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Effect of Feeding Methods on Oxygen Saturation, Pulse Rate and Respiratory Effort in Neonates with Congenital Heart Defects

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سورة المجادلة الآية (11)

Supervisor certification

I certify that this thesis, which is entitled (**Effect of Feeding Methods on Oxygen Saturation, Pulse Rate, and Respiratory Effort in Neonate with Congenital Heart Defect**), was prepared under my supervision at the College of Nursing at the University of Karbala in partial fulfillment of the requirements for the degree of master in nursing sciences.

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Dedication

My master's degree journey has come to end after much fatigue and hardship…

And here I am concluding my thesis with full energy and enthusiasm…

I am grateful to everyone who has been a part of my scientific and educational journey, And help me…

my family , friends, and esteemed professors…

I dedicate this thesis…

-ZA-

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Abstract

Background: Congenital Heart Defect (CHD) is the most common congenital anomaly, impacting 9 out of every 1000 live births. Up to 60% of children with CHD face growth failure and poor weight gain, challenge of maintaining physiological stability during feedings arises from the lack of coordination between sucking, swallowing, and breathing.

Objective: This study aims to explore variations in oxygen saturation, pulse rate, and respiratory effort across different feeding methods and their impact on neonates with CHD at various time intervals.

Method: Observational study was conducted at Karbala Teaching Hospital for Children from September 26th, 2023, to July 9th, 2024. Fifty neonates diagnosed with CHD in the Karbala Teaching Hospital for Children in Holy Karbala city , aged less than 28 days, were convenience selected.

Result: The data collected and physiological parameters measured at various time intervals during the feeding process of the neonate with CHD include the feeding process effect of oxygen saturation levels (p = 0.017), pulse rate levels (p = 0.565), respiratory rate (p = 0.027), chest retraction (p = 1.000), and nasal flaring (p = 0.001). statistically differs among those who are breastfeeding and bottle-feeding (p =.001) and tube-feeding (p =.045) in oxygen saturation, with significant differences between breastfeeding and bottle-feeding (p =.021) in pulse rate.

Conclusion: Oxygen saturation fluctuates significantly across feeding periods, while pulse rate remains stable. Transitioning from breastfeeding to bottle and tube feeding is associated with decreased oxygen saturation and increased pulse rate, 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.

Recommendation: The Ministry of Health may initiate wide-ranging knowledge and support program for newly mothers that are aimed at enhancing and supporting the breastfeeding of the neonate with congenital heart defect.

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List of Abbreviations

Abbreviation	Meaning / full form
AAP	American Academy of Paediatrics
ASD	Atrial Septal Defect
bpm	beats per minute
CCHD	Cyanotic Congenital Heart Disease
CDC	Centers for Disease Control and Prevention
CHD	Congenital Heart Defects
CHF	Congestive Heart Failure
CNS	Central nervous System
COA	Coarctation of the Aorta
DA	Ductus Arteriosus
et al	And others
FASP	Fetal Anomaly Screening Program
FSD	Feeding and Swallowing Disorders
HLHS	hypoplastic left heart syndrome
HM	Human Milk
HR	Heart Rate
IVC	Inferior Vena Cava
LA	Left Atrium (LA)
NEC	Necrotizing Enterocolitis
NICU	Neonatal Intensive Care Unit
PaO2	Partial pressure of oxygen in arterial blood
PDA	Patent Ductus Arteriosus
PGE2	Prostaglandin E2
PICU	Pediatric Intensive Care Unit
PMA	postmenstrual age
PPCU	Pediatric Palliative Care Units
PS	Pulmonic Stenosis
P-Value	Probability Value
PVR	Pulmonary Vascular Resistance
RA	Right Atrium
REE	Resting Energy Expenditure
RR	Respiratory rate (RR)
SAM	Severe acute malnutrition
SaO2	Arterial oxygen saturation
SD	Standard Deviation
SGA	Small for Gestational Age (SGA)
Sig	Significance
SpO2	Peripheral oxygen saturation
SPSS	Statistical Package for Social Sciences
TEE	Total energy expenditure
TGA	Transposition of the Great Arteries

TOS	Tetralogy of Fallot
UK	United Kingdom
US	United States
VSD	Ventricular septal defect
WHO	World Health Organization

List of Symbol

Symbol	Meaning
%	Percentage
=	Equal to
&	And
-	Minus
±	Minus/plus
>	More than

Chapter One:

Introduction

1.1. Introduction

Congenital heart defects (CHD) are one of the majority of congenital conditions prevalent in newborns. They have a major effect on the cost of healthcare, morbidity, and mortality in both adults and children. Actually, CHD accounts for over 30% of newborn deaths (Alaani et al., 2023).

Congenital cardiac abnormalities can be categorized into three major types based on the homodynamic characteristics of blood circulation, with each offering feeding complications. Defects leading to increased pulmonary blood flow might result in growth failure necessitating tube feeding, tachypnea, and higher respiratory strain in congestive heart failure (Jones et al., 2021).

Herridge et al., (2021) indicated that the children with CHD, ensuring adequate enteral nutrition during the disease presents significant challenges. Calorie deficiencies are common and result from poor intake, absorption, food intolerance, and excessive energy intake.

Jones et al., (2021) listed that neonates with CHD have anatomical and physiological cardiopulmonary differences compared to neonates without CHD, both in the presence and absence of cardiac operations, which may lead to more recurrent oral feeding problems in the early stages of life. Oral feeding skill development may be impacted in newborns with congenital heart abnormalities due to structural and physiological variations in heart function, development of the brain, and intestine performance. Understanding the different variations of infants with CHD is important to address particular therapies to provide assistance in oral feeding.

The child's shift to oral nourishment must include the development of neurobehavioral characteristics such as postural control and the maturation of the coordination of sucking, swallowing, and breathing. The inability to eat often leads to an imbalance in energy intake, resulting in reduced growth. Due to impaired cardiorespiratory function, children with congenital heart defects may experience prolonged food intake, loss of appetite, and refusal to eat, from the symptoms of dysphagia in newborns include lack of coordination between sucking and swallowing (Saad et al,. 2021)

Holst et al., (2019) reported that up to 60% of children with CHD experience poor weight gain and growth failure. Numerous conditions might cause these issues, including more severe neurological injury, persistent heart failure, gastroesophageal reflux, reduced motility or absorption, poor oro-motor control, and dysphagia.

Neonates with congenital cardiac abnormalities are more likely to experience feeding problems and developmental problems both before and after surgery. Feeding problems have a major detrimental effect on the life’s quality of children with CHD and their family members because they interfere with short-term and long-term neurodevelopment associated with nutrition and growth, social-emotional, and sensory regulation bonding with parents or caregivers (Jones et al., 2021).

According to Norman et al., (2022), reported that the feeding and Swallowing Disorders (FSD) are prevalent in newborn diagnosis of CHD and are linked to a number of serious morbidities, including respiratory infections, delayed weight gain, extended hospital stay and Pediatric Intensive Care Unit (PICU) stay, and increased caregiver stress. Furthermore, delays in hospital discharge are frequently caused by insufficient oral feeding.

Silva et al., (2023) pointed out that the dietary variables become more difficult for newborns with heart disease, particularly in terms of texture acceptance and the way food is presented, which may necessitate changes for better child acceptance. It is well known that the bio-dynamics of swallowing vary depending on whether food is offered by breast or bottle, due to functional and anatomical differences.

Walsh et al., (2020) reported that enteral feeding either at the breast or through a bottle is anticipated to be the primary source of nutritional assistance for full-term neonates. Because of their innate reactions, newborns can both suck and swallow and time their bursts of sucking to coincide with their pauses in breathing.

Salvatori et al., (2022) stated that the order of sucking, swallowing, and breathing represents a remarkable and effective oral-motor developmental milestone in the process of nourishment. Reflexive feeding gives away to voluntary, regulated eating during the first few months of life as an infant develops. Regrettably, children with congenital heart defects often have decreased oral feeding abilities.

Holst et al., (2019) reported that enteral tube feeding (in a gastric or nasogastric tube) is commonly utilized as a short- or long-term strategy to improve nutrition and address a number of these possible risk factors for stunted growth. This has led to an increasing amount of attention to the connection between feeding strategy and nutrition-related traits like growth trajectory and impaired neurodevelopment in the first year of life.

Breastfeeding has numerous advantages for both the child and the mother, the most notable of which is that it strengthens the link between mother and child while providing the finest source of nutrients (Couto, 2020).

The physiological and structural differences in the brain, gut function, and heart of neonates with CHD can restricted the development of skills of oral feeding. Understanding the distinct variations of children with CHD is critical for addressing specific therapies to support feeding (Jones et al., 2021).

When a child's level of arousal drops or when they grow weary during feeding, changes in respiratory control may occur. It can impact infant's success and physiologic stability to determine whether they are ready or in a suitable state to start feeding. When bottle-feeding, breathing abnormalities, including pauses, often lead to significant and repeated episodes of desaturation (Hoffman, 2016).

Silva et al., (2023) alluded to among the symptoms of CHD are exhaustion when breastfeeding, color change, a decline in peripheral oxygen saturation (SpO_2), and an accelerated heart rate. The presence of dyspnea and CHD symptoms can directly interfere with meals, resulting in nutritional, hydration, and pulmonary function deficits. Cardiac changes can cause more in coordination among suction, swallowing, breathing and, raising the likelihood of oropharyngeal dysphagia in this population.

Neonates with CHD frequently struggle to feed themselves because of dysphasia or challenges with their swallowing (Hoffman, 2016).

Newborns with CHD, dysphagia is most commonly diagnosed clinically as poor sucking and swallowing and poor coordination of breathing. Clinical indicators and manifestations of poor sucking coordination with oral feeding include an increase in energy expenditure, respiratory rate, pulse rate, gagging, retching, coughing, and red/watery eyes, in addition to a rise in oxygen desaturation (Jones et al., 2021).

Nurses should cooperate with the family in order to reduce the family's anxiety and provide the most effective care for the neonate with CHD (Yürük & Cetinkaya, 2023).

Hoffman, (2016) mentioned that the levels of oxygen saturation during and after feeding in infants with CHD are important because they can represent the level of cardiorespiratory stress required during feeding.

1.2. Important of study

For infants with CHD, physiologic instability with a recurring and crucial function like feeding is a major worry. For these susceptible newborns, feeding and nutrition are the main concerns because meeting developmental milestones and achieving desired growth require enough nutrition. By keeping an eye on physiologic data, we may assess how the baby reacts to various feeding techniques and identify any indications of distress (Hoffman, 2016).

Norman et al., (2022) cited that there are a number of factors that contribute to the feeding and swallowing disorders experienced by neonates and young children diagnosed with CHD. These factors include fatigue, lower endurance, and difficulty swallowing and coordinating breathing due to the increased effort, respiratory rate during breathing associated with diagnosis of congenital heart defects, which results in inadequate calorie intake. Prolonged enteral feeding may lead to a lack of exposure to oral feeds due to fragility and increased nutritional needs, which may cause challenges or delays possible in the development of feeding skills.

Since there have been no prior data on the incidence of congenital abnormalities in Iraq overall, some papers have really examined the prevalence of these conditions in the particular society.

A research from the province of Basra has found that the greatest prevalence of congestive heart defect has been identified by data analysis of patients with the disease. Of the 1414 children checked retrospectively via echocardiography in major facilities over a 24-month period, 57 (40%) had CHD, The other research on prevalence was conducted in Mosul. The most prevalent kind was ASD (42%), followed by VSD (30%), and then by PDA, and the prevalence was 6.1/1000 patients (Al-Allaf & Mahmmod, 2022)

Congenital heart defects (CHD) are the most frequent fetal abnormalities and the leading cause of newborn mortality due to congenital abnormalities. CHD has a larger prenatal incidence (2.4%–52%) than a postnatal incidence (0.3%–1.2%) (Doumbia et al., 2022).

Other was conducted at Al-Fallojah, Iraq to determine the prevalence of these defects. The study involved screening and examining newborns and children over the course of five years utilizing clinical examination, color Doppler, two-dimensional echocardiography, and occasionally cardiac catheterization. 19.7/1000 is the total prevalence Alaani, (2023)

Globally the prevalence of CHD in newborns are between 3.7% and 17.5% per 1,000 births, accounting for 30%–45% of all congenital deformities. Birth prevalent varies by continent, ranging from 9.3% per 1,000 in Asia to 6.9% per 1,000 births in Europe (Alaani, 2023).

Silva, (2023) stated that the prevalence of CHD has risen in recent years, with roughly 12–14 per 1000 live births affected.

The most common birth anomaly is CHD, occurring in 9 out of 1000 live births (Salvatori, 2022).

In the United States (US), CHD account for 29% of birth deformity-related deaths and 5.7% of all newborn child deaths. Neonates account for 57% of CHD related newborn child deaths (Al-Jeboori, 2019).

Zmora, (2021) noted that the majority of neonatal deaths resulting from birth defects are caused by CHDs in the United States, 8 out of 1,000 infants develop a CHD within the first year, and around 40,000 children are born with a CHD in the United States each year.

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Jones et al., (2021) referred to the overall mortality rate for children with CHD has decreased dramatically, there is an increasing number of people with CHD living into adulthood. Improvement of long-term development and quality of life is therefore necessary.

Hoffman, (2016) cited that the challenging situation in which the neonate is secure, stable physiologically, engaged, and behaviorally ordered, in general and in oromotor activity, and pleasant is classified as quality feeding. Physiologic stability in a newborn is defined as constant vital signs, good color, and decent muscular tone when the infant is in bed alone or during basic handling. A newborn is considered to have stable vital signs if their pulse rate PR is 20% of their recent resting heart rate (or another range specified for that neonate), their blood oxygen saturation SPO2 levels are within the unit guidelines' recommended range, and their breathing rate ranges from 40 to 60 breaths per minute, or a different range that is tailored to that neonate. An infant must exert more effort to maintain oxygenation if their breathing rate is higher than the recommended respiratory rate. The most common defects at birth and account for 40% of all fetal malformation (Fall et al., 2020). The incidence of congenital cardiac disease during the prenatal period is greater (2.4% to 52%) than the incidence of the disease after birth which was (0.3% to 1.1%).2%) (Doumbia et al., 2022).

Khasawneh et al., (2020) reported that the occurrence of CHD varies based on the population, with rates ranging between 4 to 50 per 1,000 live births. The Centers for Disease Control and Prevention (CDC) reported that prevalence of congenital heart disease in the United States is approximately 1%, or 10% cases per 1,000 live births.

Jones et al., (2021) cited the fact that the primary objective of eating is to obtain adequate nutrients for normal growth and development. When a newborn feeds themselves by mouth to push a bolus of milk down the esophagus without aspirating it into the respiratory airway , it's a complex procedure that combines breathing, sucking, and swallowing. healthy sucking for nourishment begins in utero and integrates a variety of sensory and motor CNS functions. The next few weeks following birth are spent on its orderly development. Healthy full-term children are able to structure their sucking habits into productive intervals of sucking and pauses, something that newborns in perinatal distress find difficult to achieve.

Tsintoni et al., (2020) quoted that the development of growth restriction in extrauterine, the neonates and infants with CHD is extremely risky. Despite having a normal birth weight for their gestational age, it has been shown that they struggle to thrive. Because, insufficient physical growth and development during the first year of life can affected on both anthropometric and long-term neurodevelopmental results, neonates are generally considered a vulnerable population. Energy imbalance brought on by cardiac and extra-cardiac causes is typically the cause of malnutrition in newborns with CHD.

By thoroughly evaluating oxygen saturation, Marino, (1995) discovered variations when bottle-feeding is used instead of breastfeeding, in the cardiorespiratory effort of neonate with CHD. Many studies on feeding techniques for critically ill newborns, particularly premature infants, have been undertaken. However, It's unclear what the best course of action is for a severely ill newborn with congenital heart defects. One of the biggest obstacles to developing optimal feeding strategies for infants with complex congenital heart illnesses is the absence of reliable information. Because of their poor feeding ability, these newborns are in danger of stunted growth and nutrition. A deeper understanding of the physiologic reactions associated with each feeding approach can aid in determining if one strategy is superior to another.

The interpretation of physiological instability during feeding is crucial. Episodes of physiological instability during feeding are a way for a baby to communicate that he or she is not safe and needs more support with feeding. the use of physiological monitors that “count” the episodes of apnea, bradycardia, or desaturation that occurred during feeding, Support the interventions that best help the child (Pados, 2021).

1.3. Problem statement

For this vulnerable group physiological stability during feedings is a concern, since they often have an uncoordinated suck-swallow-breathe cycle and may use greater energy than is needed during a consuming.

The development of oral feeding abilities can be impaired in infants with CHD due to structural and physiological variations in their heart function, brain development, and gut functioning. for these susceptible newborns, feeding and nutrition are the main concerns because meeting developmental milestones and desired growth depend on appropriate nutrition. for newborns with CHD, physiologic instability during a routine and important action like feeding is a serious worry.

Many studies on feeding techniques for critically ill newborns, particularly premature infants, have been undertaken. However, the best way to feed critically unwell children with congenital heart defect is uncertain.

One of the biggest obstacles to developing optimal feeding strategies for infants with complex congenital heart illnesses is the absence of reliable information. Because of their poor feeding ability, these newborns are in danger of weakening their growth and nutrition. A greater understanding of the physiology associated with each feeding strategy can aid in determining whether one method is advantageous to another.

It's critical to understand feeding readiness indicators, connected physiological data that can be seen on patient monitors, and cues given to the newborn during a feeding. Long-term benefits in growth and development may result from the use of better techniques to enhance the feeding experiences of infants with congenital heart defects.

1.4. Objectives of the study

- To Investigating the differences in oxygen saturation, pulse rate and respiratory effort at different time points for feeding method of neonate with CHD
- To Determining the influence of feeding methods on oxygen saturation, pulse rate, and respiratory rate in neonates diagnosed with congenital heart defects.
- To Exploring variations in oxygen saturation, pulse rate, and respiratory effort among neonates with congenital heart defects, taking into account their clinical data.

1.5. Research question

Do SpO_2, HR, and respiratory efforts vary by the feeding methods (breastfeeding, bottle feeding, and tube feeding) in a neonate with a congenital heart defect?

1.6. Definition of term

1.6.1.Oxygen saturation (spo2):

A. Theoretical definition:

The amount of hemoglobin that is now associated with oxygen in the blood can be determined by the saturation level of oxygen (SpO_2). represented as arterial oxygen saturation (SaO_2). A typical, healthy SpO_2 reading is between 95% and 100%, and a reading below 90% is considered hypoxemia (Hafen et al., 2018).

B. Operational definition:

Oxygen saturation (SpO2) is a critical measure of how effectively oxygen is being transported in the blood.

1.6.2. Pulse rate :

A. Theoretical definition:

The pulse rate, also known as the heart rate (the normal heart rate for neonates or newborns is between 70 to 190 beats per minute (bpm) the median heart rate in neonates increases from 127 bpm at birth, reaching a maximum of 145 bpm at approximately one month of age (Anton et al., 2019).

B. Operational definition:

The frequency of heart contractions measured per minute (bpm).

1.6.3. Respiratory effort:

A. Theoretical definition:

Respiratory effort in neonates that refers to the work the newborn must exert to breathe effectively, characterized by signs such as tachypnea (rapid breathing), grunting, nasal flaring, chest retractions, use of accessory muscles, and Cyanosis (bluish coloring of mucous membranes and skin brought on by oxygen deficiency) (Sweet et al., 2017).

B. Operational definition:

Respiratory effort in neonates refers to the physical work and energy exerted by a newborn baby to breathe. It is a crucial aspect of assessing the baby's respiratory function and overall health.

Chapter Two :

Literature Review

2.1. Overview of congenital heart defect

Congenital heart defects (CHD) represent the most prevalent anomalies present at birth. (Singh, 2018). Congenital heart defects are developmental anomalies of the cardiovascular system (Kinda et al., 2016).

That defects are present at birth and result from a developmental defect during embryonic life (Niang et al., 2023). Significant medical advances have improved the survival rate of children affected by these developmental disorders (Kinda et al., 2016). Among all birth defects, CHD continue to be the leading cause of death in pediatric age groups (Khasawneh et al., 2020).

