The necessity of echocardiography in evaluation of neonates with respiratory distress admitted to NICU

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Abstract

Introduction:
Respiratory distress is the most frequent cause of admission to the NICU. Immediate differentiation between cardiac and non-cardiac causes could influence the course of treatment. This study aimed to evaluate the necessity of echocardiography in evaluation of neonates with respiratory distress in NICU.

Materials and Methods:
This retrospective study recruited 349 neonates admitted to the NICU of Izadi and Hazrat-e-Masoumeh hospitals in the city of Qom in 2013 due to respiratory distress. Data was collected and analyzed by chi-square test and t-test in SPSS.

Results:
Sepsis was the most common cause of respiratory distress, among the extra-pulmonary causes which accounted for 15% of the causes of respiratory distress. Echocardiography was performed for 55.3% of neonates. Among cardiac causes of respiratory distress, large and very large PDAs (27.3%), large ventricular septal defect (22.7%) and dTGA (18.2%) were the most common causes. Gender of the infant, type of delivery, season of the birth, length of hospital stay and the 5-minute Apgar score were not significantly different among cardiac and non-cardiac causes, but gestational age and infant's age at admission were significantly higher in babies with cardiac diseases.

Conclusions:
It seems being full term and the age of the infant should also be considered for decision-making about echocardiography in addition to the current criteria: respiratory distress and murmurs.

Keywords: Respiratory Distress Syndrome, NICU, Echocardiography, Congenital Heart Defects

Introduction

Respiratory distress is the most frequent cause of term and pre-term infants' admission to NICU, with a prevalence of nearly 7% of infants (1). Respiratory distress in infants manifests as rapid breathing, grunting, intercostal retraction, along with nasal flaring, cyanosis, decreased breath sounds, rhonchi, pallor, and apnea. In fact, this is a non-specific response to severe illness and is not solely because of impaired respiratory system, rather it is a syndrome due to respiratory, cardiovascular, infectious, hematologic, musculoskeletal and metabolic diseases and may directly or indirectly involve the lungs (1-3).

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Among the causes of respiratory distress in newborns are respiratory distress syndrome, transient tachypnea of the newborn, hyaline membrane disease, meconium aspiration syndrome, sepsis, pneumonia, congenital heart disease, heart failure, cardiac arrhythmias, pulmonary hypertension, hypoglycemia, intracranial diseases, metabolic disorders, pneumothorax, interstitial emphysema, pulmonary hemorrhage, patent ductus arteriosus, Kwan atresia, esophageal atresia, tracheoesophageal fistula, diaphragmatic hernia, pulmonary hypoplasia, and other abnormalities of the respiratory system. Sometimes, these etiologies need specific treatments in addition to measures taken to support respiratory system (2).

Previous studies have shown that respiratory distress occurs more due to underlying pulmonary diseases (83.7%) than non- pulmonary diseases (13.3%). Among the pulmonary causes, hyaline membrane disease is the most common cause in preterm neonates leading to 51% of the mortality and 30-50% of all hospital stays. (4, 5). The underlying reason behind it is the premature development of the lungs which results in reduced production of surfactant (6). Transient tachypnea and meconium aspiration syndrome are the most common causes of hospitalization in term neonates (7,8). Sepsis and heart diseases are the main non-pulmonary causes of distress (4). Furthermore, congenital heart diseases occur in infancy with a relatively high prevalence, which may happen with or without cyanosis. Therefore, neonatologists should quickly differentiate between cardiac and non-cardiac causes because the cardiac causes in infancy are usually related to ductus arteriosus and in most cases exacerbates as it gets smaller (9).

Echocardiography is an important diagnostic tool for the pediatric cardiologists to evaluate the hemodynamic and cardiac abnormalities, which can affect the treatment process and outcomes in neonates admitted to NICU. The effects are in emergency surgery interventions, medications and cardiac follow-ups (10, 11). Given the high prevalence of respiratory distress in neonates admitted to NICU and high mortality due to neonatal respiratory problems, timely distinction of cardiac and non-cardiac causes and providing supportive therapies can partially reduce their mortality and improve the prognosis. Currently, there is no specific guideline for performing echocardiography in neonates with respiratory distress. However, when neonates with respiratory distress or cyanosis do not respond to initial treatments, echocardiography is performed in some health centers. Typically, echocardiography is performed whenever the physician thinks that respiratory distress might have a cardiac etiology; therefore, identifying factors contributing to the diagnosis of cardiac causes of distress are important. Therefore, the present study was conducted to examine the necessity of echocardiography in evaluation of neonates with respiratory distress admitted to NICU.

