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ORIGINAL RESEARCH

Effect of Feeding Methods on Respiratory Efforts in Neonate with Congenital Heart Defect

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ABSTRACT

Background: Congenital heart disease (CHD) encompasses heart or blood vessel abnormalities arising during fetal development, affecting around 9 per 1,000 live births annually, totaling approximately 1.35 million infants. CHD is clinically classified as either cyanotic or acyanotic and often coincides with malnutrition and failure to thrive. Infants with CHD are at an increased risk of developing or pharyngeal dysphagia, characterized by difficulties in swallowing. Pediatric nurses play a crucial role in monitoring CHD, including respiratory rates and overall health, with particular attention to assessing nasal flaring for signs of respiratory distress as chest retractions and cyanosis.
Objectives: Study aims to Assess variations in respiratory rate across different feeding methods and their impact on neonates with CHD at various time intervals.
Methodology: A prospective observational study was carried out at the neonatal unit of Karbala Teaching Hospital for Children in Iraq. Fifty neonates, aged less than 28 days and diagnosed with CHD, were purposively recruited for the study. Inclusion criteria targeted neonates who were undergoing enteral feeding.
Results: Analysis of records from 50 neonates revealed significant variations in respiratory rate across distinct feeding periods (p=0.027). and unveils noteworthy variations in nasal flaring throughout distinct feeding periods (p=0.001). And no significant differences in chest retraction across distinct feeding periods (p=1.000), no significant differences between breastfeeding, bottle-feeding and tube-feeding across time intervals of neonates feeding.
Conclusion: Respiratory rate demonstrates significant variations across feeding periods. There are no significant differences in respiratory rates before-after feeding among breastfeeding, bottle-feeding, and tube-feeding.

Keywords: Effect of Feeding Methods, Respiratory Rate, Neonate with Congenital Heart Defect.

INTRODUCTION

Congenital heart defects (CHDs) stand as the leading cause of mortality among infants afflicted with birth anomalies (Ardianti, et al., 2023). In the United States recorded a prevalence of 8 CHD cases per 1,000 live births within the first year, Annually, an estimated 40,000 newborns in the United States are impacted by CHDs (Zmora, R. 2021). Congenital cardiac abnormalities not only pose considerable morbidity and mortality risks in infants but also exert a lasting impact on quality of life throughout childhood

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and into adulthood (Elsayed, et al., 2024). The symptoms of CHD can include difficulties with feeding, oxygen deprivation, cardiac insufficiency, rapid breathing, pulmonary hypertension, hormonal imbalances, and upper respiratory tract infections. Children not only manifest the clinical signs of the condition but also demonstrate indications of malnutrition and developmental delays.

A considerable percentage of children with CHD, ranging from 25% to 55%, suffer from malnutrition, with a striking 80% requiring hospitalization (Yürük and Çetinkaya, 2023). The notable prevalence of malnutrition among children with congenital heart disease presents a substantial challenge (Chinawa, et al., 2021). Current methodologies for assessing and addressing the nutritional requirements of neonates with CHD lack consistency and vary across healthcare institutions and hospitals (Centeno-Mafaz, 2023). A combination of cardiac and extracardiac factors typically contributes to malnutrition in infants with CHD, disrupting the energy equilibrium. Untreated CHD infants experience heightened total energy expenditure (TEE) due to increased metabolic demands stemming from factors such as elevated respiratory effort, heightened cardiac workload due to left-to-right shunts, elevated pulmonary artery pressures, and increased catecholamine release (Tsintoni et al., 2020). Infants born with CHD present unique physiological differences affecting heart function and structural, gastrointestinal performance, and brain development, which can hinder the acquisition of oral feeding skills.