Alaani et al., (2023) informed that the heart murmur or irregular heart sound, cyanosis, characterized by the appearance of blue on the skin, fingers, and/or lips, fast respiration, anorexia, poor weight gain, an inability to exercise, and excessive perspiration are some of the warning indications of congenital heart defects in neonates.

Over the past 30 years, significant improvements in the diagnosis, surgical management, and perioperative management of these patients have resulted in the majority of children surviving to adulthood as long-term survival improves. The focus is now increasingly on the quality of life of surviving children (Jowett, 2017).

Khasawneh et al., (2020)mentioned that large differences in the incidence of countries about congenital heart disease. This difference may be influenced by the age of the cases, the size of heart defects, and the methodology used for diagnosis.

Khasawneh et al., (2020) mentioned that the CHD accounts for 36.95 percent of all congenital cardiac defects.

Newborns can have a broad spectrum of severity when it comes to congenital heart abnormalities. Approximately 2 to 3 out of every 1,000 newborns experience signs of heart illness within their first year of life. The condition is identified in 40–50% of individuals with congenital heart disease within the first week after birth, and in 50–60% within the first month after birth (Bernstein, 2019).

2.2. Cardiovascular anatomy and physiology for fetus

2.2.1. Fetal circulation "antenatal"

The fetal circulation differs physically and physiologically from the adult circulation in multiple significant ways (fig: 2-1). The placenta serves as a low-resistance circulatory channel where the blood in the fetus becomes oxygenated, fetal arterial oxygen tension (PaO2) is lower than adult levels at approximately 25 mmHg; and fetal hemoglobin binds more readily to oxygen than adult hemoglobin. The fetal brain requirement the greatest concentration of oxygen, but the lungs are practically nonfun-ctional, resulting in a reduced requirement for blood in fetal life (Pritišanac et al., 2021).

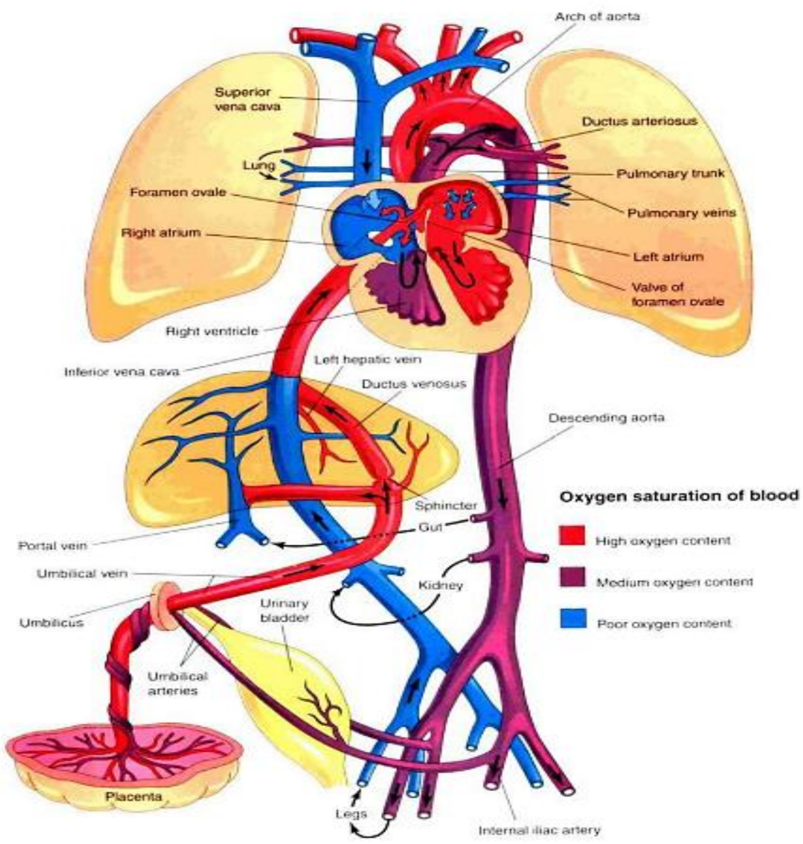


Fig:(2-1) Fetal circulation (Ezhil, 2012).

2.2.1.1. The Foramen Ovale and Ductus Venosus

During the development of the fetus, the process of oxygenating the blood takes place through the placenta. The oxygenated blood is then carried back to the fetus through the umbilical vein, which is connected to the portal vein of the hepatic hilum. The ductus venosus diverts blood flow to the left lobe of the liver, bypassing most of the liver and enabling it to reach the inferior vena cava (Kiserud & Kessler, 2023)

The proportion of umbilical cord blood flowing via the venous canal varies considerably, ranging from 20% to 90%. The blood flow velocity in the ductus venosus ranges from 65 to 75 cm/s, while in the abdominal vein it is roughly 16 cm/s. Hence, the blood flows from the inferior vena cava to the right atrium (Ashworth, 2022).

The presence of diminished oxygen saturation in the right hepatic vein and the inferior vena cava in the abdominal cavity are indicative of lower velocity in the anterior flow. The blood exiting the ductus venosus exhibits increased velocity and significantly elevated oxygen saturation levels. The blood is directed through the Eustachian valve and is given preferential flow towards the foramen ovale due to its increased velocity (Kiserud & Kessler, 2023).

The majority of the blood originating from the inferior vena cava is directed through the tricuspid valve, whereas the deoxygenated blood from the superior vena cava is particularly channeled towards the tricuspid valve and the right ventricle. Approximately 5% of this blood traverses the foramen ovale (Ashworth, 2022).

2.2.1.2. Systemic circulation (Ductus Arteriosus and lungs)

The right ventricle propels blood into the pulmonary artery. As a result of elevated pulmonary resistance, less than one-third of the blood flow from the right ventricle is directed towards the lungs, while more than two-thirds travels through the ductus arteriosus and into the descending aorta. During the latter trimester of pregnancy, the fetus experiences a blood flow rate of 75 ml per kilogram per minute and 175 ml per kilogram per minute, respectively. The left atrium receives blood from the fossa ovalis and pulmonary veins (Remien & Majmundar, 2022).

The blood flows through the mitral valve and is ejected from the left ventricle into the ascending aorta, which mostly delivers blood to the brain and upper extremities. Approximately 25% of the blood that is expelled from the left ventricle flows via the aortic isthmus and enters the descending aorta through the ductus arteriosus. The blood flow ratio from the right ventricle to the left ventricle is roughly 1.2–1.3:1, which is equivalent to 200:250 ml/kg/min in a fetus at the end of pregnancy (Chakkarapani, 2023).

The circulation in foetuses involves the merging of oxygenated and deoxygenated blood at many locations, including the liver, the inferior vena cava, and the left atrium, in contrast to the circulation in adults. The blood circulation somewhat impedes mixing by selectively directing oxygenated blood through the fossa ovalis to the left heart and subsequently to the brain. Furthermore, it enhances the circulation of blood from the inferior and superior vena cava to the right ventricle and subsequently through the ductus arteriosus to the descending aorta. Subsequently, the blood is routed towards the placenta (Ashworth, 2022).

2.2.2. Transition of the fetal circulation

During the transition from fetal to postnatal life, the fetus undergoes many adaptations in its cardiovascular and respiratory systems. In order for gas exchange to occur, it is necessary for the transfer of gases to take place from the placenta to the lungs. Additionally, the valves in the fetal circulatory system need to close, and there must be an increase in the output of the left ventricle. Following childbirth, multiple events lead to the termination of placental circulation. The umbilical arteries respond and constrict in reaction to longitudinal stretching and elevated levels of PO2 in the blood. Clearly, reinforcing the umbilical cord externally will improve this process (Chakkarapani, 2023).

Following the cessation of blood flow in the placenta, there is a substantial reduction in the amount of blood passing via the ductus venosus and a notable drop in the return of blood into the inferior vena cava. The closure of the ductus venosus occurs through passive means throughout a span of 3 to 10 days after birth. This closure coincides with the end of pregnancy, during which the pulmonary vascular resistance (PVR) steadily decreases. Following birth, there is a remarkable reduction in pulmonary vascular resistance (PVR) and a significant 8- to 10-fold rise in pulmonary blood flow due to pulmonary hypertrophy. Studies conducted on fetal lambs have demonstrated that mechanically expanding the lungs with non-oxidized gases can greatly lower PVR. The decrease in pulmonary vascular resistance (PVR) may be attributed to the enlargement of the lungs and the opening of the pulmonary vasculature (Singh & Lakshminrusimha, 2021).

It is believed that this is caused, at least in part, by the activation of receptors in the lungs that sense expansion, leading to a reflexive widening of blood vessels. Enhanced oxygenation of blood in newborns also counteracts the narrowing of blood vessels in the lungs caused by oxygen deficiency, thereby leading to a further decrease in pulmonary vascular resistance (Iqbal et al., 2022).

These two variables facilitate the equalization of pressure in the left atrium (LA) and right atrium (RA). At this stage, the foramen ovale valve is pushed into the atrial septum, essentially sealing the atrial valve. This initial closure of the foramen ovale takes place from a few minutes to a few hours after birth. Tissue proliferation leads to anatomical closure. When the PVR (Pulmonary Vascular Resistance) declines, the loss at the DA (Ductus Arteriosus) level becomes bidirectional (Tan and Lewandowski, 2020).

Sealing of the ductus occurs in two distinct stages. Functional closure of the ducts occurs within 96 hours in healthy babies born at full term. The functional closure is subsequently followed by anatomical closure through the growth of endothelial and fibrous tissue. This increase in pulmonary blood flow results in a significant rise in pulmonary venous return to the left atrium. The aforementioned decrease in inferior vena cava (IVC) flow leads to a decrease in the amount of venous blood returning to the right atrium (RA) opening (Singh & Lakshminrusimha, 2021).

The precise method by which the duct closes is not yet understood, however elevated levels of PO2 in the blood of infants cause a direct constriction of the smooth muscle in the duct. Moreover, the level of PGE2 synthesized in the placenta declines swiftly after childbirth, resulting in the constriction of the milk ducts. The duct tissue may exhibit reduced sensitivity to the vasodilating properties of prostaglandins (Iqbal, et al., 2022).

2.2.3. Newborn circulation ″postnatal adaptation‟

This reduction in pulmonary vascular resistance has several implications. Facilitates the redistribution of blood flow originating from the right ventricle, diverting it away from the ductus arteriosus and directing it towards the lungs. consequently, there is an augmented circulation of blood from the lungs to the left atrium, leading to an elevation in left atrial pressure. The heightened pressure exerts force on the elliptical border of the fossa, creating a tight seal at the atrial junction against the septum (Ashworth, 2022).

Following delivery, the lungs of the fetus assume the role of oxygenating the blood, which was previously carried out by the placenta, as seen in (fig :2-2). When babies takes their first breath, it fills their lungs with air. This helps to decrease the resistance in the blood vessels of the lungs, which remains high in the first few weeks after birth. This process also helps to reshape the blood vessels in the lungs. In healthy full-term babies, the closure of the ductus happens in two stages. The first stage, known as functional closure, takes place within 96 hours after birth. This is followed by anatomical closure, which occurs later through the proliferation of endothelial and fibrous tissue (Iqbal et al., 2022).

Breathing causes an elevation in arterial oxygen saturation, which results in the constriction of the ductus arteriosus. This leads to the functional closure of the ductus arteriosus about 10–15 hours after birth. The closure of the ductus venosus, which is a blood vessel in term infants, typically happens around the fourth day after birth. However, in premature infants and infants who have received prenatal steroids, the closure process may take up to two more days due to fibrosis (Chakkarapani, 2023).

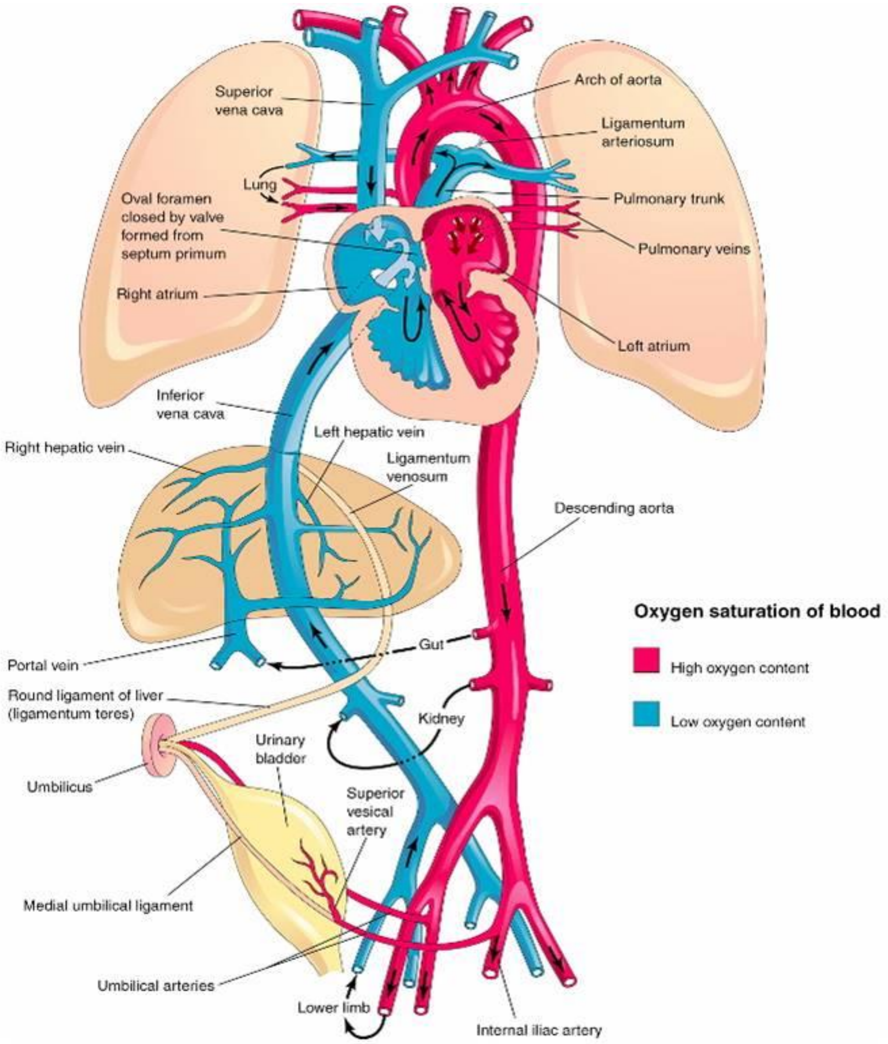


Fig:(2-2) Neonate Circulation (Ezhil, 2012).

2.3. Alter hemodynamics newborn with CHD.

Newborns with cardiac disease that affects blood flow are most likely to have nutritional depletion, malnutrition exacerbates the lack of adequate development that is common in children with congenital heart defects, regardless of the type of heart defect and the presence or absence of cyanosis. The causes of malnutrition in cardiac patients are reduced energy intake, increased catabolism due to infections and tachycardia, and increased energy requirements (Abdelhamid & Elsharawy, 2024).

Heart defects that cause hypoxemia and cyanosis are those that allow unsaturated venous blood (blue blood) to enter the systemic circulation without passing through the lungs. Three types of defects cause cyanosis in newborns (Hockenberry et al., 2021).

The degree of malnutrition can range from mild to severe stunted growth. In developed countries, approximately 64% of patients did not develop normally. In developing regions, this value can reach 90%. There is a correlation between stunted growth and irregular blood flow in infancy. The specific kind of heart defect and the extent of blood flow impairment contribute to the malnourishment of newborns with CHD. The occurrence of congestive heart failure (CHF), cyanosis, or pulmonary hypertension can impact the nature and severity of malnutrition (Abdelhamid & Elsharawy, 2024).

The first condition is a significant impediment to the circulation of blood in the lungs and the flow of blood from the right side of the heart to the left side. The tetralogy of Fallot is a prevalent condition characterized by the mixing of arterial and venous blood inside the chambers of the heart. A specific instance can be illustrated using a solitary chamber (Galvis et al., 2023).

The third anomaly, known as transposition of the major arteries, is a distinct condition in which the pulmonary and systemic circulations run parallel to one another instead of being sequential. Deoxygenated blood is sent back to the lungs, whereas oxygenated blood is returned to the body. To improve oxygenation, babies with transposition of the great arteries needed mixing inside the heart through a patent foramen ovale, septal connection, or ductus arteriosus (Hockenberry et al., 2021).

2.4. Clinical screening for congenital heart defect

Screening is “a simple test performed on the general population to identify people who have or are at risk of developing a particular disease.” In order for screening to be efficacious, the screening instrument must possess the qualities of safety, affordability, accessibility, simplicity, high sensitivity, and specificity, as well as offer practical options for subsequent treatment (Kumar, 2016).

Congenital heart diseases are characterized by any alteration in the structure or function of the heart that leads to the demise of a newborn or necessitates surgical intervention or cardiac catheterization within the initial 28 days of life in order to avert mortality or significant harm to vital organs. Timely detection of CHD prior to sudden loss of blood circulation leads to enhanced cardiorespiratory and neurological consequences. Nevertheless, the majority of neonates do not show any symptoms upon birth (Minocha, 2018).

Jullien, (2021) referred to the neonates screening for Critical Congenital Heart Disease (CCHD) can simplify the identifications of specific the cases, enable prompt diagnosis, treatment, and potentially avert impairment or mortality.

Kumar, (2016) reported that the American Academy of Pediatrics (AAP) recommended in 2011, the exploitation the oximeter of pulse as a screening tool for all neonates in order to identify potential the cases of CHD. The screening of prenatal for CHD can be performed using scan by a fetal ultrasound, which is capable of identifying mane severity form of CHD from the 14^{th} to 16^{th} weeks of gestation.

Screening of fetal cardiac was identifying into the UK through screening program in the meddles of 1990s and involved uniformity of a normal four ventricles chamber appearance. The objectives of the UK Fetal Anomaly Screening Program (FASP) is to ensure that some cases are sufficiently informed about the future management and prognosis of the disease by screening for anomalies in the 18^{th} to 20^{th} week of gestation (Jowett, 2017).

Postnatal period, during pulse oximetry and physical examination (Kumar, 2016). Pulse oximetry allows for the systematic monitor of cardiopulmonary differences due to nutrition. The methods of device allow for ongoing, non-intrusive tracking of heart rate and arterial oxygen saturation, offering an unbiased assessment of physiological fluctuations that take place during eating like activities (Niaz et al., 2021).

The incidence of cardiac deformities identified within the initial one year is predicted to range from 6% to 8% per 1,000 live births. Roughly a quarter of cardiac deformities are potentially fatal and can manifest prior to the initial standard clinical assessment. Failure to promptly identify these crucial alterations shortly after birth leads to delay in seeking medical intervention and higher rate of morbidity and mortality (Vaidyanathan et al., 2011).

Pulse oximetry measured by SpO_2 by detecting variation in the absorption spectra of oxygenated and deoxygenated hemoglobin in arterial blood. neonates are monitoring for oxygen saturation by use pulse oximetry. The normal SpO_2 value from 90% to 100% in neonates (Falsaperla et al., 2022).

Mohsin et al., (2019) reported that to demonstrated that pulse oximetry has a high level of specificity and sensitivity when use to early detected of CHD in newborns. By integrating clinical examination with a pulse oximetry, the capacity of nurses professional to promptly identify threatening of life of neonate with CHD can be enhance.

The proportion of hemoglobin in oxygen-saturated blood is measured using a pulse oximeter. The following algorithm was developed to represent the selection phases (Kemper et al., 2011).