Materials and Methods

This retrospective study used census sampling to select all infants admitted to NICU from March 2014 to March 2015 in Izadi and Hazrat Ma'soomeh teaching hospitals of Qom () because of respiratory distress or developing respiratory distress during hospitalization.

The records of all neonates who had Inclusion criteria were studied to extract the data including age, gender, being pre-term or term, type of birth, length of hospital stay, season, and Apgar score. Neonates that had no obvious cause of respiratory distress, their state did not improve with treatment of possible respiratory causes, or their history and examination findings were in favor of a heart disease, received consultation and if necessary echocardiography to investigate cardiac causes. The results of consultation

and echocardiography were also registered. All neonates received consultation and echocardiography from a pediatric cardiologist. A total of 467 cases were examined, of whom 67 did not have inclusion criteria and 43 were incomplete, thus only 349 cases were analyzed. In terms of hospitals, 161 of 1609 cases in the Izadi Hospitals and 188 of 298 cases in the Hazrat Masoomeh (AS) Hospital were studied. Finally, the recorded data were analyzed in SPSS software Version 18. Given the normal distribution of the variables, the chi-square test was used to analyze data related to the qualitative variables and independent t-test was used to analyze the quantitative data. The p-value less than 0.05 was considered significant.

In this study, the data of patients were collected anonymously and ethical issues were considered at all stages of the study.

Results

The demographic of the neonates is summarized in Table 1. A total of 349 neonates were studied. The mean age at admission was 4.3±0.7 days (range 0-33 days).

The most common cause of respiratory distress was hyaline membrane disease (59.6%) and the least common cause was meconium aspiration syndrome (2.6%). Other causes in order of frequency were sepsis (15.2%), transient tachypnea (12%), congenital heart disease (6.3%) and pneumonia (4.3%). Regarding the frequency of hospitalization in the study population, 247 cases (70.8%) were discharged, 43 cases (12.3%) died, 18 cases (5.2%) were referred to other hospitals, and 41 cases (11.7%) were discharged against medical advice.

Echocardiography was done for 193 cases (55.3%). Among them, 29 cases (15%) had a completely normal echocardiogram, 164 cases (85%) had abnormal echocardiography, and 54 cases (28%) had moderate or severe heart disorders.

The echocardiographic findings in order of frequency were 97 cases of patent foramen ovale (50.3%), 97 cases of patent ductus arteriosus (50.3%), 68 cases of tricuspid regurgitation (35.2%), 30 cases of atrial septal defect (15.5%), 25 cases of ventricular septal defect (13%), 14 cases of pulmonary hypertension (7.2%), 10 cases of mitral regurgitation (5.2%), 5 cases of coarctation of the aorta (2.6%), 4 cases of transposition of the great vessels (2.1 %), 3 cases of hypoplastic left heart (1.6%), 3 cases of double outlet right ventricle (1.6%), 1 case of atrioventricular septal defect (0.5%), and 1 case of single ventricular heart (.0.5%). Among the neonates with abnormal findings in echocardiography, based on medical diagnosis and response to treatment, only 22 neonates had cardiac causes, and among the rest of the studied variables only gestational age and age at the onset of respiratory distress in neonates with cardiac malformations were significantly higher (Table 2).

Table 1: Demographic information of the subjects

Gender, number (percent)	Male	207 (59.3)
	Female	142 (40.7)
Birth, number (percent)	Term	95 (27.2)
	Pre-term	254 (72.8)
Season of birth, number (percent)	Spring	101 (28.9)
	Summer	90 (25.8)
	Fall	86 (24.6)
	Winter	72 (20.6)
Type of delivery, number (percent)	Caesarean section	277 (79.4)
	Normal delivery	72 (20.6)
Fifth minute Apgar score (out of 10), mean ± SD		8.2±9.8
Gestational age (weeks), mean ± SD		3.4±4.8

Table 2: The distribution of time of birth variables based on cardiac and non-cardiac causes of respiratory distress

Time of birth variables		Cardiac causes, number (percent)	Non-cardiac causes, number (percent)	Type of test P-value
Gender	Male	12 (5.8)	195 (94.2)	Chi-squared P=0.399
	Female	10 (7.1)	132 (92.9)	
Time of birth	Term	16 (16.8)	79 (83.2)	Chi-squared P=0.000
	Pre-term	6 (4/2)	248 (6/97)	
Type of delivery	Caesarean section	17 (6.1)	260 (93.9)	Chi-squared P=0.489
	Normal delivery	5 (9/6)	67 (1/93)	
Hospitalization season	Spring	3 (3)	98 (97)	Chi-squared P=0.188
	Summer	8 (8.9)	82 (91.1)	
	Fall	8 (9.3)	78 (90.7)	
	Winter	3 (4.2)	69 (98.8)	
Fifth-minute Apgar		8.3±9.6	7.9±9.1	t-test P=0.397
Age at onset of respiratory distress (days)		7.6±14.9	0.3±1.3	t-test P=0.000
Gestational age (weeks)		36.2±3.1	33.1±3.8	t-test P=0.000