Various factors contribute to feeding difficulties, impacting both the infant and the family. CHD-diagnosed infants are at a higher risk of malnutrition, feeding issues, reliance on tube feedings, dysphagia, cognitive impairments, and developmental delays, which may persist into childhood. Understanding the distinct disparities among CHD infants is crucial for implementing targeted interventions aimed at facilitating oral feeding (Jones, C. E., et al., 2021). The population in question often lacks coordination in their suck-swallow-breathe cycle, which can lead to a loss of physiologic stability during feedings. This can result in them expending more energy than they ingest during a feeding, which is a cause for concern (Hoffman, 2016). Pediatric nurses and nutritionists collaborate to oversee the nutrition, growth, and development of children with CHD. Health care workers develop a customized nutrition plan that aligns with the child's specific energy requirements based on their age group. (Yürük and Çetinkaya, 2023).

AIMS OF THE STUDY

To Assess the differences in respiratory effort at different time points for feeding method of neonate with CHD. and determine the influence of feeding methods on respiratory rate in neonates diagnosed with CHD.

METHODOLOGY

Design:

A prospective observational study in correlational design to Assess the relationships between variables without manipulating them.

Setting:

The study was conducted in Karbala Teaching Hospital for Children. The hospital contains (26 bed) a neonatal unit and (9 bed) a NICU from period of September 26th, 2023, to July 9th, 2024.

Study Sample:

(purposive sample) 50 neonates with CHD aged less than 28 days who admitted to Neonatal Unit or NICU.

Inclusion Criteria:

Neonates with CHD that admitted to Neonates Unit or NICU that feeding in breastfeeding, bottle feeding, or tube feeding method.

Exclusion Criteria: Included Critical child because of potential effect on feeding response.

Tools for data collection: Data was collected through two parts:

Part I: clinical data of neonate with congenital heart defect: This section includes five items:

The infant health history was obtained from the medical record and included gestational age and chronologic age , birth weight, gender, type of feeding, and diagnosis (cyanosis or acyanosis).

Part II: Physiological parameters at different time points for feeding method of neonate with CHD:

This section comprises measurements of respiratory rate. Data were collected both before initiating neonatal feeding and at specific intervals afterward: immediately after feeding, 30 minutes post-feeding, and 1 hour post-feeding. To mitigate observer bias, respiratory rate was assessed in calm newborns verbally over a one-minute period. Simultaneously, chest in drawing was monitored, deemed present if the chest wall contracted during inhalation. Nasal flaring was also noted, defined as widening of the nostrils upon newborn inhalation.

Content validity:

A committee of 15 experts in scientific and practical specializations reviewed the study tool. They made the necessary modifications, and after taking their opinions into consideration, the validity of the tool for measuring the variables was proven.

Reliability assessment:

The researcher employed a random exploratory sample comprising 10% of the original sample, meticulously collected by two investigators – the primary researcher and a well-trained assistant. Notably, this subset of 5 samples was later excluded from the original sample, which formed the basis for the conclusive study. The reliability coefficient was assessed using the test-retest correlation coefficient (Inter-retort/ Inter-observer r = .433).

Ethical Consideration:

On November 5, 2023, with approval number uok.con.23.002, the Ethics Committee of the College of Nursing, University of Kerbala, granted authorization for the study to be conducted. Prior to commencing data collection from the sample The researcher notifies the participant's mother or caregiver of the study's goal before they participate in it. The researcher also told them that taking part in the study was optional and provided them with confirmation that the data would be kept secure and secret both during and after the study.

Procedure:

Following obtaining informed written consent from parents, arrangements were made for data collection during a feeding session chosen by the mother. Collection times varied based on the duration of the feeding session. Infant health history was extracted from the medical records. Respiratory rates were documented before commencing neonatal feeding, immediately after feeding, at 30 minutes post-feeding, and 1 hour post-feeding completion. Feedings were conducted with the infant in a semi-reclined position. Respiratory rate assessment was conducted verbally (because Conventional pulse oximeters do not provide the respiratory rate of a patient) in calm newborns over a one-minute interval. It is imperative for newborns to remain calm during parameter measurement, as physical exertion or crying can distort measurements and impact them due to increased metabolic demands. Routine, painful invasive procedures such as heel pricks were avoided during this 2-hour observation period to mitigate stress and its effects on vital parameters.