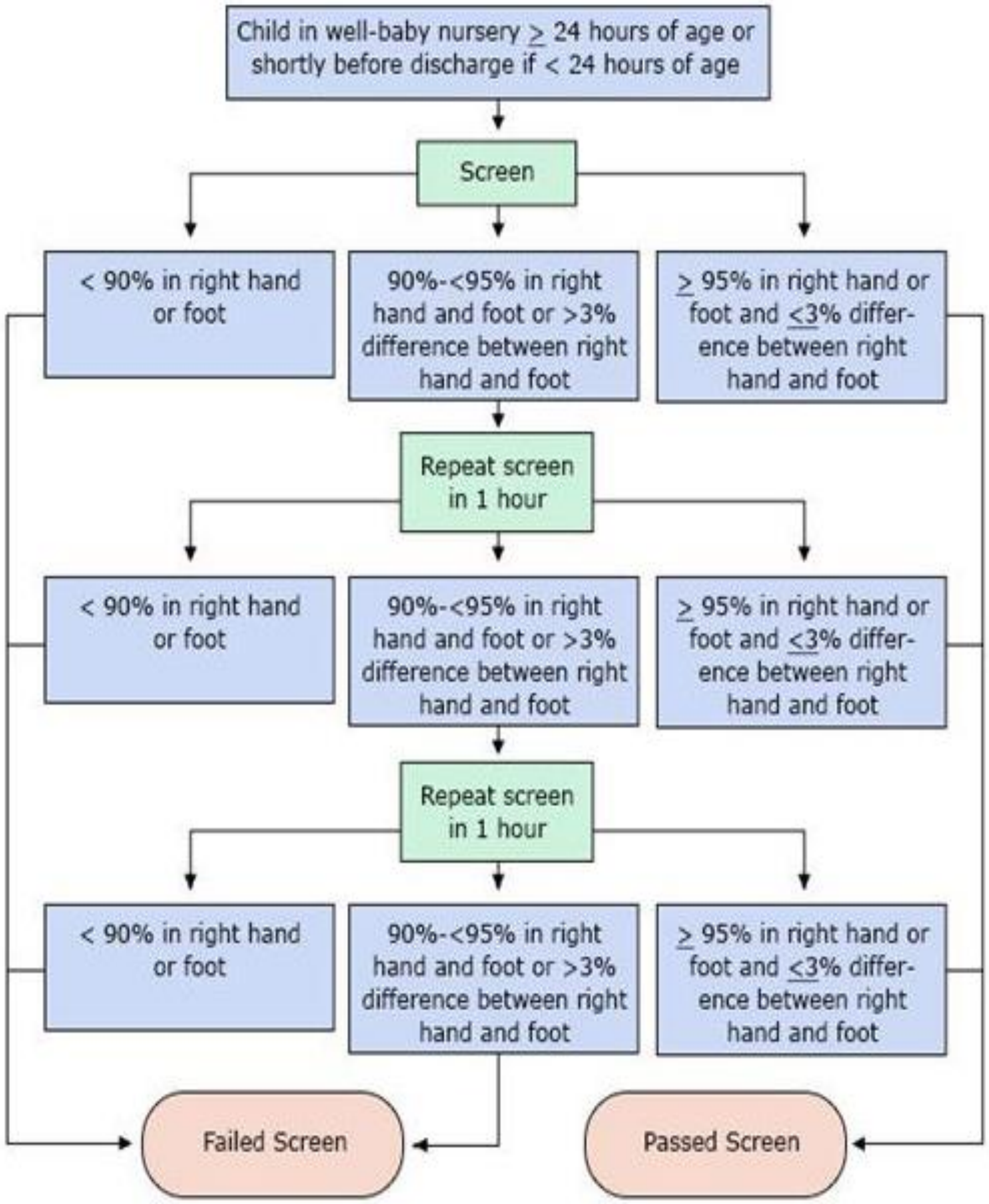


Fig: (2-3) Algorithm show the steps of screening (Gunaratne et al., 2021).

2.4.1. The screening protocol:

In order for a screen to be considered unsuccessful, the following conditions must be satisfied: Oxygen saturation measures, whether in the initial screen or subsequent screens, should be below 90%. And oxygen saturation levels in the right hand and foot should be below 95% in three separate measurements taken one hour apart. Alternatively, there should be a difference of more than 3% in oxygen saturation between the two hands in three measurements taken one hour apart (Oster et al., 2016).

If a newborn fails the test, they should get evaluation for hypoxemia. An echocardiography is usually included in the diagnostic process. However, if a treatable cause of low oxygen levels in the blood is identified, an echocardiogram may not be necessary. It is imperative to promptly inform the pediatrician and consider referring the newborn to a cardiologist (Jiang et al., 2022).

A test is deemed successful if the oxygen saturation measurement is 95% in either the right hand or foot, with a 3% absolute disparity between the two. Under those circumstances, the screening process would be completed. While pulse oximetry screening may not detect all severe CHDs, a positive screening result in a baby does not rule out the possibility of a critical CHD or another form of CHD (Klausner et al., 2017).

2.5. Etiology and Risk factor of affected newborn with Congenital heart defect.

The genuine etiology of congenital heart defects remains in large part unknown. Despite advances in medical and surgical treatments, the etiology of coronary artery disease is still not fully understood (Richards, 2010). With approximately 80–90% of these cases thought to have a genetic and environmental interaction (Doumbia, 2022).

Congenital heart defects children with a percentage of 8%–12% have a chromosomal defect or aneuploidy, 3%–5% have a copy number variation, and 3%–5% have a single-gene problem in an identified CHD gene (Nees, 2020).

The pathogenesis of CHD is known to be complicated. These factors encompass genetic predispositions and environmental triggers. Having family history of near relatives significantly elevates the likelihood of developing coronary heart disease during a subsequent pregnancy (Bernstein, 2019).

The probability of having children with CHD is 6% for mothers with the condition and 2% for fathers with the condition. The occurrence of a heart defect in a newborn poses a 2-3% chance of the same condition in a later pregnancy. However, if a infant is born with hypoplastic left heart syndrome (HLHS) or if there are two or more newborns with heart defects, the risk of another child having a CHD increases by 10%, making it approximately ten times higher. Substantial advancement has been achieved in comprehending the hereditary causes of coronary artery disease in youngsters (Singh, 2018).

This syndrome has various causes, including genetic factors like chromosomal defects, monogenic illnesses, and polygenic disorders. Environmental factors such as smoking and exposure to certain substances like dyes, varnishes, and pesticides also play a role. Certain medications like alcohol, diazepam, and retinoic acid can lead to congenital abnormalities. Maternal conditions like pulmonary stenosis and untreated diabetes can increase the risk. Viral infections like rubella and HIV can also have similar effects (Yürük & Cetinkaya, 2023).

A new study suggests that a group of several hundred genes with de novo point mutations collectively accounts for approximately 10% of severe congenital cardiac disease. Likewise, environmental variables at a critical developmental stage can have similar effects. The incidence of congenital heart disease linked to chromosomal anomalies ranges from 4%

to 12%, but can increase to 22% when accounting for prenatal (fetal) fatalities (Singh, 2018).

2.6. Clinical presentation of congenital heart defect.

The alterations in cardiovascular physiology resulting from the transitional circulation, namely the closure of the ductus arteriosus and the reduction in pulmonary vascular resistance, have been recorded. CHD abnormalities can be categorized into three clinical presentations (Abdumansur, 2022).

2.6.1. A child with a blue appearance due to CHD:

Cyanotic congenital heart defects account for around 20% of coronary heart disease cases. The timing of presentation can range from shortly after birth to later in infancy or even early childhood, depending on factors such as the function of the ducts, the reliance of pulmonary circulation on the duct, the level of obstruction in the right ventricular outflow, and the presence of any additional heart abnormalities. TOF is the predominant recognized CHD responsible for cyanosis. However, Transposition of the Great Arteries (TGA) is a common CHD that causes cyanosis. It is usually identified within the first week after birth (Singh, 2018).

2.6.2. Congenital Heart Diseases that present as neonatal collapse or sudden infant death :

Characterized by a reliance on the patency of the ductus arteriosus for systemic circulation. When the ductus arteriosus closes, tissue perfusion becomes impaired, resulting in impalpable pulses and progressive acidosis. Infants who have CHDs that rely on the duct for blood flow, such as coarctation of the aorta (CoA), hypoplastic left heart syndrome (HLHS), interrupted aortic arch, and severe CHDs (Bernstein, 2019).

2.6.3. Neonatal cyanosis:

Rohit et al., (2017) mentioned that observed the skin a bluish discoloration, is a critical cases related to the CHD. Closure of the patent ductus arteriosus (PDA) can exacerbate several cardiac abnormalities, which are referred to as duct-dependent diseases. Prostaglandin E1 (PGE1) infusion is administered to children in emergency situations to maintain patency of the duct.

2.6.4. Cardiac failure or a cardiac murmur

Singh, (2018) stated that signs of CHD that are detected in newborns and infants and indicate a significant likelihood of CHD.

2.7. Classification of congenital heart defect

Congenital cardiac abnormalities are classified into multiple categories. Previously, the physical characteristic known as cyanosis has been used to differentiate between two types of abnormalities: acyanotic and cyanotic (Rohit et al., 2017).

In infants with cyanotic heart defects, acyanotic anomalies occur when oxygen-rich blood is able to pass from the left side of the heart to the right side through a hole or small aperture. As a result, there is a rise in the volume of blood flowing through the lungs, an elevation in the pressure inside the pulmonary arteries, and an increase in the strain experienced by the pulmonary system (Siemieński, 2019).

Valvular lesions and obstructive lesions are the two categories into which acyanotic congenital cardiac defects fall. Typically, two separate and independent systems organize the blood vessels responsible for carrying oxygenated and deoxygenated blood, running alongside each other. They only interact in the lungs and peripheral tissues, where they oxygenate deoxygenated blood and vice versa. Any interaction between these two parallel structures results in a blood shunt (Rohit et al., 2017).

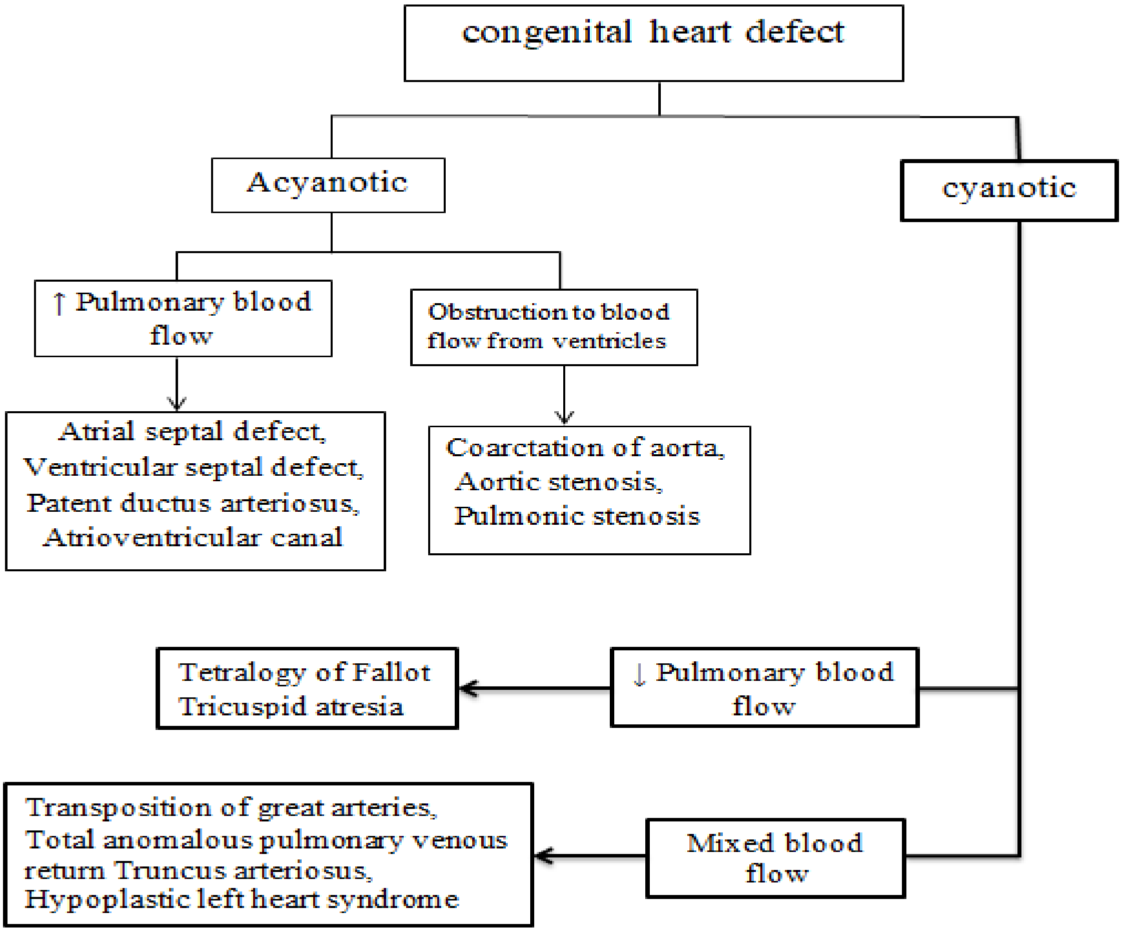


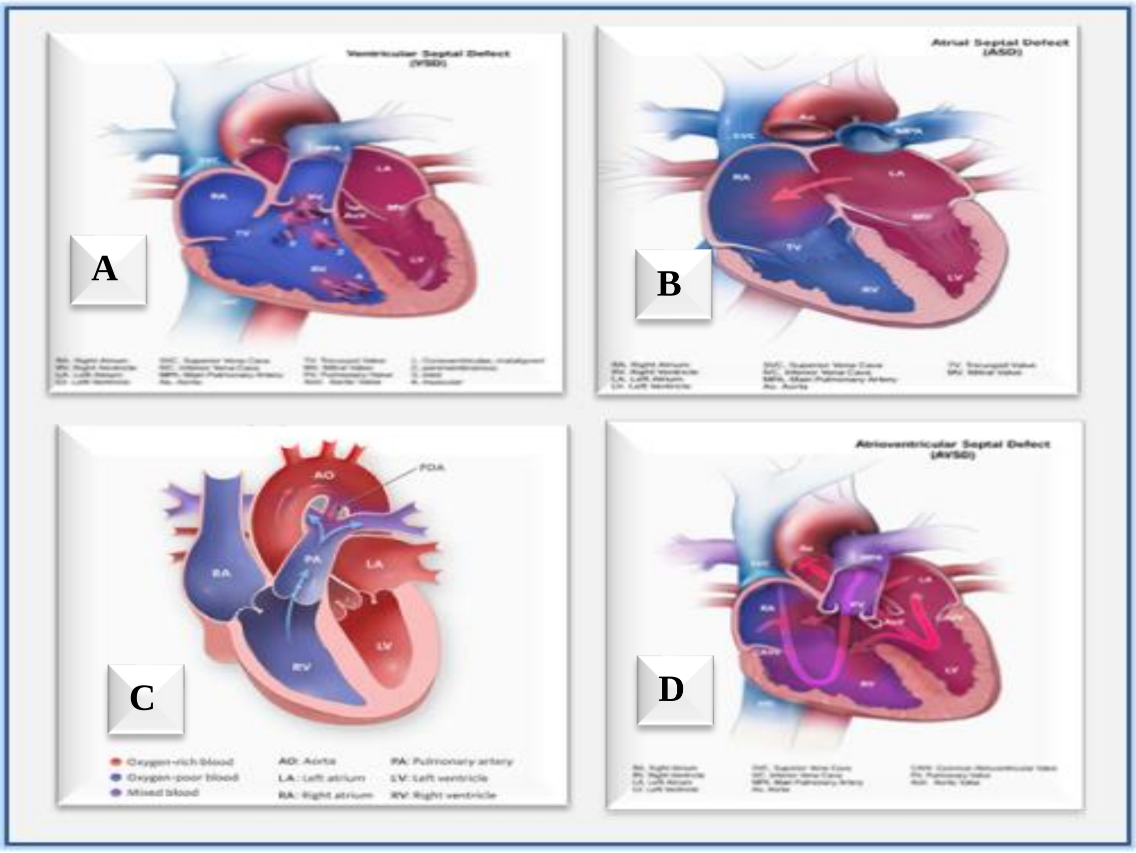
Fig: (2-4) Classification types of CHD (Hockenberry et al., 2021).

2.7.1. Acyanotic congenital heart defects that increased pulmonary blood flow

Leaks occur from the left side to the right side, distinguishing lesions. The left-right shunt refers to the phenomenon when oxygenated blood enters the circulation with low oxygen levels, bypassing the tissue. The conditions mentioned are atrial septal defect (ASD), ventricular septal defect (VSD), PDA, and atrioventricular canal anomalies (Rohit et al., 2017).

2.7.1.1. An atrial septal defect (ASD)

Characterized by an anomalous aperture between the atria of the heart. This aperture permits the passage of oxygenated blood from the left atrium to the right atrium, bypassing the left ventricle. Consequently, oxygen-rich blood combines with oxygen-poor blood (Siemieński, 2019).



Fig(2-5): Acyanotic congenital heart defects that increased pulmonary blood, A: atrial septal defect (ASD), B:ventricular septal defect (VSD), C:Patent ductus arteriosus (PDA) D:Atrioventricular septal defect (CDC, 2022).

2.7.1.2. A ventricular septal defect (VSD)

A structural abnormality in the heart known as an interventricular septal defect allows oxygenated blood from the left ventricle to flow back into the right ventricle rather than out through the aorta (Micheletti, 2019).

2.7.1.3. Patent ductus arteriosus (PDA)

The fetal ductus arteriosus, a connection between the aorta and the pulmonary artery, fails to close during the initial weeks of life. This blood vessel stays open all the time, so blood can flow from the high-pressure aorta to the low-pressure pulmonary artery. This creates a left-right shunt (Hockenberry et al., 2021).

2.7.1.4. Atrioventricular septal defect

A small atrial septal defect (ASD) that is in line with a large VSD, as well as the fissures of the mitral and tricuspid valves. These fissures combine to form a sizable central atrioventricular (AV) valve, facilitating the circulation of blood among the four chambers of the heart. The resistance in the pulmonary and systemic systems, the pressures in the left and right ventricles, and the elasticity of each ventricle govern the direction and pathways of flow. However, flow often happens from the left side to the right side. The prevalence of this cardiac anomaly is highest among children diagnosed with Down syndrome (Micheletti, 2019).

2.7.2. Acyanotic congenital heart defects that obstruction to blood flow from ventricles

Obstructive defects occur when blood flowing from the heart contacts a small region (stenosis) within the anatomical structure, causing a blockage in the blood flow. The stenosis causes an increase in pressure in the ventricle and major artery located before it, whereas the pressure in the area behind the stenosis drops (Hockenberry et al., 2021).

Acyanotic obstructive congenital heart disease typically manifests in older children and adults. However, it can show as a serious condition in newborns, necessitating prompt intervention such as balloon dilation in cases of pulmonary and aortic valve stenosis (Rohit et al., 2017).

2.7.2.1. Coarctation of the aorta (CoA)

Refers to the narrowing of the aorta. Encompasses the process of aortic constriction, resulting in reduced blood flow as the arteries diverge to distribute blood to the body by alternate routes. Aortic stenosis results in elevated blood pressure and heart rate in the upper body while causing reduced blood pressure and heart rate in the lower body (fig: A) (Siemieński, 2019).

2.7.2.2. Aortic stenosis

Aortic valve stenosis is a condition where the aortic valve becomes narrowed or constricted, leading to reduced blood flow from the left ventricle, decreased cardiac output, enlargement of the left ventricle, and congestion in the pulmonary blood vessels. characterized by a gradual increase in blockage. This condition can lead to rapid bouts of myocardial ischemia or inadequate cardiac output, which can ultimately result in sudden death (fig: B) (Hockenberry et al., 2021).

2.7.2.3. Pulmonary stenosis

Characterized by the constriction of the pulmonary artery, which is responsible for transporting blood from the heart to the lungs (fig: C). Blood flow resistance narrows the pulmonary artery at its entrance, resulting in a decrease in pulmonary blood flow and the growth of the right ventricle. Pulmonary atresia is the most extreme manifestation of pulmonic stenosis (PS) (Micheletti, 2019).

