1	4
Age	<1 year old	7	19
	1-3 years old	2	49
	3-5 years old	8	21
	>5 years old	3	9.
Gestational ag	<28 weeks	1	6
	28-32 weeks	3	7
	32-37 weeks	9	2
Birth weight	<2380 gr	2	6
	>2830 gr	1	3
Asphyxia	Yes	3	7
	No	1	2
Mechanical ventilator	Yes	1	3.
	No	3	96
Hyperbilirubin ia	Normal	1	35
	Hyperbilirubine a with exchang transfusion	1	2.
	Hyperbilirubine without exchan transfusion	2	62

In right ear, about 22.9% had normal hearing while 58.62% children had sensorineural hearing loss with 93.27% having very severe hearing loss, 0.98% children had conductive hearing loss and 0.74% children had mixed hearing loss. Most of them were in age within 1-3 years old about 49.51 % with 54.73% having very severe sensorineural hearing loss. Children with low birth weight had higher incidence of having hearing disorder in about 81.32%. Children with history of hyperbilirubinemia accounted for 56.27% have sensorineural hearing loss while 63.07% who had history of asphyxia having

very severe sensorineural hearing loss and all children with history of using mechanical ventilator had hearing disorder.

Children who had hearing disorder in left is are mostly boy within age 1-3 years old. Most of them were having sensorineural hearing loss. In line with the data for right ear involvement, children with left ear involvement mostly had history of low birth weight (84,05%), asphyxia (10.46%), using mechanical ventilator (100%), and hyperbilirubinemia (100%).

DISCUSSION

BERA is found to be the most cost-effective non-invasive method to detect hearing disorder.[8] Considering about 1 out of 1000 children were born deaf worldwide, hearing function screening is likely to be the strategy for early detection and early treatment for favorable outcome.[8] This study showed that children with a history of prematurity who came for a hearing screening examination were mostly boys rather than girls It is known that baby boy has a higher risk for having problem in brain maturation especially in white matter and neurological disfunction rather than baby girl, but the mechanism for hearing disorder based on sex is still unknown.

Hearing disorder in infancy is hard to diagnose due to inability for parents to recognize and bring their children to be examined. Parents usually recognize it when their children ad delayed speech or unresponsive to call or noise.[8] Language and speech development start to occur within age 1-3 year old and is in line with the result of the study where children mostly brought by their parents to conduct BERA by age 1-3 years old (49.51%). Thirunavukarasu et al in 2015 showed a prevalence of hearing disorder in children less than 5 years old 68% and Thakkar et al in 2018 who showed a prevalence of 80% in children at the same age range.[9,10] This showed that hearing function screening program has not been completely working. The screening targets infants age less than 1 month for their hearing function to be checked and to be reconfirmed in 3 months after their last check and therefore any hearing disorder supposed to be diagnosed in infants age less than 1 year old.

Sensorineural hearing loss is found to be more prevalent in children in our study. Sensorineural hearing loss is condition where there is transduce vibration into neural impulses disturbance in cochlea while conductive hearing loss is a condition where there is disturbance of sound transmission through external and middle ear.[12] This more prevalent result can be explained exclusion of children with craniofacial abnormality from the study. Conductive hearing loss is found to be more prevalent in children with craniofacial hearing loss.[12] Lieu et al stated in their study that sensorineural hearing loss is more prevalent in congenital hearing loss. moreover, delayed-onset hearing loss is associated with sensorineural or mixed hearing loss in children.[13]

Prematurity along with another birth-related condition plays an important factor for hearing disorder in children. Hirvonen et al stated that hearing loss incidence increased 7 times higher in very preterm children, 2 times higher in moderately premature children, and 1.5 times higher in late premature children.[11] Frezza et al in 2019 also showed that infant with gestational age less than 33 weeks had a higher risk of having hearing disorder.[12] About 63.3% of participants in this study had history of prematurity. Prematurity gives a higher risk for incomplete cochlear maturation in neonates and therefore might interfere its function.[13]

As stated previously, history of low birth weight contributes in hearing disorder in children. It was linked with prematurity where low birth weight infant usually was born prematurely. In this study, about 25.2% had a low birth weight and 49.4% had a very low birth weight. Children with low birth weight tend to have a lowered auditory sensitivity and therefore a longer latency in BERA as a sign of hearing loss.[10] Wang et al in Taiwan even stated that children with very low birth weight has 30 times higher risk of having hearing disorder.[17] It can be explained that ear in infants with low birth weight might have not fully developed and explained the reduced function wit