Discussion

The present study was conducted to examine the necessity of echocardiography in the evaluation of neonates with respiratory distress in NICU of hospitals in Qom, Iran. Among the causes of respiratory distress in this study, the pulmonary causes were the most common, among which hyaline membrane disease accounted for 59.6% of the cases. The extrapulmonary causes accounted for 21.5% of cases of which sepsis followed by congenital heart defects (6.3%) were the most common causes. In a study by Khalili et al. to determine the prevalence of respiratory distress causes and the course of disease in neonates admitted to NICU of Baqiyatallah Hospital, 83.7% of neonates had pulmonary problems-related distress with a hyaline membrane disease prevalence of 51.6%. In this study, 16.3% of neonates had respiratory distress related to extrapulmonary problems. Among them, 8 patients (5.2%) were hospitalized because of respiratory distress caused by heart disease (4). Total prevalence of lung diseases in the two studies was approximately equal, but despite the high number of preterm infants in the present study, the percentages of neonates diagnosed with hyaline membrane disease were equal, which can be due to correct

and timely use of corticosteroids in pregnancies with the risk of a premature birth. On the other hand, heart diseases had a higher percentage (6.3% vs. 5.2%). This difference could be due to the fact that one of the hospitals enrolled in the study had an NICU with a cardiac care unit.

Kadivar et al. studied 241 patients suspected of heart disease, where echocardiography found congenital structural anomalies (33%), hemodynamically significant patent ductus arteriosus (3%), persistent pulmonary hypertension in children (6%), and left ventricular dysfunction (3%) (10). In the present study, the percentage of neonates undergoing echocardiography with normal cardiac anatomy was half of Kadivar's study (15% vs. 34%). In another study in Shahid Mostafa Khomeini Hospital, 20 out of 93 cases (17.6%) had normal echocardiogram results (12). It seems that most of the differences are due to the different selection criteria for echocardiography. The selection criteria for undergoing echocardiography in Kadivar's study was the presence of any murmur, even mild, or any structural anomalies.

In a study by Chahab et al. Doppler echocardiography was done for 159 cases

(14.4%) out of 1105 neonates admitted to six NICUs. They reported congenital heart diseases in 53 cases (33.3%), secondary pulmonary hypertension in 14 (8.8%), ischemic cardiomyopathy in 4, and patent ductus arteriosus in 3, and 81 patients (50.9%) had a normal echocardiogram. Among the 123 cases undergoing full echocardiography, patent foramen ovale, tricuspid regurgitation and patent ductus arteriosus were found in 52% and 49% of the patients, respectively. The mitral valve prolapse was significant in 5% of patients (13). The number of subjects undergoing echo was approximately 4 times as many (55.3% vs. 14.4%). The overall percentage of patent ductus arteriosus in both studies was approximately equal, but the percentage of patent foramen ovale and tricuspid valve regurgitation was observed less in the present study.

In a study by Moss et al. in 2003 in Liverpool where 157 echocardiographies were done on 82 patients during 8 months, the mean gestational age was 32 weeks and the mean age at the time of echo was 2 days. They reported 14 cases of patent ductus arteriosus, 8 cases of ventricular septal defect, 1 case of coarctation of the aorta, Epstein anomaly, and transposition of the great vessels (14). The mean gestational age and the mean age at the time of echo in the present study were 33.5 weeks and 2.5 days, respectively, while in the study by Moss they were 32 weeks and 2 days, respectively. The percentage of neonates with a normal echo was higher in this study (15% vs. 9.8%).

The distribution of gender, type of delivery, season, the length of hospital stay, and fifth minute Apgar score were not significantly different between neonates with cardiac and non-cardiac causes, while gestational age and age at the onset of respiratory distress in neonates with cardiac abnormalities was higher. Higher age of the neonates can be due to the fact that as time passes, ductus arteriosus is closed and pulmonary hypertension is reduced, worsening symptoms in many congenital heart diseases.

Conclusion

It is recommended that cardiac causes be more considered in term and near-term newborns with respiratory distress in addition to the previous inclusion criteria of the neonates admitted to NICU requiring an echocardiography, including prolonged respiratory distress, murmurs, and rales. Since the mean age of the neonates at the time of heart disease diagnosis was 7.5 days, it is recommended cardiac causes be more considered for neonates with respiratory distress after the first week of their life.

Acknowledgments

Conflict of interest

The Authors declare that there is no conflict of interest in this paper.

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