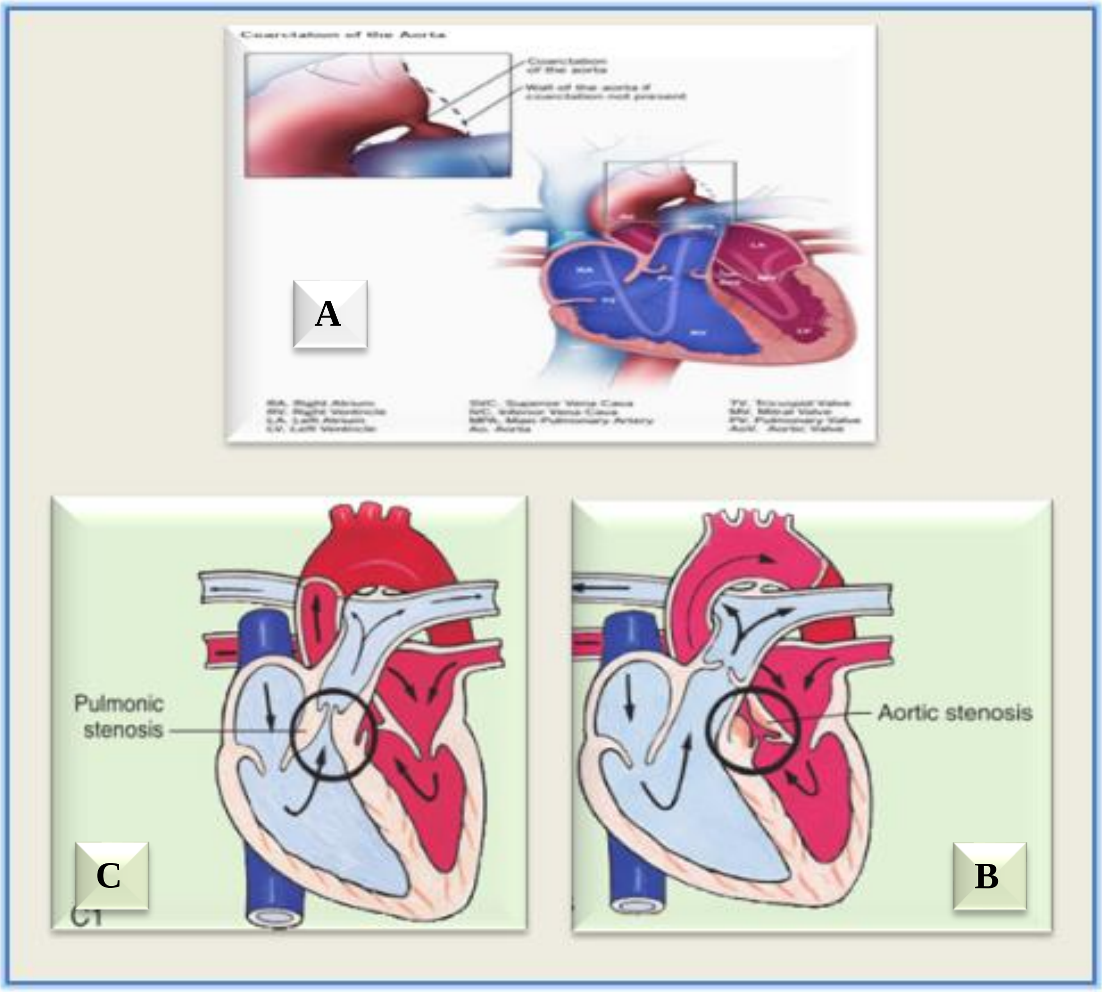


Fig2-6: acyanotic congenital heart defects that Obstruction to blood flow from ventricles, A: Coarctation of the aorta (CoA), B: Aortic stenosis, C: Pulmonary stenosis (CDC, 2022).

Cyanotic congenital heart disease (CCHD) is an anomaly in the development of the heart and great vessels, characterized by the desaturation of arterial blood with oxygen, which is responsible for the blue coloration of the mucous membranes and the integuments, or cyanosis, characterized by a left shunt, after which oxygen-poor blood enters the oxygen-containing parts of the vascular circulation (Rohit et al., 2017).

2.7.3. Cyanotic congenital heart defects that decreased pulmonary blood flow

There are structural problems (like an atrial septal defect or ventricular septal defect) between the right and left sides of the heart that can cause reduced pulmonary blood flow anomalies. This happens when blood flow is blocked in the lungs. As a result of the difficult passage of blood from the right side of the heart through the pulmonary artery, the pressure on the right side increases and exceeds the pressure on the left side. This facilitates flowing deoxygenated blood from the right side of the heart to the left side, resulting in a reduction of oxygen levels in the left side of the heart as well as in the overall circulation of the body. Clinically, these patients display hypoxemia and commonly present with cyanosis. The most common anomalies observed in this specific group are tetralogy of Fallot and tricuspid atresia (Hockenberry et al., 2021).

2.7.3.1. Tetralogy of Fallot

This condition includes four problems at the same time: a ventricular septal defect (a hole between the heart's lower chambers), a partial obstruction in the right side of the heart (specifically, the right ventricle and pulmonary valve), which stops blood from getting to the lungs; the aorta being in the wrong place so it covers the ventricular septal defect; and the right ventricle being abnormally thickened (Siemieński, 2019).

2.7.3.2. Tricuspid atresia

The tricuspid valve fails to form, resulting in the absence of a connection between the right atrium and the right ventricle. Blood circulates through an atrial septal defect (ASD) or patent foramen ovale on the left side of the heart and then passes through the ventricular septal defect (VSD) into the right ventricle and lungs (Yürük & Cetinkaya, 2023).

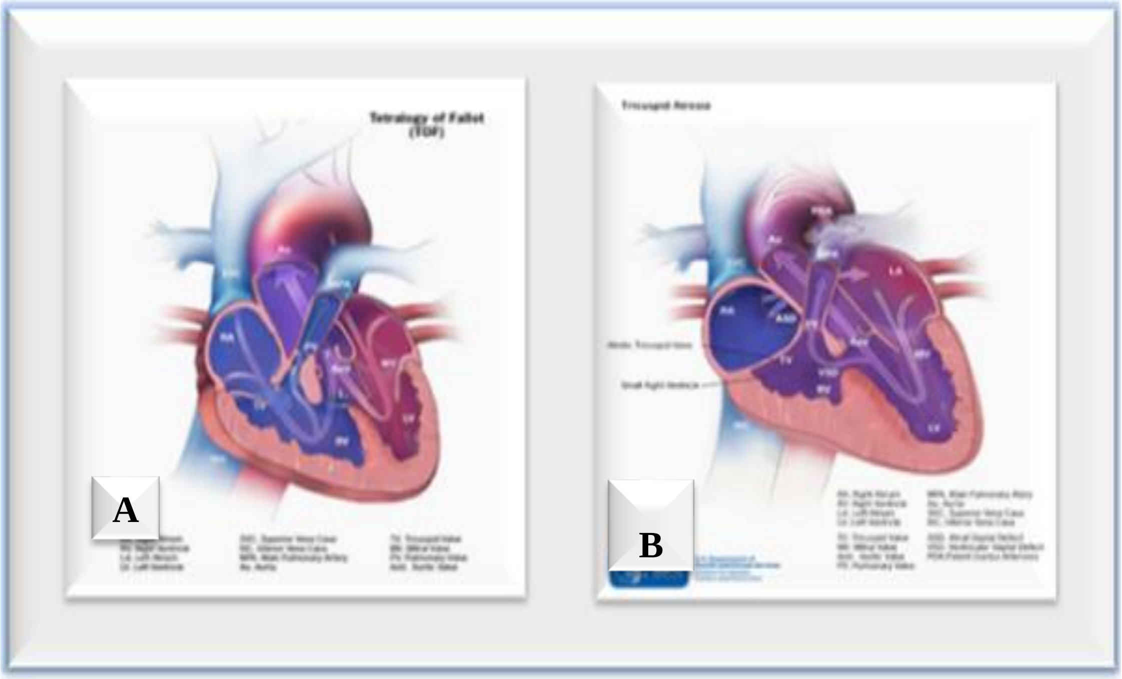


Fig 2-7: Cyanotic congenital heart defects that decreased pulmonary blood flow, A: Tetralogy of Fallot, B: Tricuspid atresia (CDC, 2022).

2.7.4. Cyanotic congenital heart defects that mixed blood flow

A mixed blood flow defect occurs when fully oxygenated blood from the body combines with oxygen-depleted blood from the lungs, resulting in a reduction in the oxygen saturation of the body's blood. Pulmonary congestion occurs as a result of differences in pressure between the pulmonary artery and the aorta, which enable blood circulation in the lungs. Increased ventricular capacity results in a reduction in the amount of blood pumped by the heart per unit of time. The patients have various clinical manifestations, which may include a certain degree of desaturation and signs of heart failure (Hockenberry et al., 2021).

2.7.4.1. Transposition of the great arteries (TGA)

It is acondition in which the pulmonary artery and the aorta, two major arteries that carry blood out of the heart, switch positions. Dextro-transposition of the great arteries (d-TGA) is the most prevalent condition, characterized by the reversal or transposition of the pulmonary artery and aorta. Within a healthy cardiovascular system, the pulmonary artery transports blood that lacks oxygen to the lungs for the purpose of oxygenation, whereas the aorta is responsible for conveying oxygenated blood from the lungs to all parts of the body. The reversal of these arteries leads to the dispersion of deoxygenated blood throughout the body. Levo-transposition of the great arteries (l-TGA) is a cardiac condition where the right and left lower chambers and great arteries of the heart are completely reversed (Siemienski, 2019).

2.7.4.2. Total anomalous pulmonary venous return

A lack of communication between the pulmonary veins and the left atrium characterizes pulmonary venous atresia, an uncommon anomaly. Still, there is a strange connection between the pulmonary veins and the systemic venous circulation. This connection happens through the right atrium or other veins that bring blood into the right atrium, like the superior vena cava. Because of the strange connection, a mixture of blood flows backwards into the right atrium and then goes from right to left through the atrial septal defect (ASD) (Bernstein, 2019).

2.7.4.3. Truncus arteriosus

This condition occurs when there is either partial or complete separation between the aorta and pulmonary artery. The majority of the blood originating from the left atrium passes through the patent foramen ovale into the right atrium, thereafter flowing through the right ventricle and exiting the body via the pulmonary artery. The descending aorta gets blood from the patent ductus arteriosus, which facilitates the distribution of blood throughout the body's systemic circulation (fig: C) (Hockenberry et al., 2021).

2.7.4.4. Hypoplastic Left Heart Syndrome (HLHS)

A medical condition characterized by underdevelopment of the left side of the heart. The left ventricle has significant hypoplasia, which can be caused by atresia, stenosis, or hypoplasia of the aortic and/or mitral valves. The ascending aorta and arch have also not fully developed. Most of the blood that comes from the left atrium flows through the patent foramen ovale into the right atrium, right ventricle, and pulmonary artery. The descending aorta gets blood from the patent ductus arteriosus, which facilitates the circulation of blood throughout the body (refer to figure D) (Micheletti, 2019).

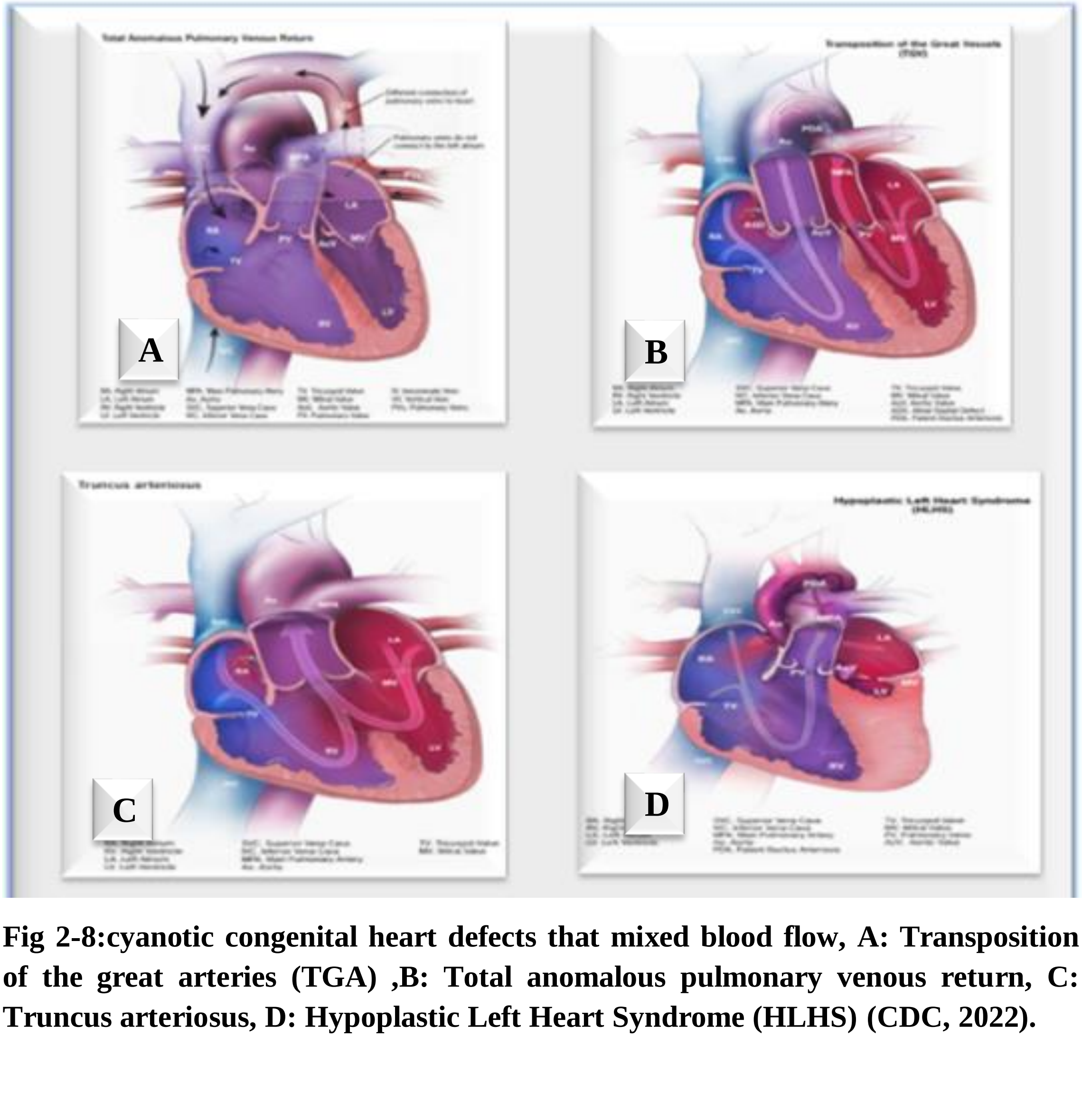


Fig 2-8:cyanotic congenital heart defects that mixed blood flow, A: Transposition of the great arteries (TGA) ,B: Total anomalous pulmonary venous return, C: Truncus arteriosus, D: Hypoplastic Left Heart Syndrome (HLHS) (CDC, 2022).

A clinical setting, this system presents a challenge, as children with cyanotic anomalies may experience the development of cyanosis. Furthermore, individuals with cyanotic abnormalities may exhibit a rosy complexion and display a greater number of clinical symptoms associated with heart failure. Given the intricate nature of numerous abnormalities and the variety of their clinical manifestations, the cyanosis classification system has been deemed insufficient and deceptive. A more practical categorization approach is founded on hemodynamic attributes, which pertain to the movements associated with blood circulation (Hockenberry et al., 2021).

Table (2-1) : Relative prevalent of Major Congenital Heart Lesions (Bernstein D. 2019)

LESION	% OF ALL LESIONS
Ventricular septal defect	35-30
Atrial septal defect (secundum)	6-8
Patent ductus Arteriosus	6-8
Coarctation of aorta	5-7
Tetralogy of Fallot	5-7
Pulmonary valve stenosis	5-7
Aortic valve stenosis	4-7
D-Transposition of great arteries	3-5
Hypoplastic left ventricle	1-3
Hypoplastic right ventricle	1-3
Truncus Arteriosus	1-2
Total anomalous pulmonary venous return	1-2
Tricuspid atresia	1-2
Single ventricle	1-2
Double-outlet right ventricle	1-2
Others	5-10

2.8. Nutritional status of neonates with congenital heart disease.

Studies indicate that breastfeeding could be a viable choice for infants with congenital heart disease. However, there are still concerns regarding the amount of energy expended during breastfeeding, which has traditionally been believed to be higher than bottle feeding. It is crucial to evaluate the frequency and duration of feeding, as well as the preparation method, to prevent any complications that may arise from improper preparation. Both over-dilution and over-concentration can lead to inadequate growth, disturbances in electrolyte levels, and damage to the gastrointestinal system (Luca et al., 2022).

Infants who have congenital heart disease are more likely to experience malnutrition and growth deficits, which can have detrimental long-term effects on their neurological development. currently, there is insufficient research addressing the nutritional strategy for these patients and no guidelines are currently accessible. Nevertheless, the literature emphasizes the significance of diet in the management of infants with coronary artery disease (Mangili et al., 2018).

A newborn baby at full-term typically needs an initial intake of 40 to 60 kilocalories per kilogram per day, which gradually increases to 90 to 120 kilocalories per kilogram per day. The recommended daily carbohydrate intake is 9 to 14 grams per kilogram of body weight per day, which should make up 40 to 50% of total calorie intake. Protein intake should be 1.8 to 2.2 grams per kilogram of body weight per day, accounting for 7 to 16% of total calorie intake. Lipid intake should be 4 to 6 grams per kilogram of body weight per day, making up 34 to 35% of total calorie intake (Luca et al., 2022).

Most neonates with CHD are born with a normal weight for their gestational age. However, they often have nutritional and growth deficiencies during the early months of life. The occurrence of malnutrition in babies with CHD is affected by both cardiac and extracardiac factors (Karpen, 2016).

Infants with congenital heart disease should have their daily calorie intake increased by up to 50%, as long as it does not exceed a fluid volume of 150 ml/kg/day. In addition, their daily protein needs may reach up to 3 grams per kilogram per day (Luca et al., 2022).

2.8.1. There are basically three organ systems that can be examined to determine the nutrition of a newborn with CHD:

The most apparent system is the cardiorespiratory system. Infants who are at a high risk of severe heart failure, such as those with hypoplastic left heart syndrome, may have a rapid breathing rate that makes it unsafe for them to be fed orally. They may also have restrictions on their fluid intake due to their increased metabolism and greater calorie needs. Occasionally, it can lead to respiratory dysfunction and hinder the ability to consume meals orally (Tsega et al., 2022).

The gastrointestinal system is the second system. For instance, gastrointestinal functions can be hindered as a result of decreased reflexes, diminished sensory inputs, hypoxemia, neurological injury, or ischemia damage to the gut. Consequently, the intestinal function may be compromised, which can contribute to increase morbidity risks. During hypothermic cardiac bypass, patients often have low blood pressure and less blood flow to the colon. This makes it harder for the body to absorb nutrients and makes the intestines more permeable (Maynord et al., 2021).

Infants born with congenital cardiac disease are more likely to experience neurological complications. Infants born with congenital cardiac disease face a heightened vulnerability to central nervous system traumas, including bleeding or stroke (Peyvandi & Rollins, 2023).

2.9. Nutritional challenges for cardiopathic newborns.

In these patients, there is an increase in myocardial oxygen consumption to 20–30% of the body's total oxygen consumption, instead of the usual 10%, due to the occurrence of ventricular hypertrophy and dilatation. Newborns with congenital cardiac disease that affects blood flow require more substantial dietary support than healthy newborns. The energy intake can range from 130 to 150 kcal/kg/day and 175 to 180 kcal/kg/day, depending on the specific kind of congenital cardiac disease (Salvatori et al., 2022).

While resting energy expenditure (REE) remains within normal levels or slightly raised, total energy expenditure experiences a considerable increase, especially during critical illness. Several factors contribute to this process: heightened metabolic requirements resulting from heart failure (often accompanied by respiratory failure and insufficient tissue oxygenation), the physiological strain of surgery, impaired nutrient absorption, and inadequate calorie consumption (Mangili et al., 2018).

Illustrates three hemodynamic pathways that impact nutrition and growth retardation. Hypoxia can occur in several congenital heart defects, such as dual right ventricular outflow (DORV), TGA, TOF, pulmonary atresia/pulmonary stenosis (PA/PS), aberrant pulmonary venous return (APVR), and critical aortic valve obstruction (CAVO). Hypoperfusion can occur in conditions such as aortic interruption (AI), CoA, critical aortic valve obstruction (CAVO), TA, hypoplastic left heart syndrome (HLHS), and PDA. Excessive blood flow, as seen in conditions like VSD, ASD, PDA, complete atrioventricular septal defect (CASD), and truncus arteriosus (Salvatori et al., 2022).