Statistical analysis:

The researcher employed both SPSS-24. These software tools were utilized to meticulously analyze the data, establishing relationships between variables and applying a battery of statistical tests. Descriptive statistics encompass a collection of mathematical and statistical techniques employed to quantitatively depict key characteristics of data, often through the use of tables and charts use the frequencies and percentages, mean and Standard Deviation. Tests of Normality, Kruskal-Wallis H Test, Mann-Whitney U Test, Simple Linear Regression for Inferential approach.

RESULTS

(Table:1) Distribution of study sample by their clinical characteristics, when examining the clinical characteristics of the 50 neonates (in different gestational age and birth weight) with congenital heart defect included in this study, we observed a gestational age group ≤ 37 weeks were (34) represented (68%), their chronological age spanned from 7 to 28 days were (41) represented (82%). Notably, a majority of the participants were male (56%), while the remaining were female (44%). Regarding birth weight and current weight, we observed a birth weight range of 2500g to 4000g were (20) represented (40%). Additionally, the current weight ranged from 2,500g to 4000 g were (33) represented (66%). Furthermore, (80%) of the neonates were diagnosed with acyanotic lesions.

(Table:2) Comparison the Effect of Feeding Methods on Respiratory Rate, The Kruskal-Wallis analysis reveals significant variations in respiratory rate across distinct feeding periods (p= 0.027). The mean ranks for respiratory rate exhibit an ascending trend after immediate feeding (117.40), followed by a slight decrease after 30 minutes of feeding (106.59), a further decline after 1 hour of feeding (92.55), ultimately stabilizing before feeding (85.46).

(Table:3) Comparison the Effect of Feeding Methods on Nasal Flaring, The Kruskal-Wallis analysis unveils noteworthy variations in nasal flaring throughout distinct feeding periods (p= 0.001). Nasal flaring is not observed consistently across different time points, including before feeding (108.50), after feeding at 30 minutes (108.50), and after feeding at 1 hour (108.50). However, there is a notable present in nasal flaring immediately after feeding (76.50).

(Table 4) Comparison the effect of feeding methods on chest retraction, The Kruskal-Wallis analysis reveals no significant differences in chest retraction across distinct feeding periods (p = 1.000), including before feeding (100.50), immediately after feeding (100.50), 30 minutes after feeding (100.50), and 1 hour after feeding (100.50).

(Table:5) Comparison of feeding methods on respiratory rate in neonates with congenital heart defects, The observed respiratory rates immediately after feeding in neonates with congenital heart defects (CHD) exhibit no significant differences between breastfeeding and bottle-feeding (p=.352) and tube-feeding (p= .847). Similarly, such rates are no differ significantly between bottle-feeding and breastfeeding (p= .352) and tube-feeding (p= .235). However, there is no statistically significant difference in respiratory rates between tube-feeding and breastfeeding (p= .847) or bottle-feeding (p= .235).

In the case of respiratory rates observed 30 minutes after feeding, there is no statistically significant difference between breastfeeding and bottle-feeding (p=.622) and tube-feeding (p= .689). Likewise, the respiratory rates no differ between bottle-feeding and breastfeeding (p= .622) and tube-feeding (p= .335). There is no statistically significant difference in respiratory rates between tube-feeding and breastfeeding (p= .689) or bottle-feeding (p= .335).

After 1 hour of feeding, the respiratory rates are no statistically different between breastfeeding and bottle-feeding (p=.564) and tube-feeding (p= .904). Similarly, the respiratory rates are no differ significantly between bottle-feeding and breastfeeding (p= .564) and tube-feeding (p= .461). There is no statistically significant difference in respiratory rates between tube-feeding and breastfeeding (p= .904) or bottle-feeding (p= .461).

DISCUSSION:

The study of neonates with congenital heart defects and fluctuations of respiratory rates in different feeding periods brings exciting findings which draw a picture of the complicated relationship between feeding and respiratory parameters. The statistical analysis has shown that there is a strong correlation (p=0.027) between feeding times and respiratory rates, thus drawing attention to the need of tracking the health of neonates in a dynamic and time-sensitive manner.