Table 2. BERA characteristic in right ear

Characteristic	Normal	Sensorineural Hearing Loss				Conductive Hearing Loss				Mixed Hearing Loss				Total
	n=93 (22.9%)	n=306 (75.37%)				n=4 (0.98%)				n=3 (0.74%)				
		M	Md	S	VS	M	Md	S	VS	M	Md	S	VS	
Sex														
Boy	98 42.61%	1 0.43%	3 1.3%	4 1.74%	121 52.6%	1 0.43%						2 0.87%		230
Girl	66 37.5%	3 1.7%	2 1.14%	3 1.7%	101 57.38 %			1 0.57%						176
Age														
<1	24 30.83%	2 2.53%			51 64.55 %									79
1-3	80 39.8%	1 0.49%	4 1.9%	4 1.9%	110 54.73 %	1 0.49%	1 0.49%					2 2.53%		201
3-5	37 41.57%	1 1.12%		3 3.37%	48 53.93 %									89
>5	23 62.16%				13 35.13 %									37
Gestational age														
<28 w					9 100%									9
28-32 w	97 32.12%	3 0.99%	3 0.99%	4 1.32%	193 63.9%	1 0.33%	1 0.33%					1 0.33%		302
32-37 w	67 70.53%	1 1.05%	2 2.1%	3 3.16%	20 21.05 %							1 1.05%		95
Birth weight														
<2380 gr	34 13.23%	2 0.78%	4 1.55%	5 1.95%	209 81.32 %			1 0.39%				2 0.78%		257
>2380 gr	130 87.25%	2 1.34%	1 0.67%	2 1.34%	13 8.72%	1 0.67%								149
Asphyxia														
Yes	102 33.33%	3 0.98%	3 0.98%	3 0.98%	193 63.07 %			1 0.33%				1 0.33%		306
No	62 62%	1 1%	2 2%	4 4%	29 29%	1 1%						1 1%		100
Mechanical ventilator														
Yes			2 13.3%	2 13.3%	11 73.33 %									15
No	164 41.94%	4 1.02%	3 0.77%	5 1.28%	211 53.96 %	1 0,26%		1 0,26%				2 0.51%		391
Hyperbilirubinemia														
Normal	65 45.45%	1 0.7%	2 1.4%		74 51.75 %									143
With exchange transfusion				2 18.18 %	9 81.82 %									11
Without exchange transfusion	99 39.3%	3 1.19%	3 1.19%	5 1.98%	139 55.16 %	1 0.39%						2 0.79%		252

Table 3. BERA characteristic in left ear

Characteristic	Normal	Sensorineural Hearing Loss				Conductive Hearing Loss				Mixed Hearing Loss				Total
	n=93 (22.9%)	n=306 (75.37%)				n=4 (0.98%)				n=3 (0.74%)				
		M	Md	S	VS	M	Md	S	VS	M	Md	S	VS	
Sex														
Boy	50 21.74%		8 3.48%	13 5.65%	154 66.95 %			3 1.3%			2 0.87%			230
Girl	43 24.43%	12 6.82%	7 3.98%	25 14.2%	87 49/43 %		1 0.57%			1 0.57%				176
Age														
<1	25 31.64%	2 2.53%		4 5.06%	45 56.96 %		1 1.26%	2 2.53%						79
1-3	34 16.91%	6 2.98%	2 0.99%	20 9.95%	136 67.66 %			1 1.12%		1 0.49%	2 0.99%			201
3-5	16 17.97%	4 4.49%	3 3.37%	6 6.74%	60 67.41 %									89
>5	18 48.65%		3 8.1%		15 40.54 %									37
Gestational age														
<28 w	1 11.11%	2 22.22 %	3 33.33 %	1 11.11 %				1 11.11 %			1 11.11 %			9
28-32 w	74 24.5%		5 1.65%	19 6.29%	202 66.88 %		1 0.33%			1 0.33%				302
32-37 w	18 18.95%	10 10.53 %		10 10.53 %	54 56.84 %			2 2.1%			1 1.05%			95
Birth weight														
<2380 gr	38 14.78%	9 3.5%	6 2.33%	17 6.61%	184 71.59 %			2 0.78%		1 0.39%				257
>2380 gr	55 36.91%	3 2.01%	2 1.34%	13 8.72%	72 48.32 %		1 0.67%	1 0.67%			2 1.34%			149
Asphyxia														
Yes	32 10.46%	10 3.27%	5 1.63%	18 0.06%	235 76.8%		1 0.33%	2 0.65%		1 0.33%				306
No	61 61%	2 2%	3 3%	12 12%	21 21%			1 1%			2 0.65%			100
Mechanical ventilator														
Yes		4 26.67 %		4 26.67 %	7 46.67 %									15
No	93 23.79%	8 2.05%	8 2.05%	26 6.65%	249 63.38 %		1 0.25%	3 0.77%		1 0.25%	2 0.51%			391
Hyperbilirubinemia														
Normal	38 26.57%	5 3.49%	2 1.39%	4 9.79%	82 57.34 %			1 0.7%			1 0.7%			143
With exchange transfusion	55 21.83%	7 2.78%	6 2.38%	4 36.36 % 12 4.76%	7 63.63 % 167 66.27 %		1 0.39%	2 0.79%		1 0.39%	1 0.39%			11 252
Without exchange transfusion														

Sensorineural hearing loss become more prevalent with occurrence of 54.68% in right ear and 63.05% in left ear. This result is higher than study conducted in 2016 by Gunawan et al with sensorineural hearing loss occurrence of 46.6% in right ear and 43.9% in left ear.[14] In sensorineural hearing loss, the abnormality occur within cochlea due to its contributing factor in the study as mentioned earlier.