Infants with CHD are frequently critically unwell, as they require surgical intervention. As a result, there is elevation in the breakdown and replacement of proteins. The objectives of nutrition for critically sick patients are to guarantee sufficient protein consumption to promote wound healing, regulate the inflammatory response, and preserve muscle mass. Nevertheless, in newborns diagnosed with CHD, about half of the cases exhibit malnutrition and chronic protein shortage. Only 68% and 40% of the recommended energy and protein requirements are reached, respectively (Mangili et al., 2018).

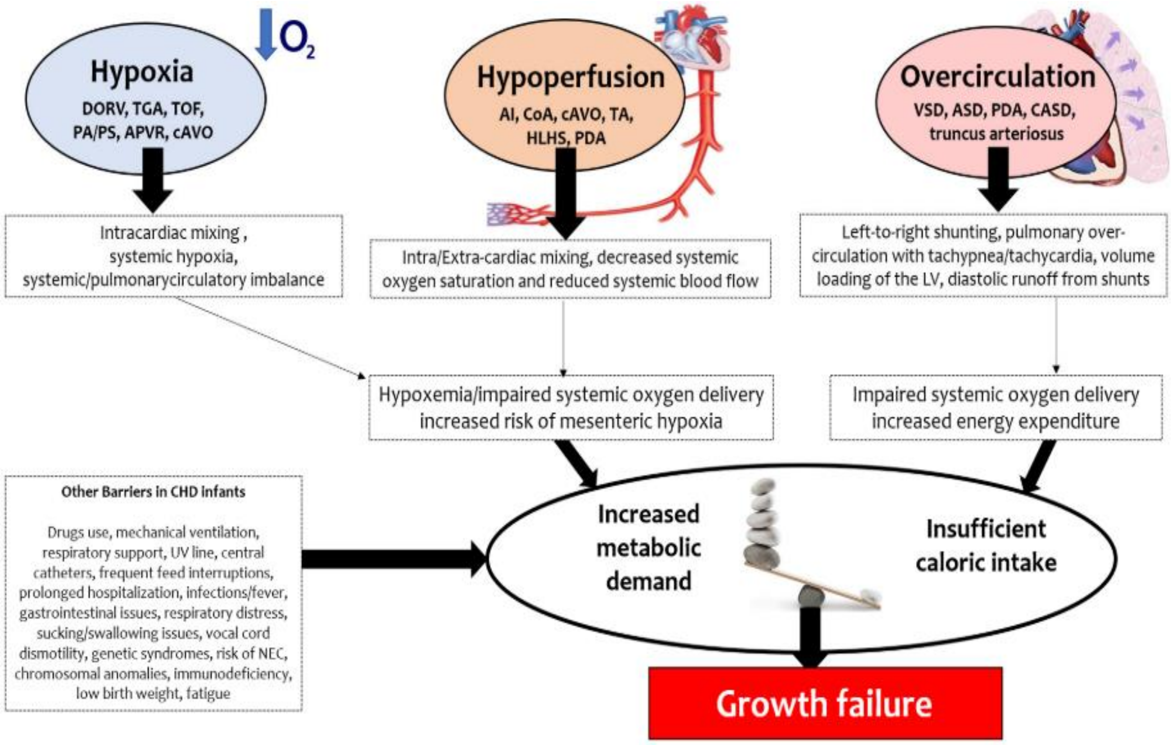


Fig2-9: Influence of hemodynamic mechanisms on nutrition and growth retardation

The heightened metabolic demand in coronary artery disease is ascribed to the amalgamation of persistent oxygen deprivation, heightened cardiovascular and respiratory effort, accumulation of blood in the veins, elevated pressure in the pulmonary artery, and the release of catecholamines (Salvatori et al., 2022).

The American Society for Parenteral and Enteral Nutrition's latest clinical guidelines for nutrition in critically ill children establish that infants aged 0 to 2 years should consume 2–3 grams of protein per kilogram of body weight each day. During the critical period, preterm newborns require a higher amount of protein, specifically 3.5 to 4 grams per kilogram per day, in order to support their growth (Mangili et al., 2018).

2.10. Malnutrition of neonates with congenital heart disease.

Congenital heart disease (CHD) is a structural and functional anomaly that occurs during embryogenesis (Luca et al., 2022). It is the most common birth defect, affecting approximately 0.8% of live births, and many require surgery in infancy (Herridge et al., 2021). CHD are a known cause of malnutrition (Luca et al., 2022).

Malnutrition affects a significant proportion of children with CHD, with a prevalence ranging from 25% to 55%. Furthermore, it has been reported that around 80% of these infants require hospitalization (Yürük & Cetinkaya, 2023).

The cause of these nutritional disorders is multifactorial and includes both cardiac and noncardiac factors that cause energy imbalance, which includes important aspects such as metabolic needs, energy expenditure, intake or intestinal absorption. Total energy expenditure (TEE) is increased in newborns with congenital heart defects who have not undergone surgery (Tsintoni, 2020).

The etiology of feeding impairment or the timing of the acquisition of feeding skills in infants with congenital heart disease remains poorly understood. A scoping review revealed a prevalence of 42.9% for feeding and swallowing difficulties in infants and children with congenital heart defects, with 32.9% reporting aspiration. A different study found that 28.7% of infants with CHD were not receiving oral nutrition when they were discharged (Norman et al., 2022).

Mechanisms of increased metabolic demand include increased work of breathing, left-right shunts that increase the workload of the heart, increased pulmonary artery pressure, and increased catecholamine secretion. age and timing of cardiac surgery influence the potential to restore good nutrition (Tsintoni, 2020).

Early detection and timely, appropriate intervention, combined with frequent screening, are critical to reducing morbidity and mortality associated with malnutrition. However, current practices in nutritional assessment and management of newborns with congenital heart disease are heterogeneous and vary between health facilities and hospitals (Centeno, 2023).

Infants born with CHD experience malnutrition as a result of inadequate dietary consumption and heightened nutritional requirements. Resting energy consumption is increased, leading to higher energy requirements (Singal et al., 2022).

Fifteen percent of children with CHD have moderate or severe malnutrition. This is more common in cases where there is pulmonary hypertension due to increased pulmonary blood flow or left heart stenosis. Half of these newborns have a low amount of caloric intake, and only a small number receive support to sufficient nutritional (Blazquez et al., 2016).

2.11. Physiological challenges faced by neonates with CHD

Neonates with CHD face several physiological challenges. It is highlight the importance of comprehensive care for newborns with CHD, addressing their unparalleled medical needs, and ensuring their well-being. which can be in general classified into the following categories: Homeostasis challenges neonates with complex CHD have markedly different homeostasis challenges compared to premature, which may impact their length of stay at the hospital (Lisanti et al., 2023).

Tran et al., (2022) reported that the circulatory challenges infantes with CHD may experience hypotensive, which can be a sign of cardiac dysfunction.

The heightened metabolic requirements observed in individuals with congenital cardiac anomalies can be due to a mix of many factor, including persistent hypoxia, elevating cardiopulmonary exertion, venous congestion, increased pulmonary arterial pressure, and the release of catecholamines. In these children patients, there is a periodic occurrence of ventricular dilatation and hypertrophy, which leads to an increased the myocardial oxygen consuming. This increased account for 20% to 30% of the body's total oxygen consuming, as opposed to the usual 10%. Consequently, children patients with hemodynamically significant congenital heart anomalies require greater nutritional support than healthy newborns (Salvatori et al., 2022).

2.12. Feeding newborns with congenital heart defects and physiological stability.

Hoffman, (2016) reported that the neonate born with CHD may experience feeding challenges, which consequently increased their susceptibility to developmental and growth issues. The groups in question faces challenges in maintaining physiological stability while feeding, as they often struggle with coordination in breathing, swallowing, and deglutition. This might result in an excessive expenditure of energy during feeding.

The fetus exhibits coordinated and periodic movements of closing and opening its jaw, followed by swallowing actions, which indicate the consumption of amniotic fluid which may starting at 14 weeks. Fetal sucking and swallowing serve both preparatory and functional purposes, as they are key regulators of the volume of amniotic fluid. Furthermore, the act of fetal sucking and swallowing alters the makeup of the fluid present in the nasal and laryngeal channels. In the third trimester, there is an increase in sucking behavior, and the volume of amniotic fluid consumed also rises to 500 ml per day. It is anticipated that these swallowing and sucking abilities will be fully operational in healthy, full-term newborns upon birth (Einspieler et al., 2021).

Infants with congenital cardiac disease often experience challenges with swallowing and feeding, Professional clinicians must possess the ability to assess and scrutinize these systems in order to formulate a suitable treatment strategy aimed at enhancing oral feeding proficiency and ensuring safety (Desai et al., 2023).

2.13. Neonate feeding method.

The trajectory of growth and maturation in newborns aged 0-3 years will have a profound impact on their overall health over their entire lifespan. Malnourishment at this period will adversely affect their future growth, development, and intellectual progress. The newborn era is the crucial stage in an individual's life. Thus, implementing an early and appropriate feeding regimen not only guarantees optimal nutritional status in newborns but also boosts their immunity and resilience, thereby contributing to the promotion of good health and the prevention of chronic diseases in adulthood. Early techniques of feeding infants include nursing, combination feeding, and artificial feeding. During nursing, the only source of nourishment is breast milk, and no other fluids are consumed (Xiaoli et al., 2022).

The feeding techniques may encompass breastfeeding, the use of donor milk, formula feeding, and the introduction of complement foods. During the infancy stages, the feeding practice significantly contribute to a infant's optimal growth, overall development, and well-being (WHO, 2020).

The age of a newborn after delivery is strongly correlated with their ability to acquire milk in a safe and efficient manner (Kotowski et al., 2020).

In the context of this study, the term "infant feeding practices" pertains to many procedures employed to supplement nourishment to the infant. Infants feeding techniques significantly impact a child's health and early growth. Globally, the WHO advise that breast-feeding is the preferred methods of feeding for infants who are less than six months of old (WHO, 2020).

2.13.1. Neonate breast feeding method.

The WHO and the United Nations International Children's Emergency Fund (UNICEF) advise that neonates should be exclusively breastfeeding during the initial six months of age from their lives. Nutritionally appropriate and safe solid foods to infants after six months of old. It is also advised to continue breastfed until the infants reaches at least two years of age or older (WHO, 2018).

According to global data, the mortality risk for newborns who are exclusively breastfed is 12% lower compared to infants who are not nursed (Moss, 2022).

Breastfeeding significantly decreases infant mortality and the occurrence of serious health conditions such as severe acute malnutrition (SAM), pneumonia, diarrhea, and allergies during the first six months of a newborn's life (WHO, 2019).

Exclusive breastfeeding (EBF) has enduring health advantages for both newborns and moms. Infants gain from it as it decreases neonatal mortality, lowers the risk of childhood obesity, and promotes growth and cognitive development. Mothers also benefit from it as it reduces the risk of breast and ovarian cancers (Mekebo et al., 2022).

For an infant's healthy growth and development, breast milk is the perfect nutrition. Breast milk's immunoglobulin is an essential element in helping newborns struggle with illness; it could enhance immunity, intelligence, and mother-infant emotions for infants (Xiaoli et al., 2022).

Exclusive breastfeeding: the infant receives only breast milk from the mother (Morley et al., 2019).

Breast milk contains significant amounts of immunoglobulin A, proteins, and amino acids, which effectively reduce the likelihood of developing respiratory and autoimmune illnesses (Luca et al., 2022).

2.13.2. Neonate formula feeding method.

When a newborn is bottle-fed, they receive liquids from a bottle, such as breast milk, formula, and non-human milk (Morley-Hewitt et al., 2019). When nursing is not feasible due to various circumstances, formula milk is the only option utilized (Xiaoli et al., 2022).

When fluid intake volume is restricted, concentrated feeding formula which may include a high-calorie formula or fortified human milk is a means to provide additional calories and nutrients (Luca et al., 2022).

2.13.3. Neonate-mixed feeding method.

The benefits of both artificial and breastfeeding nutrition are combined in mixed feeding, It can lessen an infant's over-reliance on breast milk, compensate for deficiencies in the early stages of exclusive breastfeeding, and postpone the introduction of complementary foods. In terms of infants' intellectual and physical development, it is superior to artificial feeding and breastfeeding (Xiaoli et al., 2022).

2.14. Effect of various feeding techniques on essential physiological indicators.

The search results indicate that various feeding strategies can affect important factors including oxygen saturation, pulse rate, and respiratory effort in infants with congenital cardiac abnormalities. Research has indicated that breastfeeding is a more natural and biologically appropriate way of feeding premature infants, whereas bottle-feeding may induce higher levels of stress (Hill et al., 2020).

Patel et al., (2022) founded that preterm infants who are bottle-fed experience increased cardiorespiratory effort. During bottle feeding, the respiratory rate is reduced while the newborn is actively sucking, and it increases during breaks (Issac & Choi, 2022). In infants with congenital heart disease, bottle-feeding has been associated with lower oxygen saturations compared to breastfeeding (Marino et al., 1995).

Nevertheless, a study conducted on healthy full-term newborns did not notice significant fluctuations in oxygen saturation levels while breastfeeding. However, a decrease in oxygen saturation below 90% was noted after feeding (Niaz et al., 2021).

Additional investigation is required to comprehend the impact of various feeding techniques on essential indicators in newborns with congenital cardiac abnormalities (Hoffman, 2016).

2.15. Early feeding skill of neonatal with congenital heart defects.

Infants who are born full-term and have CHD face a significant chance of experiencing developmental and nutritional challenges. These issues arise from a mix of factors, including underdeveloped brain structures, early surgical procedures, complications after surgery, and changes in their routine care. Congenital heart disease in newborns frequently leads to neurobehavioral immaturity that resembles that of premature infants. This can make it challenging for them to attain stability in their physiological and behavioral subsystems (Desai et al., 2019).

In general, the approach to assessing oral feeding capabilities in neonatal units is based on monitoring the daily volume consumed by suction, the number of feedings performed daily by suction, reducing adverse events during nutrient suction (apnea, oxygen desaturation, inadequate alertness when the baby falls asleep or cries), and daily weight gain (Zinoni et al., 2021).

As a consequence, individuals have diminished arousal, irregular muscular tone, and impaired state regulation, which hinders their readiness for oral feeding and impedes their advancement in oral feeding abilities (Desai et al., 2019).

2.16. Feeding abilities of neonatal with congenital heart defect

Children with cyanotic congenital heart defects often exhibit significantly impaired growth in comparison to children with acyanotic congenital heart defects (Maya et al., 2020).

We can attribute the differences in nutritional capacity between acyanotic and cyanotic heart disorders to the diverse nature of heart disease development and the resulting variations in treatment techniques needed to address their specific pathophysiological requirements. The intensity of treatment and support techniques varies according to the nature and degree of the lesion. Neonates with acyanotic congenital heart disease require fewer interventions compared to those with cyanotic congenital heart disease. Length of time for which respiratory assistance is required, the administration of narcotics, the use of vasopressors, the necessity for cardiac bypass, or the chosen enteral tube feeding methods may all reflect these factors. that have the have the potential to affect the achievement of feeding milestones (Luca et al., 2022).

Those diagnosed with acyanotic CHD have a higher probability of achieving normal developmental outcomes compared to those diagnosed with cyanotic CHD (Melani et al., 2023).

Due to energy waste and the presence of neurological, motor, gastrointestinal, endocrine, and renal developmental issues linked to complex cardiac malformations, newborns with congenital heart abnormalities face challenges in starting and maintaining an effective diet (Luca, 2022).

Nutritional status due to the inability to feed often leads to an imbalance in energy intake and thus stunted growth. Due to impaired cardiorespiratory function, these children may experience prolonged feeding or anorexia and food refusal. Feeding difficulties may not be associated with difficulty swallowing in the mouth and throat (Rosa, 2014).

There are basically three organ systems that can be examined to determine the nutrition of newborn with congenital heart disease: The most obvious is the cardiorespiratory system. Infants at risk of significant heart failure, such as those with hypoplastic left heart syndrome, may simply breathe too rapidly to allow safe oral feeding or may experience fluid restriction due to their increased metabolism and higher calorie intake need food. Sometimes, it can cause respiratory impairment and a negative impact on oral food intake (Jadcherla et al., 2009).

Ensuring optimal nutrition is crucial for improving the immediate and long-term outlook for infants with congenital cardiac abnormalities. Implementing standardized enteral and/or parenteral feeding protocols, tailored to the specific systemic implications of the heart defect, has the potential to enhance both short- and long-term outcomes (Luca, 2022).

2.17. Neonate with congenital heart defect feeding method.

Optimal feeding is essential for neonates with congenital cardiac abnormalities to promote both appropriate growth and enhance immunity and postoperative recovery. However, newborns with congenital heart defects typically have difficulty ensuring adequate nutritional intake due to feeding difficulties (Torowicz et al., 2015).

Infant feeding methods encompass the provision of nutrients and nourishment to an infant throughout their life. Proper nutrition, health, and development for infants are considered fundamental practices. Infant feeding practices are also referred to as strategies by which the infant receives optimal nutrition Stabilization before interventions (Yun, 2021).

Stabilizing neonates with CHD preoperatively allows for safer surgical or catheterization-based interventions. Ensuring physiological stability is a critical aspect of their care, particularly in the context of surgical interventions (Tran et al., 2022).

Many infants have inadequate energy intake prior to cardiac surgery due to swallowing difficulties such as dysphagia with uncoordinated sucking and swallowing, loss of appetite, vomiting, rapid heartbeat, delayed feeding signals and food cravings, and increased metabolism. Furthermore, gastrointestinal problems make feeding newborns with congenital heart defects even more difficult. Underdevelopment and inflammation of the digestive system hinder the process of breaking down and absorbing vital nutrients, resulting in consequences such as necrotizing enterocolitis and an elevated number of hospital admissions. The feeding behaviors of infants with congenital cardiac disease, namely the choice between formula and breast milk, vary (Siemienski, 2019).

The process of hospitalization can induce significant stress for both parents and physicians. However, it is noteworthy that this stress can have a direct influence on the ability of mothers to breastfeed or express breast milk for their infants. Dietary choices can impact the health of a child with congenital cardiac disease in both the short and long term (Torowicz et al., 2015).

Breast milk provides optimal nutrition for newborns, and its benefits are even greater for premature or sick newborns. The numerous benefits of breast milk, such as: reducing the incidence of chronic and infectious diseases, improving cognitive functions and providing benefits for growth and development (Perrella et al., 2021).

Consuming a diet only consisting of human milk provides numerous advantages to the infant, such as a reduced susceptibility to infection and the occurrence of necrotizing enterocolitis, as well as a decreased duration of hospitalization. The occurrence of necrotizing enterocolitis in term infants is infrequent. However, among neonates with congenital heart disease, the estimated prevalence of necrotizing enterocolitis ranges from 1.62% to 7.8%. While human milk (HM) is the preferred source of sustenance for infants, it is unclear how often infants with CHD in intensive care units receive human milk. Given the limited information available on maternal health (MH) and the direct breastfeeding of infants with congenital heart disease (CHD), it is crucial to comprehend the trends in breastfeeding initiation and continuation among mothers of infants with CHD (Torowicz et al., 2015).

2.17.1. Breastfeeding Infants with Congenital Heart Disease.

Previously, it was believed that breastfeeding was too physiologically challenging for an infant with CHD, as it would cause the child to experience more respiratory strain compared to bottle-feeding. However, a study by Marino et al. (1995) discovered that infants with CHD had higher and more consistent blood oxygen saturation levels while nursing compared to bottle-feeding. This suggests that breastfeeding reduces cardiorespiratory stress in infants, regardless of whether they are healthy or have a non-contraindicated chronic condition (Russel, 2021).

The American Academy of Pediatrics, the World Health Organization, the American Dietetic Association, and the American College of Obstetricians and Gynecologists all support the recommendation of exclusively breastfeeding infants for the first 6 months of their lives. After that, a combination of breastfeeding and the introduction of complementary foods should continue until the child is at least 12 months old. Breast milk is widely regarded as the optimal choice for nourishing infants, as it contains essential nutrients and other substances that have physiological advantages for the baby (Siemienski, 2019).