The mean ranks for respiratory rates show a specific trend over different feeding times indicating a complex interrelationship of feeding and respiratory activity. The sharp increase in mean ranks directly after feeding (117.40) calls for an explanation regarding the physiological immediate effects of nutrient consumption. This initial increase may be attributed to the energy expenditure during the feeding process or potential physiological stress of the feeding. This is corroborated by Lopes et al., (2018), where they demonstrated that the respiratory rate is inversely correlated to the duration of fasting periods in these neonates. Extended periods of fasting were associated with an increase in respiratory rate, implying that deferred or rare feedings aggravate respiratory stress in this at risk group.

However, following a 30-minute feeding period, there is a slight decrease in the mean ranks (106.59). This decline may represent a transitional or adaptation phase, during which the neonate's respiratory system stabilizes after the stress induced by feeding. These results suggest the necessity for further investigation into the short-term effects of feeding on respiratory dynamics and whether this decrease is consistent across different congenital heart defects, as confirmed by Slater et al. (2021). These findings align with those of the present study.

Luca et al., (2022) which their reported that the later decrease in mean ranks (92.55) indicates a gradual adjustment of the respiratory rates, which could be a delayed physiological response or an adaptation to the post-feeding state. The consideration of this temporal feature of respiratory rate fluctuations is paramount in establishing strategies to manage neonates, particularly those with congenital heart diseases and this finding correspond with present study.

The study on the neonates with CHD shows many interesting variations in the nasal flaring phenomena during the feeding periods with a very significant p-value of 0.001. The research focuses on the dynamics of the nasal flaring phenomenon at various points of time, thus shedding light on the possible associations with the feeding process.

Compare the different time points during the feeding process, the authors found that nasal flaring does not always present. However, there is no noticeable nasal flaring observed in the before feeding (108.50), after feeding at 30 minutes (108.50), and after feeding at 1 hour (108.50). Lack of standardized flaring of the nose throughout these time points poses a lot of questions about the specific triggers or the circumstances that affect nasal flaring in neonates with congenital heart defects for these periods.

Patel and Carr, (2017) reported that, the study draws a different trend presence of nasal flaring just after feeding (76.50). However, this particular time-point is unique because it implies that feeding may be the cause of the observed nasal flaring in neonates with congenital heart problems. and this agree with current result which mentioned that needed to dissect the physiological/behavioural factors that underlie the post-feeding response observed immediately after a meal.

Souza et al., (2018) their reported that plausible explanation is that the act of sucking elevates the physiological load of neonates having congenital heart disease, thus leading to a hyperventilation. The immediate nasal flaring after feeding may reflect the baby’s effort to provide the cardiovascular system with the needed support during this specific stage and this finding agree with present study.

The study on newborns with CHD examined chest retractions during feeding, finding consistent patterns throughout different time points (p value = 1.000). This underscores the importance of monitoring respiratory patterns in these infants, as feeding methods don't significantly affect respiratory rates (p= .352 for breastfeeding, p= .847 for tube feeding). Additionally, there were no differences in respiratory rates between bottle feeding and tube feeding (p=.235), indicating a consistent physiological response regardless of feeding method. From these results it seems that the effect of one feeding method on breathing outcomes in neonates with CHD is not a dominant factor. The absence of meaningful divergence in respiratory rates among the various modes of nutrition.

CONCLUSION:

Respiratory rate demonstrates significant variations across feeding periods, with an ascending trend immediately after feeding and subsequent declines after 30 minutes and 1 hour, stabilizing before feeding. There are no significant differences in respiratory rates before-after after feeding among breastfeeding, bottle-feeding, and tube-feeding.

RECOMMENDATIONS:

Health care workers in the neonatal unit should pay attention to the properties of Respiratory rate and nasal flaring, which are changing during the feeding periods in neonates with congenital heart disease.

Competing interests:

The authors declare that they have no competing interests.