Another birth-related factor contributing to hearing disorder in children is history of asphyxia. Sarosa et al showed that 35.3% children with hearing disorder had history of asphyxia. In line with this study where children with asphyxia accounted 3 times higher than children without asphyxia. Asphyxia might cause hair cell hyperpolarization and destruction causing decreased number of neurotransmitters released to auditory nerve and lowered hearing function.[15]

There is a significant relationship between hyperbilirubinemia and abnormalities detected in Brainstem Evoked Response Audiometry (BERA). A study conducted on a sample of 64.78 patients revealed that 62.36% of individuals with a history of hyperbilirubinemia experienced abnormalities in the right ear, while 79.09% experienced abnormalities in the left ear. These findings can be attributed to the detrimental impact of bilirubin on the brainstem auditory nucleus, auditory nerve, and ganglion cell. Wroblewska-Seniuk et al. also conducted research that supported these observations, demonstrating a higher prevalence of hearing loss in children with hyperbilirubinemia, particularly in those who had additional risk factors such as prematurity and low birth weight.

Hyperbilirubinemia, characterized by high levels of bilirubin in the blood, is a condition commonly associated with newborns, where the liver is still developing and may have difficulty processing bilirubin effectively. The accumulation of bilirubin in the bloodstream can have detrimental effects on various organs, including the auditory system. Specifically, the brainstem auditory nucleus, auditory nerve, and ganglion cell, which play crucial roles in the transmission and processing of auditory signals, can be affected by the toxic impact of bilirubin.

In the study mentioned earlier, the researchers found a strong correlation between a history of hyperbilirubinemia and abnormal BERA results. BERA is a diagnostic test that measures the electrical activity of the auditory system in response to sound stimuli. The results indicated that the majority of patients with a hyperbilirubinemia history experienced abnormalities in their auditory system, with a higher occurrence in the left ear compared to the right ear. These findings suggest that the left ear may be more susceptible to the damaging effects of bilirubin.

Moreover, the study conducted by Wroblewska-Seniuk et al. further supported the link between hyperbilirubinemia and hearing loss. They found that children with hyperbilirubinemia were more likely to experience hearing impairments, particularly when combined with other risk factors such as prematurity and low birth weight. These additional factors could exacerbate the damaging effects of hyperbilirubinemia on the auditory system, leading to a higher prevalence of hearing loss in affected children.[16]

An intriguing discovery in the study revealed that children with hearing loss had a lower history of mechanical ventilator use. This finding contradicts the results of a study conducted by Hajare and Mudhol, where they stated that a history of mechanical ventilator use, along with asphyxia and oxygen needs, was one of the risk factors for hearing loss in children. It is important to note that children who require mechanical ventilation are exposed to constant noise generated by the mechanical components within the ventilator and the air turbulence in the circuit. However, our results align with a study conducted in Malaysia, which concluded that the use of mechanical ventilators is not an independent risk factor for hearing loss in children.

The discrepancy in the findings of our study compared to previous research may be attributed to the duration of mechanical ventilator use. Abdullah et al. suggested that hearing loss in children is associated with the use of mechanical ventilators for more than five days. It is possible that the duration of mechanical ventilator use in the children included in our study was shorter, which could explain the difference in outcomes.

While it is commonly believed that exposure to noise generated by mechanical ventilators can contribute to hearing loss, our study's findings challenge this notion. The lower incidence of hearing loss in children with a history of mechanical ventilator use suggests that there may be other factors at play in the development of hearing impairments. It is crucial to explore these factors further to gain a comprehensive understanding of the complex relationship between mechanical ventilator use and hearing loss in children.

Further research is warranted to investigate the specific mechanisms through which mechanical ventilation and its associated noise may affect the auditory system. Factors such as noise intensity, duration of exposure, and the vulnerability of the individual's auditory system may all play a role in determining the potential risk of hearing loss. Additionally, considering the contradictory results found in different studies, a larger-scale study involving a diverse population of children could provide more comprehensive insights into the relationship between mechanical ventilator use and hearing impairments.[19]

There are several limitations in this study. First, history of drug used in infants were not assessed in this study. Ototoxic drug like aminoglycoside and loop diuretic can be used in children with suspected infection. These drugs can alter damage in the cochleovestibular system, causing damage in hair cells in the organ of Corti.[22] Second, we didn't assed the length time of mechanical ventilator use which might affect hearing function in children significantly after 5 days use.[22]

CONCLUSION

Children with history of prematurity, low birth weight, asphyxia, and hyperbilirubinemia are at higher risk of having severe hearing loss especially sensorineural hearing loss. Hearing function screening program and another prevention strategy need to be applied more rigorously to lower the number of children having hearing disorder in order to support their language, speech, cognitive, and psychosocial development and increase their quality of life.

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