Encourage breastfeeding mothers to alternate feedings of breast milk and high-calorie formula. Some lactating mothers prefer to feed their children expressed breast milk fortified with Similac or Enfamil powder, polycose, or corn oil to increase caloric intake (Hockenberry et al., 2021).

Postoperative breastfeeding is both efficacious and secure for neonates following cardiac surgery. Breastfeeding in these infants has several advantages over formula feeding. It enhances feeding tolerance, promotes quick weight gain, improves nutritional status, lowers the risk of gastrointestinal issues, and reduces the time of hospital stay (Xian, 2020).

2.17.2. Formula feeding Infants with Congenital Heart Disease.

Administering a concentrated formula to infants may enhance their weight gain, promote growth, and improve their nutritional health following surgery for congenital heart disease (Aryafar et al., 2022).

Energy- or protein-rich diet shows promise in addressing malnutrition in children following congenital heart surgery. Nevertheless, the impacts of a diet that is rich in energy or protein have been well examined in this particular group. The scientific data ware assessed to have a moderate to high level of certainty, indicating that a diet that is rich in energy and/or protein may be considered safe for children who have undergone congenital heart surgery. Furthermore, this intervention enhances nutritional status and reduces the time spent on mechanical ventilation as well as the duration of hospitalization in both the critical care unit and the general hospital setting. Nevertheless, the overall finding of this meta-analysis must be validated in a patient population with diverse cardiac physiology (Ni, 2023).

The calorie density of formulas is often increased by concentrating and then adding polycose (or, less commonly, corn oil or medium-chain triglyceride oil). Infant formula provides 20 kcal/oz and the use of additives can increase calories to 30 kcal/oz or more. This allows the baby to consume more calories despite consuming less formula. The calorie density of infant formula should be increased slowly (2 kcal/ounce/day) to prevent diarrhea or formula intolerance (Hockenberry et al., 2021).

2.17.3. Gavage feeding Infants with Congenital Heart Disease.

Around 30-50% of infants who receive neonatal surgery for CHD are unable to achieve their oral feeding targets by the time they are discharged and therefore need to rely on feeding tubes for help at home. Feeding tubes are linked to higher rates of readmission, resulting in increased expenditures for hospitals, payers, and families, and placing a load on family caregivers. Identifying modifiable risk factors for oral feeding issues could provide focused care for infants who are at risk (Elgersma et al., 2023).

Infants with feeding difficulties are usually fed through a nasogastric tube to supplement oral food intake and ensure adequate calorie intake. If they are stressed, tired, experiencing shortness of breath, or tachypnea at 80 to 100 breaths per minute, oral feeding may be stopped and all nutrition given by nasogastric tube. Tube feeding is usually a temporary measure until the baby's health improves and nutritional needs can be met through oral nutrition. Infants with severe heart failure, neurological deficits, or significant gastroesophageal reflux may require gastrostomy tube placement to ensure adequate nutrition (Hockenberry et al., 2021).

2.18. Respiratory function and safe oral feeding of neonate with congenital heart defect.

Proper integration of respiratory functions is required for safe oral nutrition. As children get older, their respiratory function typically changes. Initially, newborns breathe at a rate of 40 to 60 breaths per minute, or 1.5 to 1 breath per second. Since swallowing is still immature in the pharynx, it can take from 0 to 30 minutes. From 35 to 0.75 seconds, the remaining time for safe air exchange may be compromised (Lau, 2015).

An important issue faced by hospitalized newborns with CHD is insufficient oral intake, gastrointestinal complications, and difficulties with feeding. Prior to surgery, there are early concerns regarding the nutrition of children with CHD, which include potential mechanisms of intestinal injury or instability in the cardiorespiratory system. The length of time that respiratory support was provided showed a strong correlation with the outcomes of feeding (Jadcherla et al., 2009).

Furthermore, while feeding, the rate of air flow in and out of the lungs reduces, the duration of exhaling increases, and the duration of inhaling decreases. These incidents highlight the crucial need for the bolus to quickly transit via the common pharyngeal channel to ensure safety and proper exchange of oxygen and carbon (Lau, 2015).

2.19. Monitoring oxygen saturation in neonate with CHD.

The fetal blood exhibits much lower oxygen levels compared to that of the neonate. Shortly after birth, the level of oxygen in the arteries rises from approximately 50–60% to 90–95%. The initial respiratory efforts create negative pressure in the chest, which moves fluid from the airways into the space between the lung tissues. This process helps breathing of the lungs, oxygenation of the blood, and widening of the pulmonary arteries (Lara et al., 2022).

Hypoxemia is a condition characterized by lower-than-normal levels of blood oxygen pressure (PaO2) or tissue oxygenation (SaO2). It is identified by measuring arterial blood oxygen saturation (SaO2) to detect reduced levels. Hypoxemia can lead to a decrease in PaO2, which disrupts cellular processes (Hockenberry et al., 2021).

As a result, there are alterations in the flow within the heart (specifically the foramen ovale) and outside the heart (specifically the ductus arteriosus), causing a transition from sequential circulation to a parallel circulation in the pulmonary and systemic systems (Lara et al., 2022).

Cyanosis refers to a condition where the mucous membranes, skin, and nail beds of a child appear bluish due to a decrease in oxygen saturation. Cyanosis often arises when the concentration of deoxygenated hemoglobin in the blood reaches 5 g/dL or more, and when the levels of SaO2 (arterial oxygen saturation) are 85% or below. It is important to note that the definition of cyanosis is subjective. The look of the object can differ based on factors such as skin pigmentation, lighting conditions, room color, and the child's attire (Hockenberry et al., 2021).

During the initial days after birth, many types of CHD that cause bluish discoloration of the skin (cyanosis) often result in a significant decrease in oxygen levels in the blood (severe hypoxemia) with a Pao2 level below 50 mm Hg. Interestingly, these infants do not have difficulty in breathing (respiratory distress) (Fuhrman & Zimmerman, 2022).

The presence of cyanosis may not accurately reflect arterial hypoxemia, as both SaO_2 and the amount of circulating hemoglobin play a role. Children with severe anemia may not develop cyanosis despite severe hypoxemia because hemoglobin levels may be too low to produce the characteristic blue color. In contrast, patients with polycythemia may experience cyanosis despite a near-normal PaO2 (Hockenberry et al., 2021).

2.20. Nursing Considerations for Nutritional care in the NICU.

Around 10% to 15% of newborns in the United States require the specialized attention provided by a NICU (Messer, 2016). The field of pediatric cardiology is constantly developing in response to the increasing severity of patients' conditions and the complexity of their care. This is referred to as "stepped therapy" by the American Association of Critical Care Nurses (Flocco et al., 2018).

As nurses, it is essential to educate ourselves about signs of stress and readiness to breastfeed, the associated physiological data that can be observed on patient monitors, and the baby's signals during feeding, nutrition, and how the physiological response to that comparing artificial breastfeeding with the needs of breastfeeding to determine the best feeding practices (Hoffman, 2016).

Children who have congenital heart disease are susceptible to malnutrition because they have higher metabolic needs, irregular calorie intake, and difficulty in efficiently utilizing calories. Pediatric Palliative Care Units (PPCU) patients aim to enhance their calorie targets in order to optimize their diet (Flocco et al., 2018).

Proper care of a critically ill newborn requires understanding the unique characteristics of underdeveloped organs, the way the neonatal circulation changes, and how congenital heart defects might affect other organ systems (Fuhrman & Zimmerman, 2022).

Seeking guidance from a nutritionist might assist in assessing the children patient's dietary needs and developing a plan for nutritional care. Feeding issues frequently increases in newborns who have congenital heart anomalies as a result of respiratory diseases, complications following surgery (such as voice cord paralysisor infection), difficulties with oral coordination, and gastric reflux. Occupational therapy and speech therapy may be utilized to increases the children patient's oral coordination, benefiting not only the children patients themselves but also their relatives and caregivers. In order to minimize calories expenditure and avoid fatigue (Flocco et al., 2018).

That the infant be allowed to consume food orally for a maximum of 30 minutes during each feeding meeting, while the remaining nourishment should be delivered through an enteral tube. By engaging in this activity, your infant can increase their oral and motor skills and build their physical intensity, all while conserving calories (Typpo, et al., 2020)

Hoffman, (2016) mentioned that the implementing evidence-based protocols to promote the feeding experiences of neonates with congenital heart defects who struggle with self-feeding and achieving optimal nutrition. it has been found that engaging in some activities can result in lasting prominent in child growth and development.

A different methods is to permit the infants or toddler to taking food through mouth during the daytime and then supplement this with enteral nourishment during the nighttime. If there is minimal or no promoting in oral nutrition, it would be appropriate to consider long-term enteral nutrition. neonates who are born with congenital heart anomalies are at a risk of developing necrotizing enterocolitis (NEC) that is 10 times higher than the risk faced by the general neonate population. Preterm born, hypoplastic left , truncus arteriosus, heart syndrome, and bouts of inappropriate systemic blood flow or shock elevated the likelihood of NEC. Children patients with CHD often experience reflux. It is significant to take prevention steps to decrease the occurrences of these conditions (Flocco et al., 2018).

2.21. Previous studies

2.21.1. First Study:

The study under entitled “Evaluation of Pulse Rate, Oxygen Saturation, and Respiratory Effort after Different Types of Feeding Methods in Preterm Newborns”, prospective analytical observational study conducted at Bhaikaka Uni versity, India, from April 2020 to September 2021. Patel et al., (2022) reported that the variations in vital parameters with preterm neonates based on postmenstrual age (PMA) and different feeding strategies. It is observed that vital indicators of fluctuate at different time intervals in different feeding strategies, with the exception of gavage feeding. The range of respiratory rate (RR) and saturation of oxygen (SpO_2) showed substantial variations at different postmenstrual ages (PMA). No instances of chest indrawing or nasal flaring were observed following feeds in any of the groups, as indicated by the data. 110 babies were included in the analysis, with a total of 383 records examined. None of the neonate exhibited indrawing of the chest or nasal flaring following any feeding methods. Throughout the three hours monitoring period, there were notable change in vital indicators, with the exception of the gavage feeding methods group. Although the mean PR remained constant, the mean RR and SPO2 exhibited substantial changes at diffrent points in postmenstrual of old (PMA).

2.21.2. Second study

In their retrospective cohort study titled "Impact of feeding mode on neurodevelopmental outcome in infants and children with congenital heart disease," Holst et al., (2019) examined 208 children with CHD who underwent surgery at University Hospital, Developmental Outcome Clinic. The study aimed to investigate the effects of feeding mode on neurodevelopmental outcomes in children with CHD. Children with congenital heart disease (CHD) experience different neurological development outcomes depending on their method of nourishment. Compared to children fed orally, children receiving enteral feeding tubes showed significantly lower developmental quotient (DQ) scores in cognition, communication, and motor function at both 12 and 24 months. Enteral tube-fed children had higher rates of developmental delays (DQ < 70) throughout the 6, 12, and 24-month check-ups. The findings indicate that children who had an enteral feeding tube after corrective congenital heart surgery are more likely to experience neurodevelopmental delays at 12 and 24 months.

2.21.3. Third study

Tume et al., (2018) conducted a survey titled "Enteral feeding practices in infants with congenital heart disease across European Pediatric Intensive Care Units: a European Society of Pediatric and Neonatal Intensive Care survey. At European pediatric intensive care units that admit infants with congenital heart disease pre- and post-operatively, This study aims to investigate enteral feeding patterns in pre- and post-operative newborns with CHD in European PICU by a cross-sectional electronic survey. The survey has revealed significant diversity and limited uniformity in feeding practices among European PICUs. Many of these procedures are frequently derived from suggestive anxieties that are extrapolated from other categories of patients, primarily preterm infants. While pediatric intensivists were typically involved in the care of these newborns in most European nations, there was a lack of focused involvement from dieticians. This is worrisome considering the importance of providing optimum nutrition for young children. There is a scarcity of evidence to guide the most effective method of providing nutrition through the digestive system to newborns with CHD.

2.21.4. Four study

Observational study at the Children’s Hospital of Philadelphia in Cardiac Intensive Care Unit. under titled “Breastfeeding neonates with congenital heart defect," the Rickman, (2017) reported that breastfeeding practices and identified factors that influence the duration and exclusivity of breastfeeding in neonates with CHD. The initial findings indicate that newborns with CHD have similar breastfeeding methods to healthy newborns throughout the first two weeks of life.

2.21.5. Fiveth study

In the study titled "Physiologic Response to Bottle-Feedings in Infants with CHD: Three Case Studies," at the intensive care unit children’s hospital in the Ohio State, Hoffman, (2016) utilized a multiple case study design (exploratory study) to examine the physiological response of neonates with CHD to feeding. The study aimed to describe the infant feeding skill during bottle feeding and highlight the urgent concern of physiological instability in neonates with CHD when performing a repeated and critical task like feeding. Compared to the baseline, the results indicated that the heart rates of two newborns increased during the feeding and remained elevated after the feeding. Both newborns experienced a decrease in oxygen saturations while eating. One infant's oxygen saturations declined from 88% at the start to 85%, while the other infant's oxygen saturations decreased from 85% to 75% after feeding. The pulse rate and saturation of oxygen of the third neonate remained quite stable during the meal. The two neonates who exhibited worrisome physiological reactions also received lower scores on the EFS. Newborns had their highest pulse rate during the interval after feeding, and their lowest saturation of oxygen levels occurred after feeding. Furthermore, neonates obtained scores below three on all subscales of the EFS, proposing the presence of clinical concern to some range.

2.21.6. Sixth study

In a retrospective study under titled “Enteral Feeding of Newborns with Congenital Heart defect," Natarajan et al., (2010) tested a group of 67 newbors with congenital heart defect who were born at 32 weeks of gestation and underwent surgical repair before reaching one month of old. The objective of study to analyze the feeding methods of newborns with CHD both before and after surgical repair, to identify the appearance and risk factors of feeding related complications. The conclusion of the study that difficulties and intricacies involved in providing enteral feeding to neonates with congenital heart defect. It highlights the necessity for evidence-based feeding strategies to enhance outcomes for this neonates. Emphasizes the significance of additional assessments and the creation of efficient feeding guidelines to meet the distinct requirements of these neonate.

2.21.7. Seventh study

In their prospective study titled "The Effect of Breast- and Bottle-Feeding on Oxygen Saturation and Body Temperature in Preterm Infants," at Taichung Veterans Hospital, Chen et al., (2000) published the findings. In order to assess the clinical impact of breast-feeding versus bottle-feeding, we monitored oxygen saturation, heart rate, respiratory rate, and body temperature at one-minute intervals for a duration of 20 minutes during feeding sessions. A study comprised 25 preterm newborns with a birth weight less than 1800 g. The preterm newborns had significantly elevated oxygen saturation and body temperature levels when they were fed directly at the breast. Two cases of apnea, defined as a stop in breathing more than 20 seconds, and twenty cases of oxygen desaturation ($PaO2 < 90\%$) occurred though bottle-feeding, while none were observed though breastfeeding methods. These findings suggest that breastfeeding is a more natural feeding method for premature , while bottle-feeding may stimulate more stress.

2.21.8. Eight study

In the study under titled “Oxygen Saturations During Breast and Bottle Feedings in Infants With CHD”, at pediatric tertiary hospital in the northeastern United States, Marino, (1995) conducted a correlational exploratory study to assessment the potential correlation between methods of feeding (breast vs. bottle) and saturation of oxygen (SpO_2) in neonates with CHD. The study reported that the significant of assessing saturation of oxygen during bottle feedings in neonate with CHD as a crucial feeding aspect evaluation. Breastfeeding is association with improvement of oxygenation in certain neonates with CHD. The results indicated that the oximetry measurement of the neonate throughout both bottle feeding and breast feeding. The neonate’s oxygen saturation rapidly decrease to 80% when start of the feeding, rebounded to its initial level, and then declined again towards the end of the feeding and continued to be low during the rest interval of the bottle feeding. During breast feeding, the neonate's oxygen saturation level declined to 91% when start of the meal and then rebounded to almost the initial level of 95% for the balance of the feeding session and the subsequent rest time.

Chapter Three:

Methodology

3.1. Study design

Observational study in correlational design to investigate the relationships between variables without manipulating them. was carried out to monitor the feeding methods of neonates with congenital heart defects in Karbala Teaching Hospital for Children admission to the pediatric care unit from the period of 26th September, 2023, to 13th May, 2024.

3.2. Administrative arrangements.

Formally, the study title, an objective and instrument designed for measurement were presented to the College of the Nursing Scientific Research Ethics Committee, which reviewed the study, reviewed the study instruments, and approved the study's conducted in 5 November 2023 (Appendix: A).

It was submitted a formal request by the College of Nursing\ University of Karbala to the Karbala Health Department to facilitate the task of collecting samples (Appendix: B).

Karbala Health Directorate's Training and Development Department assigned the researcher to fill out the approval form of the Research Protocol\ Ministry of Health to obtain the approval of the Research Committee in the Karbala Health Department's Training and Development Department in the 8 November 2023 (Appendix: B1).

The Training and Development Center sent approval to the Karbala Teaching Hospital for Children to obtain permission to collect samples from the neonatal care unit (Appendix: B2).

3.3. Ethical Considerations

The researcher got informed written permission from each mother or caregiver. The researcher notifies to the participant's mother or caregiver of the study's goal before they participate in it. The subjects' agreement sheet states that 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.

3.4. Study setting

The study was carried out in Karbala Teaching Hospital for Children in Holy Karbala city. This hospital contains (26) incubator in a neonatal care unit and (9) incubator intensive care unit, where newborn with CHD are admitted, for providing medical and nursing care.

3.5. Sample size

Non-probability (convenience sampling) the researcher use time and availability to determine the sample size during three months from 3^{rd}, November 2023 to the 26^{th}, February 2024 to include a sufficient number of participants to address the research question, 50 neonates with congenital heart defect aged less than 28 days who being admitted to the Neonatal Unit or NICU, In addition to (5) neonates for pilot study which gave permission to the researcher to begin collecting samples

3.6. Study Sample

Clinicians make feeding decisions for individual newborns with CHD who are entry to the NICU throughout their everyday rounds. These decisions are based on clinical examination results as well as feedback received from nurses and mothers. Mothers gave their informed agreement so that the infant's medical record would be used to gather demographic information and so that pulse oximetry could be used for monitoring the infant's oxygen saturation and pulse rate. The respiration rate was measured in the quiet newborn verbally for a full minute in order to prevent observer bias. prior to eating, immediately after, thirty minutes later, and for one hour later following breastfeeding, bottle feeding, or tube feeding.

3.7. Steps of the study (Study Instrument)

The modified measurement tool based on extensive review of related studies like (Patel, 2022), (Hoffman, 2016). In addition to the researcher's experience in the field of neonatal care in the neonatal intensive care unit.

Part I: Demographic and clinical data of neonate with congenital heart defect.

There are five items in this section: The medical record contained information on the infant's birth weight, sex, type of feeding, gestational age and chronologic age, and a specific heart abnormality (diagnosis: cyanosis or acyanosis).

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

This section includes three items: Physiologic response was measured using heart rate within the range 120 to 160 of recent resting levels, oxygen saturation levels within the range of 90% to 100%, and respiratory effort (breathing rate between 30 and 60 breaths per minute, chest retraction, and nasal flare). Data were collected before initiating neonatal feeding, immediately after feeding, 30 minutes after, and 1 hour after completion of feeding.

3.8. Testing the Validity of the Study Instrument

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. The experts were distributed according to their field in tab (3-1).

3.9. A pilot Study

This preliminary study aims to evaluate the study tool's stability, credibility, clarity, and efficiency. The findings validated its reliability, and the average time necessary to collect data for each subject was calculated during the monitoring process. Additionally, the study aimed to identify potential difficulties that may be encountered in the process.