Authors' contributions:

All authors equally substantially contributed to the work design, acquisition, analysis, and interpretation of the data, drafting or revising it critically for important intellectual content. All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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TABLES:

Table (1): Distribution of study sample by their clinical characteristics

Neonate characteristics	Classification	No.	%
Gestational age/ Weeks	≤37	34	68.0
	38-42	14	28.0
	>42	2	4.0
	Min–Max	*28–43*	
	Mean ± SD	*33.88 ± 3.39*	
Chronologic age/ days	<7	9	18.0
	7-28	41	82.0
	Min–Max	*3–28*	
	Mean ± SD	*12.78 ± 6.63*	
Sex	Male	28	56.0
	Female	22	44.0
Birth weight/ Kg	<1000g	4	8.0
	1000g - 1.400g	11	22.0
	1.500g - 2.400g	13	26.0
	2.500g - 4000g	20	40.0
	≥4000	2	4.0
	Min–Max	*1–4.3900 kg*	
	Mean ± SD	*2.82 ± 0.94*	
Current weight/ Kg	1000 - 1.400	4	8.0
	1.500g - 2.400g	13	26.0
	2.500g - 4000g	33	66.0
	Min–Max	*1–400 kg*	
	Mean ± SD	*2.35 ± 0.75*	
Methods of feeding	Breastfeeding	13	26.0
	Bottle-feeding	22	44.0

	Tube feeding	15	30.0
Diagnosis	Cyanotic lesions	10	20.0
	Acyanotic lesions	40	80.0

No. Number; %= Percentage

Table (2): Comparison the Effect of Feeding Methods on Respiratory Rate

Variable	Ranks			$^{b}\chi^2$	d.f	Sig.
	Periods of Feedings	No.	Mean Rank			
Respiratory Rate (RR)	Before feeding	50	85.46	9.176	3	.027
	Immediately after feeding	50	117.40			
	30 min after feeding	50	106.59			
	1 h after feeding	50	92.55			

b= Kruskal Wallis Test; n= number,; sig.= significant level at 0.05.

Table (3): Comparison the Effect of Feeding Methods on Nasal Flaring

Variable	Ranks			$^{b}\chi^2$	d.f	Sig.
	Periods of Feedings	No.	Mean Rank			
Present of Nasal flaring	Before feeding	50	108.50	51.913	3	.001
	Immediately after feeding	50	76.50			
	30 min after feeding	50	108.50			
	1 h after feeding	50	108.50			

b= Kruskal Wallis Test; n= number,; sig.= significant level at 0.05.

Table (4): Comparison the effect of feeding methods on chest retraction

Variable	Ranks			$^{b}\chi^2$	d.f	Sig.
	Periods of Feedings	No.	Mean Rank			
Present of Chest retraction	Before feeding	50	100.50	0.000	3	1.000
	Immediately after feeding	50	100.50			
	30 min after feeding	50	100.50			
	1 h after feeding	50	100.50			

b= Kruskal Wallis Test; n= number,; sig.= significant level at 0.05.

Table (5): Comparison of feeding methods on respiratory rate in neonates with congenital heart defects

Periods	RR (I)	RR (J)	Mean Difference (I-J)	Std. Error	Sig.
Immediately	**Breastfeeding**	Bottle-feeding	-3.20629-	3.41148	.352
		Tube feeding	.71795	3.69533	.847
	Bottle-feeding	Breastfeeding	3.20629	3.41148	.352
		Tube feeding	3.92424	3.26539	.235
	Tube feeding	Breastfeeding	-.71795-	3.69533	.847
		Bottle-feeding	-3.92424-	3.26539	.235
After 30 min	**Breastfeeding**	Bottle-feeding	-1.60490-	3.23330	.622
		Tube feeding	1.41026	3.50233	.689
	Bottle-feeding	Breastfeeding	1.60490	3.23330	.622
		Tube feeding	3.01515	3.09485	.335
	Tube feeding	Breastfeeding	-1.41026-	3.50233	.689
		Bottle-feeding	-3.01515-	3.09485	.335
After 1 hour	**Breastfeeding**	Bottle-feeding	-1.90559-	3.28058	.564
		Tube feeding	.43077	3.55354	.904
	Bottle-feeding	Breastfeeding	1.90559	3.28058	.564
		Tube feeding	2.33636	3.14010	.461
	Tube feeding	Breastfeeding	-.43077-	3.55354	.904
		Bottle-feeding	-2.33636-	3.14010	.461

*The mean difference is significant at the 0.05 level.