Table (3-1): The Experts' Distribution According to the Field

The field	*No.*
A faculty member of the Karbala University\ College of Nursing	6
A faculty member of the Babylon University\ College of Nursing	2
A faculty member of the Baghdad University\ College of Nursing	1
A faculty member of the kufa University\ College of Nursing	1
Heart surgeon from Imam AL-Hassan AL-Mujtaba Hospital	1
Pediatrician from Ibn Saif Children's Hospital	2
Medical physiologist from Ibn Saif Children's Hospital	1
NICU nurse from Imam Zain Al-Abidin Hospital	1

3.9.1. The pilot study accomplished the following objectives:

1. Enhancing the development and rigorous testing of the research instruments to ensure their adequacy and reliability.
2. Evaluating the feasibility of research instruments to gauge their practicality and effectiveness.
3. Anticipating and addressing logistical challenges that may arise during the implementation of proposed research methods.
4. Scrutinizing the proposed data analysis techniques to proactively identify and address potential issues, ensuring the robustness of the analytical approach.
5. Estimating the timeframe required for data collection by the researcher to streamline the research process and enhance overall project management.

3.9.2. Pilot study results

1. The reliability of the study tool is consistently high, demonstrating its robustness in capturing accurate and dependable data.
2. Respondents reported a variable time range of 65 to 75 minutes for completing the questionnaire.

3. The items in the instrument were meticulously crafted, ensuring clarity and a profound understanding of the study's underlying phenomenon, as highlighted in Table 3-2.

3.10. Reliability of study instruments:

Ensuring the reliability of research instruments is crucial to guarantee consistent results when applied repeatedly to the same individuals over various time intervals. In this study, 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, which formed the basis for conclusive study, was later excluded from the original sample. The reliability coefficient was assessed using the test-retest correlation coefficient, as illustrated below.

Table (3-2): The reliability of the questionnaire under examination (*n=5*)

Inter-retort Reliability		
Co-observer	Correlation	Ass.
Inter-retort/ Inter-observer	r= .833**	Reliable

This table was statistically created to display the study instrument's reliability coefficient. The calculated outcome demonstrates that the researcher is qualified to evaluate the effect of feeding methods on oxygen saturation, pulse rate, and respiratory effort in neonates with congenital heart defect during the collection of the original study samples underlying the study phenomenon, according to its availability in the same group at any point in the future.

3.11. Data Collection Methods

The mother selected a feeding period, and arrangements were developed to collect data following informed written agreement from parents. Collection times varied according to the duration of time the infant was nourished. The medical record was used to gather the infant's health history. Vital parameters were recorded before the start of newborn feeding, immediately after feeding, 30 minutes later, and 1 hour later.

Feeding was done with the infant in a semi-reclining position. SPO_2 and PR were measured with a pulse oximeter. A pulse oximeter probe was affixed to the right upper limb to ensure consistency. To eliminate observer bias, the respiration rate of the calm newborn infant was measured during a one-minute interval. It is critical that neonates remain calm while assessing these indicators, as physical exertion or crying make measurement difficult and also influence them due to increased metabolic demand.

During the counting of respiratory rates, chest indrawing was also seen. Chest indrawing was considered existent if the chest wall moved in as he or she breathed in. Nasal flaring was defined as the broadening of the nostrils when the neonate breathed in. Routine, uncomfortable invasive procedures, such as heel pricks, were avoided during this 65 to 75 minutes surveillance period to prevent stress and its influence on vital parameters. A newborn with cyanosis congenital heart defects ware on continuous oxygen that show in (Appendix: E)

3.12. Statistical Data Analysis Approach

To conduct a comprehensive statistical analysis of the data gathered from the data of study sample and derive meaningful results; the investigator employed both SPSS version 24 and Microsoft Excel (2010). These software tools were used to thoroughly evaluate the data, establishing correlations between variables and conducting a battery of statistical tests. This methodological technique was crucial in achieving conclusive research findings, which contributed to the study's robustness and reliability.

Descriptive approach

Descriptive statistics are a set of mathematical and statistical approaches used to quantitatively describe significant properties of data, commonly through the use of tables and graphs. The primary aim of descriptive statistics is to present and elucidate data that necessitates processing, organization, summarization, and categorization. These techniques facilitate the communication of information in a straightforward and comprehensible manner, enhancing the ease with which recipients can recognize and understand the content. The analysis involves the utilization of the following methods:

A. Statistical tables, showcasing frequencies and percentages.
B. Presentation of the average score, denoted as M±.
C. Examination of Standard Deviation, represented as ±SD.

$$SD = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(Xi - \bar{\chi})^2}$$

3.12.1. Inferential approach

1. Tests of Normality

Non-normally distributed data were presented as median or mean ± standard deviation and compared using Kolmogorov-Smirnov (***K*– *S test***) and to assess the normality of data used Shapiro-Wilk tests are two common ways. Kruskal-Wallis H Test or Mann-Whitney U Test if not normally distribution and ANOVA or t-test if normally distribution.

2. Kruskal-Wallis H Test

The Kruskal-Wallis H test may be a non-parametric strategy designed for cases of non-normal distribution. It is employed to assess variations in dependent variables concerning independent variables, particularly discerning disparities. This test is applicable when there are more than two categorical variables. When the obtained p-value is below 0.05, it signifies statistically significant differences.

$$\boldsymbol{H} = \frac{\boldsymbol{N}(\boldsymbol{N}+\mathbf{1})\mathbf{12}\sum \boldsymbol{niTi2}}{\mathbf{3}(\boldsymbol{N}+\mathbf{1})}$$

3. Mann-Whitney U Test

Mann-Whitney U test, also is a non-parametric strategy suitable for non-normally distributed data, serves to identify discrepancies in dependent variables relative to independent variables. It is specifically geared towards scenarios where there are two categorical variables, A significance level of 0.05 is employed to interpret the results, indicating whether statistically significant differences exist.

$$\boldsymbol{U} = \frac{\mathbf{R1} - \mathbf{2n1}}{(\mathbf{n1}+\mathbf{1})}$$

4. Simple Linear Regression

Simple Linear Regression analysis serve the purpose of assessing which study variables hold predictive value. Here, a negative coefficient (-β) implies a negative prediction, while a positive coefficient (+β) indicates a positive prediction regarding the outcome.

$$\boldsymbol{r} = \boldsymbol{mx} + \boldsymbol{b}$$

Chapter Four:
Results and Analysis

Results of the Study:

Within the framework of the present study's objectives, the findings incorporates both descriptive and inferential statistical approaches. The following aspects encapsulate the essence of this dual analytical strategy:

Table 4-1: 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-1.499g	11	22.0
	1.500g-2.499g	13	26.0
	2.500g-4000g	20	40.0
	>4000g	2	4.0
	Min–Max	*1–4.3900 kg*	
	Mean ± SD	*2.82 ± 0.94*	
Current weight/ Kg	1000-1.499g	4	8.0
	1.500g-2.499g	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

When examining the clinical characteristics of the 50 neonates 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 4-2: Comparison the effect of feeding periods on oxygen saturation

Variable	Ranks			$^{b}\chi^2$	d.f	Sig.
	Periods of Feedings	No.	Mean Rank			
Oxygen saturation (SPO2)	Before feeding	50	115.23	10.210	3	.017
	After feeding immediately	50	80.90			
	After feeding 30 min	50	97.36			
	After feeding 1 h	50	108.51			

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

The Kruskal-Wallis analysis indicates noteworthy variations in oxygen saturation across different feeding periods ($p= 0.017$). Specifically, the mean ranks for oxygen saturation were observed to be 115.23 before feeding, at immediately represented 80.90, also 97.36 after 30 minutes of feeding and finally after 1 hour of feeding represented 108.51. These findings highlight statistically significant differences, shedding light on the dynamic changes in oxygen saturation related to distinct feeding intervals.

Table 4-3.Comparison the effect of feeding periods on pulse rate

Variable	Ranks			$^b\chi^2$	d.f	Sig.
	Periods of Feedings	No.	Mean Rank			
Pulse Rate (PR)	Before feeding	50	92.27	2.035	3	.565
	After feeding immediately	50	108.08			
	After feeding 30 min	50	103.15			
	After feeding 1 h	50	98.50			

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

The Kruskal-Wallis analysis reveals no significant variations in pulse rate across distinct feeding periods ($p = 0.565$). The mean ranks for pulse rate exhibit an ascending trend after immediate feeding (108.08), followed by a slight decrease after 30 minutes of feeding (103.15), a further decline after 1 hour of feeding (98.50), ultimately stabilizing before feeding (92.27).

Table 4-4: Comparison the effect of feeding periods 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
	After feeding immediately	50	117.40			
	After feeding 30 min	50	106.59			
	After feeding 1 h	50	92.55			

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

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 4-5: Comparison the effect of feeding periods 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
	After feeding immediately	50	76.50			
	After feeding 30 min	50	108.50			
	After feeding 1 h	50	108.50			

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

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 notable present in nasal flaring immediately after feeding (76.50).

Table 4-6: Comparison the effect of feeding periods 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
	After feeding immediately	50	100.50			
	After feeding 30 min	50	100.50			
	After feeding 1 h	50	100.50			

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

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 4-7: Comparison of feeding methods on oxygen saturation in neonates with congenital heart defects

Periods	(I) SPO2	(J) SPO2	Mean Difference (I-J)	Std. Error	Sig.
Immediately	Breastfeeding	Bottle-feeding	8.65734*	2.41690	.001
		Tube feeding	5.38462*	2.61800	.045
	Bottle-feeding	Breastfeeding	-8.65734-*	2.41690	.001
		Tube feeding	-3.27273-	2.31341	.164
	Tube feeding	Breastfeeding	-5.38462-*	2.61800	.045
		Bottle-feeding	3.27273	2.31341	.164
After 30 min	Breastfeeding	Bottle-feeding	7.26224*	2.31335	.003
		Tube feeding	5.90769*	2.50584	.023
	Bottle-feeding	Breastfeeding	-7.26224-*	2.31335	.003
		Tube feeding	-1.35455-	2.21429	.544
	Tube feeding	Breastfeeding	-5.90769-*	2.50584	.023
		Bottle-feeding	1.35455	2.21429	.544
After 1 hour	Breastfeeding	Bottle-feeding	4.35664*	1.57726	.008
		Tube feeding	5.80513*	1.70850	.001
	Bottle-feeding	Breastfeeding	-4.35664-*	1.57726	.008
		Tube feeding	1.44848	1.50972	.342
	Tube feeding	Breastfeeding	-5.80513-*	1.70850	.001
		Bottle-feeding	-1.44848-	1.50972	.342

*. The mean difference is significant at the 0.05 level

The oxygen saturation observed after feeding immediately in neonate with CHD are statistically differs among those who breastfeeding and bottle-feeding (p=.001) and tube-feeding (p= .045). Such saturation are statistically differs among those who are bottle-feeding and breast-feeding (p= .001) and not differs from those who are tube-feeding (p= .164). Such saturation are statistically differs among those who are tube-feeding and breast-feeding (p= .045) and not differs from those who are bottle-feeding (p= .164).

The oxygen saturation observed after feeding in 30 minutes are statistically differs among those who breastfeeding and bottle-feeding (p=.003) and tube-feeding (p= .023). Such saturation are statistically differs among those who are bottle-feeding and breast-feeding (p= .003) and not differs from those who are tube-feeding (p= .544). Such saturation are statistically differs among those who are tube-feeding and breast-feeding (p= .023) and not differs from those who are bottle-feeding (p= .544).

The oxygen saturation observed after feeding in 1 hour are statistically differs among those who breastfeeding and bottle-feeding (p=.008) and tube-feeding (p= .001). Such saturation are statistically differs among those who are bottle-feeding and breast-feeding (p= .008) and not differs from those who are tube-feeding (p= .342). Such saturation are statistically differs among those who are tube-feeding and breast-feeding (p= .001) and not differs from those who are bottle-feeding (p= .342).

Table 4-8: Comparison of feeding methods on pulse rate in neonates with congenital heart defects

Periods	PR (I)	PR (J)	Mean Difference (I-J)	Std. Error	Sig.
Immediately	**Breastfeeding**	Bottle-feeding	-13.40210-*	5.60729	.021
		Tube feeding	-9.13846-	6.07385	.139
	Bottle-feeding	Breastfeeding	13.40210*	5.60729	.021
		Tube feeding	4.26364	5.36718	.431
	Tube feeding	Breastfeeding	9.13846	6.07385	.139
		Bottle-feeding	-4.26364-	5.36718	.431
After 30 min	**Breastfeeding**	Bottle-feeding	-12.61888-*	5.60159	.029
		Tube feeding	-10.51282-	6.06768	.090
	Bottle-feeding	Breastfeeding	12.61888*	5.60159	.029
		Tube feeding	2.10606	5.36172	.696
	Tube feeding	Breastfeeding	10.51282	6.06768	.090
		Bottle-feeding	-2.10606-	5.36172	.696
After 1 hour	**Breastfeeding**	Bottle-feeding	-11.49301-*	5.68516	.049
		Tube feeding	-10.80513-	6.15819	.086
	Bottle-feeding	Breastfeeding	11.49301*	5.68516	.049
		Tube feeding	.68788	5.44171	.900
	Tube feeding	Breastfeeding	10.80513	6.15819	.086
		Bottle-feeding	-.68788-	5.44171	.900

*. The mean difference is significant at the 0.05 level

The observed pulse rates immediately after feeding in neonates with congenital heart defects (CHD) exhibit significant differences between breastfeeding and bottle-feeding (p=.021),

While showing no significant difference from tube-feeding (p= .139). Similarly, the pulse rates differ significantly between bottle-feeding and breastfeeding (p= .021) but not from tube-feeding (p= .431). However, there is no statistically significant difference in pulse rates between tube-feeding and breastfeeding (p= .193) or bottle-feeding (p= .431).

In the case of pulse rates observed 30 minutes after feeding, there is a statistically significant difference between breastfeeding and bottle-feeding (p=.029), but no significant difference from tube-feeding (p= .090). Likewise, the pulse rates differ significantly between bottle-feeding and breastfeeding (p= .029) but not from tube-feeding (p= .696).

There is no statistically significant difference in pulse rates between tube-feeding and breastfeeding (p= .090) or bottle-feeding (p= .696).

After 1 hour of feeding, the pulse rates are statistically different between breastfeeding and bottle-feeding (p=.049) but not from tube-feeding (p= .086). Similarly, the pulse rates differ significantly between bottle-feeding and breastfeeding (p= .049) but not from tube-feeding (p= .900).

There is no statistically significant difference in pulse rates between tube-feeding and breastfeeding (p= .086) or bottle-feeding (p= .900).

Table 4-9: 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

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 pulse 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).

Table 4-10: Relationship between oxygen saturation and neonates clinical data

Table 3-10.1: Relationship between oxygen saturation and gestational age

Correlation statistics	1	2	3	4	5
1.Gestational age	1				
2.Before feeding	.300*	1			
3.After immediately	.212	.842**	1		
4.After 30 min of feeding	.243	.885**	.981**	1	
5.After 1 hour of feeding	.279	.985**	.798**	.847**	1

*. Correlation is significant at the 0.05 level (2-tailed).

Findings indicate that there appositive relationship between gestational age and oxygen saturation before feeding in neonate with congenital heart defect (*r= 0.300; p > 0.05*).

Table 4-10.2: Relationship between oxygen saturation and chronological age

Correlation statistics	1	2	3	4	5
1.Chronological age	1				
2.Before feeding	-.162-	1			
3.After immediately	-.011-	.842**	1		
4.After 30 min of feeding	-.004-	.885**	.981**	1	
5.After 1 hour of feeding	-.108-	.985**	.798**	.847**	1

*. Correlation is significant at the 0.05 level (2-tailed).

Findings indicate that there is no relationship between chronological age and oxygen saturation before feeding in neonate with congenital heart defect across four distinct feeding periods: before, immediately after, and 30 minutes and 1 hour post-feeding ($p > 0.05$).

Table 4-10.3: Statistical Differences in Oxygen Saturation with regard Neonate Sex

Periods of Feeding	Sex	No.	Mean Rank	*cz _*	*Sig.*
After feeding immediately	Male	28	23.79	260.00	.345
	Female	22	27.68		
After 30 min feeding	Male	28	23.96	265.000	.398
	Female	22	27.45		
After 1h feeding	Male	28	24.50	280.000	.581
	Female	22	26.77		

[c]= Mann-Whitney Test; n= number,; sig.= significant level at 0.05.

The Mann-Whitney U analysis reveals no significant differences in oxygen saturation and neonate their sex across after feeding immediately (p= 0.345), after 30 min feeding (p= 0.398) and after 1 hour feeding (p= 0.581).

Table 4-10.4: Relationship between oxygen saturation and birth weight

Correlation statistics	1	2	3	4	5
1.Birth weight	1				
2.Before feeding	.156	1			
3.After immediately	.026	.842**	1		
4.After 30 min of feeding	.068	.885**	.981**	1	
5.After 1 hour of feeding	.151	.985**	.798**	.847**	1

*. Correlation is significant at the 0.05 level (2-tailed).

Findings indicate that there is no relationship between birth weight and oxygen saturation in neonate with congenital heart defect across four distinct feeding periods: before, immediately after, and 30 minutes and 1 hour post-feeding ($p > 0.05$).

Table 4-10.5: **Relationship between oxygen saturation and current weight**

Correlation statistics	1	2	3	4	5
1.Current weight	1				
2.Before feeding	.193	1			
3.After immediately	.025	.842**	1		
4.After 30 min of feeding	.066	.885**	.981**	1	
5.After 1 hour of feeding	.202	.985**	.798**	.847**	1

*. Correlation is significant at the 0.05 level (2-tailed).

Findings indicate that there is no relationship between birth weight and oxygen saturation in neonate with congenital heart defect across four distinct feeding periods: before, immediately after, and 30 minutes and 1 hour post-feeding ($p > 0.05$).

Table 4-10.6: **Statistical differences in oxygen saturation with regard diagnosis**

Periods of Feeding	Type	No.	Mean Rank	*cz* _	*Sig.*
After feeding immediately	Cyanotic lesions	10	24.50	190.00	.807
	Acyanotic lesions	40	25.75		
After 30 min feeding	Cyanotic lesions	10	26.30	192.000	.585
	Acyanotic lesions	40	25.30		
After 1h feeding	Cyanotic lesions	10	26.35	191.000	.389
	Acyanotic lesions	40	25.29		

^{c}= Mann-Whitney Test; n= number,; sig.= significant level at 0.05.

The Mann-Whitney U analysis indicates that there are no statistically significant differences in oxygen saturation and neonatal diagnosis immediately after feeding (p= 0.807), 30 minutes after feeding (p= 0.585), and 1 hour after feeding (p= 0.398).

Table 4-11: Relationship between pulse rate and neonates clinical data

Table 3-11.1: Relationship between pulse rate and gestational age

Correlation statistics	1	2	3	4	5
1.Gestational age	1				
2.Before feeding	-.393-**	1			
3.After immediately	-.364-**	.952**	1		
4.After 30 min of feeding	-.389-**	.970**	.989**	1	
5.After 1 hour of feeding	-.404-**	.971**	.981**	.994**	1

**. Correlation is significant at the 0.01 level (2-tailed).

The results suggest a noteworthy inverse correlation between gestational age and pulse rate in neonates diagnosed with congenital heart defects. Specifically, this negative relationship is evident both before feeding (r= -0.393; p < 0.01), immediately after feeding (r= -0.364; p < 0.01), 30 minutes post-feeding (r= -0.389; p < 0.01), and 1 hour post-feeding (r= -0.404; p < 0.01).

Table 4-11.2: Relationship between pulse rate and chronological age

Correlation statistics	1	2	3	4	5
1.Chronological age	1				
2.Before feeding	.404**	1			
3.After immediately	.451**	.952**	1		
4.After 30 min of feeding	.472**	.970**	.989**	1	
5.After 1 hour of feeding	.460**	.971**	.981**	.994**	1

**. Correlation is significant at the 0.01 level (2-tailed).

The results suggest a noteworthy positive correlation between chronological age and pulse rate in neonates diagnosed with congenital heart defects. Specifically, this positive relationship is evident both before feeding (r= 0.404; p < 0.01), immediately after feeding (r= 0.451; p < 0.01), 30 minutes post-feeding (r= 0.472; p < 0.01), and 1 hour post-feeding (r= 0.460; p < 0.01).

Table 4-11.3: Statistical differences in pulse rate with regard neonate sex

Periods of Feeding	Sex	No.	Mean Rank	*cz _*	*Sig.*
After feeding immediately	Male	28	24.61	238.00	.625
	Female	22	26.64		
After 30 min feeding	Male	28	24.45	278.500	.564
	Female	22	26.84		
After 1h feeding	Male	28	24.32	275.000	.519
	Female	22	27.00		

[c]= Mann-Whitney Test; n= number,; sig.= significant level at 0.05.

The Mann-Whitney U analysis indicates that there are no statistically significant differences in pulse rate between neonates of different sexs immediately after feeding (p = 0.625), 30 minutes after feeding (p = 0.564), and 1 hour after feeding (p = 0.519).

Table 4-11.4: Relationship between pulse rate and birth weight

Correlation statistics	1	2	3	4	5
1.Birth weight	1				
2.Before feeding	-.114-	1			
3.After immediately	-.100-	.952**	1		
4.After 30 min of feeding	-.109-	.970**	.989**	1	
5.After 1 hour of feeding	-.115-	.971**	.981**	.994**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Findings indicate that there is no relationship between birth weight and pulse rate in neonate with congenital heart defect across four distinct feeding periods: before, immediately after, and 30 minutes and 1 hour post-feeding ($p > 0.05$).

Table 4-11.5: Relationship between pulse rate and current weight

Correlation statistics	1	2	3	4	5
1.Current weight	1				
2.Before feeding	-.017-	1			
3.After immediately	.013	.952**	1		
4.After 30 min of feeding	-.008-	.970**	.989**	1	
5.After 1 hour of feeding	-.003-	.971**	.981**	.994**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Findings indicate that there is no relationship between current weight and pulse rate in neonate with congenital heart defect across four distinct feeding periods: before, immediately after, and 30 minutes and 1 hour post-feeding ($p > 0.05$).

Table 4-11.6: Statistical differences in pulse rate with regard diagnosis

Periods of Feeding	Type	No.	Mean Rank	*cz _*	*Sig.*
After feeding immediately	Cyanotic lesions	10	22.30	168.000	.451
	Acyanotic lesions	40	26.30		
After 30 min feeding	Cyanotic lesions	10	21.80	163.000	.382
	Acyanotic lesions	40	26.43		
After 1h feeding	Cyanotic lesions	10	21.40	159.000	.331
	Acyanotic lesions	40	26.53		

^{c}= Mann-Whitney Test; n= number,; sig.= significant level at 0.05.

The Mann-Whitney U analysis indicates that there are no statistically significant differences in pulse rate among neonates based on their diagnosis immediately after feeding (p= 0.451), after 30 minutes of feeding (p= 0.382), and after 1 hour of feeding (p= 0.331).

Table 4-12: Relationship between respiratory rate and neonates clinical data

Table 3-12.1.Relationship between respiratory rate and gestational age

Correlation statistics	1	2	3	4	5
1.Gestational age	1				
2.Before feeding	-.125-	1			
3.After immediately	-.117-	.975**	1		
4.After 30 min of feeding	-.097-	.988**	.979**	1	
5.After 1 hour of feeding	-.149-	.988**	.965**	.981**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Findings indicate that there is no relationship between gestational age and respiratory rate in neonate with congenital heart defect across four distinct feeding periods: before, immediately after, and 30 minutes and 1 hour post-feeding ($p > 0.05$).

Table 4-12.2: Relationship between respiratory rate and chronological age

Correlation statistics	1	2	3	4	5
1.Chronological age	1				
2.Before feeding	-.007-	1			
3.After immediately	.014	.975**	1		
4.After 30 min of feeding	-.025-	.988**	.979**	1	
5.After 1 hour of feeding	.013	.988**	.965**	.981**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Findings indicate that there is no relationship between chronological age and respiratory rate in neonate with congenital heart defect across four distinct feeding periods: before, immediately after, and 30 minutes and 1 hour post-feeding ($p > 0.05$).

Table 4-12.3: Statistical differences in respiratory rate with regard neonate sex

Periods of Feeding	Sex	No.	Mean Rank	***cz*** _	*Sig.*
After feeding immediately	Male	28	27.16	261.500	.361
	Female	22	23.39		
After 30 min feeding	Male	28	26.07	292.500	.753
	Female	22	24.77		
After 1h feeding	Male	28	26.50	280.000	.583
	Female	22	24.23		

[c]= Mann-Whitney Test; n= number,; sig.= significant level at 0.05.

The Mann-Whitney U analysis indicates that there are no statistically significant differences in respiratory rate based on the sex of neonates immediately after feeding (p= 0.361), after 30 minutes of feeding (p= 0.753), and after 1 hour of feeding (p= 0.583).

Table 4-12.4: Relationship between respiratory rate and birth weight

Correlation statistics	1	2	3	4	5
1.Birth weight	1				
2.Before feeding	.011	1			
3.After immediately	.063	.975**	1		
4.After 30 min of feeding	.037	.988**	.979**	1	
5.After 1 hour of feeding	-.020-	.988**	.965**	.981**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Findings indicate that there is no relationship between birth weight and respiratory rate in neonate with congenital heart defect across four distinct feeding periods: before, immediately after, and 30 minutes and 1 hour post-feeding ($p > 0.05$).

Table 4-12.5: Relationship between respiratory rate and current weight

Correlation statistics	1	2	3	4	5
1.Current weight	1				
2.Before feeding	.056	1			
3.After immediately	.107	.975**	1		
4.After 30 min of feeding	.064	.988**	.979**	1	
5.After 1 hour of feeding	.033	.988**	.965**	.981**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Findings indicate that there is no relationship between current weight and respiratory rate in neonate with congenital heart defect across four distinct feeding periods: before, immediately after, and 30 minutes and 1 hour post-feeding (*p > 0.05*).

Table 4-12.6: Statistical differences in respiratory rate with regard diagnosis

Periods of Feeding	Type	No.	Mean Rank	*cz _*	*Sig.*
After feeding immediately	Cyanotic lesions	10	25.35	198.500	.971
	Acyanotic lesions	40	25.54		
After 30 min feeding	Cyanotic lesions	10	26.55	198.500	.802
	Acyanotic lesions	40	25.24		
After 1h feeding	Cyanotic lesions	10	28.50	170.000	.480
	Acyanotic lesions	40	24.75		

[c]= Mann-Whitney Test; n= number,; sig.= significant level at 0.05.

The Mann-Whitney U analysis indicates that there are no statistically significant differences in respiratory rates among neonates based on their diagnosis immediately after feeding (p= 0.971), 30 minutes after feeding (p= 0.802), and 1 hour after feeding (p= 0.480).

Chapter Five:

Discussion, Conclusions and Recommendations

5.1.Discussion the Clinical Characteristics of the Study Sample in the table (1).

5.1.1. Gestational Age and Congenital Heart Defects:

The identified gestational age of ≤37 weeks comprised (34) neonates, accounting for (68%) in table (4-1) of the total sample. This finding conforms with study carried out by Abqari et al., (2016). the gestational age has been found to have a significant effect on congenital heart defects prevalence, including preterm birth identified as a recognized risk factor, reflected the need for detailed probing into certain gestational periods which may be the most prone areas to the development of congenital heart defects. Mustafa, H. J., et al. (2020) found that the overall risk of preterm birth (PTB) increased by more than twofold to 23.2%, while the rate of preterm birth in pregnancies with fatal congenital heart defects ranged from 11.5% to 28%.

5.1.2. Chronological Age of neonate with Congenital Heart Defects:

Neonates that mean age less than 28 days was included in our study, (41) neonates is between 7 and 28 days referred to that corresponds to (82%) in table (4-1)of the total sample. Doumbia, A. K., et al. (2022) stated that as the incidence of congenital heart disease (CHD) is greater in the prenatal (2.4%–52%) compared to the postnatal period (0.3%–1.2%), so priority should be given to early prenatal screening and timely intervention.

Globally the prevalence of CHD in newborns are between 3.7% and 17.5% per 1,000 births, accounting for 30%–45% of all congenital deformities. Early detection through screening is vital for improving outcomes for affected infants (Alaani, 2023).

The high incidence of congenital heart disease as well as the associated complications makes it necessary to establish a diagnosis as early as possible to adopt the most appropriate measures in a personalized approach (Diz, et al. 2021)

5.1.3. Sex Disparity in Congenital Heart Defects:

The sex distribution refers to the male constituting a majority of study subjects (56.0%)in table (4-1), which suggests the tendency of congenital heart defects in males versus in females, from the studies that suport this result is Parvar et al., (2023) reported that the prevalence of male child patients was significantly higher than that of females. In their investigation into the birth prevalence of congenital heart defects. Zhao et al., (2020) found that the birth prevalence of total CHD was 3.533 per 1000 births for females and 4.175 per 1000 births for males In China. Gertds and Regitz, (2019) contribute to statistics that show that congenital heart diseases are not equally common in males and females.

5.1.4. Birth Weight and Current Weight of neonate with CHD

In terms of birth weight and current weight, we observed a birth weight range of 2500g to 4000g, with (20) cases represented (40%) in table (4-2). Additionally, current weight ranged from 2,500g to 4000g, with (33) cases represented (66%). And this finding agree with study by Giorgione et al., (2020), employing a retrospective cohort approach, demonstrated that low birth weight was associated with adverse neonatal outcomes among neonates with congenital heart defects. According to Ishikawa et al., (2021), there is a higher chance of death when CHD and SGA are present together than when CHD or SGA are present alone. Therefore, nutritional support and meticulous growth monitoring emerge as crucial components of comprehensive healthcare for this population.

5.1.5. Prevalence of Acyanotic Lesions:

The investigation showed that 80 percent of the neonates were diagnosed with acyanotic lesionsin table (4-1). this finding is consistent with the study by Singh, (2018), which examined the prevalence of cardiac lesions and outcome in asyanotic births and Parvar, (2023) reported in a study that acyanotic cardiac defects were the most common CHD in neonates and indicated that early detection and intervention of these abnormalities led to a better prognosis, emphasizing the importance of early diagnosis and intervention in the newborns.

5.2.Effect of Feeding period on Oxygen Saturation in Neonate with Congenital Heart Defects

The results of the study in table (4-2) showed that there are statistical differences in oxygen saturation between different stages of feeding (p= 0.017). The mean ranks of the oxygen saturation were incredibly scrutinized, bringing out several discerning patterns across four distinct meal periods.

The average mean rank for the first oxygen saturation score was 115.23. This baseline measurement represents the starting point from which you can interpret the deviations that take place during and after feeding.

Just after feeding the size of the biggest mean rank was observed to drop by the most prominent amount and then it was equal to 80.90. In this postprandial period,

The fall in saturation of oxygen can be linked to the causes such as energy-intensive digestion, the potential redistribution of blood to the gastrointestinal tract, and the altered breathing dynamics related to feeding intake (Tume et al., 2018).

That stronger diminishing is manifested after 30 minutes of feeding, as the mean rank is decreased to 97.36. Factors that may contribute to the found decrease in oxygen saturation include increased blood flow to the gastrointestinal system, heightened metabolic activity or change in respiratory rate (Indramohan et al., 2017).

Mean ranking of Oxygen saturation was also reduced, the mean rank became 108.51 after an hour of feeding. Jones et al., (2021).indicates a prospective influence of digestion on the saturation levels of oxygen led to drop it, take into account energy expenditure as well as metabolic requirements during digestion that could influence oxygen saturation.

The statistical significance of the study (p = 0.017) shows the validity of the observed differences of mean ranks. It is important to take into account the possible implications of these results in providing patient care and monitoring in general. The statistical differences that are observed demonstrate the dynamic properties of O2 saturation during the feeding periods.

Medical professionals should be aware of these variations, and they should be particularly careful in individuals with underlying health problems. The continuous monitoring of oxygen saturation during the feeding process could offer valuable insights on how the nutrition influences on the respiratory and circulatory functions.

5.3.Effect of Feeding period on Pulse Rate in Neonate with Congenital Heart Defects

The study's results in table (4-3) show that there is no difference in the variability of the pulse rate of babies with Continental heart defects across different feeding periods, as revealed by a p-value of 0.565. The statistical insignificance implies that the pulse rate stays more or less unchanged, while any variations would be within the usual range of the population.

The mean ranks for pulse rate bring more understandings of the dynamic pattern of the changes. immediately after feeding, the mean rank becomes 108.08, highest of all, indicating that there is a possibility of a temporary rise in pulse rate. As a consequence of the metabolic demands associated with the digestion, this preliminary increase may occur .

These findings suggest that the neonates are adapting to their environment or are possibly responding to interventions such as feeding or medical treatments which result in the stabilization of their pulse rate. The concept of the "regulatory mechanism" involves some form of control or regulation inside the bodies of the neonates that enable to maintain a balance in their pulse rate (Herridge et al., 2021).

However, the mean rank becomes further reduced after 1 hour of feeding, with a value of 98.50. This additional decrease may well be an evidence of the body's adaptations to the postprandial state, where the initial metabolic spike dwindles. The initial stabilization prior to the meal, with a median rank of 92.27, indicates a move towards baseline or a state of equilibrium in the absence of the immediate metabolic needs associated with digestion (Niaz et al., 2021).

The outcomes of this study were consistent with the existing literature on neonatal physiology and feeding patterns. For instance, the reports by Niaz et al. (2021) and Patel et al. (2022) have established that new-borns often experience changes in vital signs, including pulse rate, in response to feeding and other external stimuli .

The results do not show statistical significance in the fluctuations of the pulse rate during different feeding periods, however, the detailed investigation of the mean ranks enables a more detailed insight into the temporal patterns of these alterations. More studies with bigger sample sizes may be needed to validate and generalize these observations, but the present study is an important step towards understanding how feeding intervals and pulse rate interrelate in neonates with Continental heart defects.

5.4.Effect of Feeding period on Respiratory Rate in Neonate with Congenital Heart Defects

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 in table (4-4) 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

However, after a 30-minute feeding period, the mean ranks are showing a slight decrease (106.59).

These results suggest the need for more investigations into the short-term effects of feeding on the respiratory dynamics and whether this decrease is consistent across different congenital heart defects, which have been confirmed by Slater et al. (2021)

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 (Luca et al., 2022).

The short-term stabilization of mean ranks just before feeding (85.46) suggests that anticipatory responses or physiological changes before feeding are involved. Examination of the factors involved in this phenomenon can give clues on the regulatory mechanisms that control the neonatal respiratory rates during suckling (Slater et al., 2021).

5.5.Effect of Feeding period on Nasal Flaring in Neonate with Congenital Heart Defects

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 0.001)in the table (4-5). 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.

Before proceeding to the specific time points, it's important to appreciate the importance of the overall statistical variations evident. The p-value of 0.001 supports the hypothesis of a highly significant relationship, which indicates the validity of the obtained results. The data rigor gives weight to the study conclusions, showing that the observed nasal flaring variation is not a chance but is rather associated with underlying factors related to congenital heart disease.

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).

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 (Patel and Carr, 2017).

The act of sucking elevates the physiological load of neonates having congenital heart disease, thus leading to a hyperventilation agree with the study that conduct 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 (Souza et al., 2018).

These findings emphasize the relevance of considering separate time points during the feeding process for neonates with congenital heart defects when measuring nasal flaring .

5.6.Effect of Feeding period on Chest Retraction in Neonate with Congenital Heart Defects

The research on neonates with congenital heart diseases investigates the chest retraction during different feeding periods and the results revealed no significant differences among different time points ($p = 1.000$) in the table (4-6).

This therefore means that the chest retraction, a typical physiological response in new-born babies, is maintained all through the feeding period. The results of the study are in accordance with the previous research that emphasizes the significance of the respiratory patterns of infants with congenital heart defects as they can be influenced by factors such as feeding and may have implications for the overall respiratory function (Johnson et al., 2021; Ding et al., 2023).

Additionally, the study examined several time points, such as before the feeding, immediately after the feeding, 30 minutes after the feeding, and 1 hour after the feeding. The incorporation of these time intervals ensures fuller apprehension of the temporal dimensions of chest retraction in neonates with congenital heart diseases. The consistent absence of any more than the expected variations across these time points ensures the strength of the study's conclusions, which suggests that chest retractions do not change during the feeding process and the time after the feeding.

5.7.Different of Oxygen Saturation SPO2 in Differs of Feeding Methods

The study established an important association between the oxygen saturation in neonates with congenital heart defects (CHD) and the mode of feeding, i.e., breast feeding, bottle feeding, or tube feeding in table (4-7).

The study also revealed that the oxygen saturation levels varied between infants with the same CHD based on how they were fed. The findings of statistically different results should be taken seriously and constitute the mode of feeding in the management of these CHD neonates.

One of the most important findings was the statistical difference in oxygen saturation level between breastfed and bottle-fed neonates ($p = .001$). Hence, the evidence from this study is consistent with previous research stating that breastfeeding increases oxygen saturation (Elgersma et al., 2022). Breast milk is a natural source of immune and nutritional components that are associated with improved respiratory health outcomes, even among neonates with congenital heart disease (Garwolińska et al., 2018; Tsintoni et al., 2020).

As indicated by the study, there is a close relationship between tube feeding and breastfeeding status with oxygen saturation levels, which is statistically significant ($p = 0.045$).

This suggests that breastfeeding may be more valuable in neonates with congenital heart disease than tube feeding when it comes to improving oxygen saturation in these infants. Previous research has indicated the physiological and developmental benefits of breastfeeding that accelerate oxygen saturation (Jones et al., 2021; Rueda et al., 2022).

In the same line, the comparison between bottle-feeding and breast-feeding methods shows a significant difference in SPO2 levels($p=.001$).

This in turn supports the idea of a relationship between neonates with congenital heart disease and improved oxygenation through breastfeeding compared to the use of bottles. It is the responsibility of health care providers to consider these data in their guidance when parents plan the feeding schedule for their infants with CHD. Evidence for this was provided by Rickman (2017), (“The baby more oxygenation during breastfeeding than from bottle feeding”).

Unlike the higher heart rate and faster breathing rate that most babies experience while bottle feeding, breastfeeding tends to normalize a baby's heart rate and breathing, according to the findings of this study. Breastfeeding infants with congenital heart problems has better growth and neurodevelopmental outcomes than using artificial feeding methods (Harrison, 2019).

The study demonstrated that there was no statistical difference in oxygen saturation levels between tube-fed neonates and those who were bottle-fed ($p = 0.164$).

The study results show the relationship between feeding methods and oxygen saturation levels in infants with congenital heart disease, and they also open new insights. The fact that statistically significant differences were observed shows that there are some advantages for this population regarding the breastfeeding process.

5.8.Different of Pulse Rate (PR) in Differs of Feeding Methods

The study had key results in the table (4-8), that showed feeding intake via different methods by neonates with heart defect at birth caused change in their heart rate. This exploration has given important information on feeding methods and the heart rate of infants born with heart defect. The seen differences in heart rates straight after feeding in neonates with CHD provide a much more persuasive support argument to go deeper into the complex connections of the feeding ways and cardiac function.

The statistically significant difference in pulse rates between breastfeeding and bottle-feeding ($p = 0.021$) demonstrates that the physiological effects of feeding methods may also be an important factor to consider in infants with cardiac disorders

Researchers did not observe a statistically significant difference in heart rates of infants that were tube-fed and breastfed ($p= .193$) or between those that were tube-fed and bottle-fed ($p= .431$)

Studies have shown that heart rate tends to increase during breastfeeding. study by Suiter et al. (2007), found that the mean heart rate during breastfeeding was significantly higher than prefeeding values, This increase can be attributed to the physical effort involved in breastfeeding, which includes sucking and swallowing.

However, comparing breastfeeding to bottle feeding in preterm infants has shown that bottle feeding can lead to higher heart rates and more frequent oxygen desaturation episodes. Specifically, infants fed via bottle exhibited significant increases in heart rate and decreases in oxygen saturation compared to those breastfed. This suggests that breastfeeding may provide a more stable cardiopulmonary response during feeding (Patel et al.,2022).

This result is consistent with previous studies that have proven the importance of breastfeeding because of its many benefits, such as strengthening the immune system and improving cardiovascular health in neonates (Krol & Grossmann, 2018).

Study by Chen et al. (2000) concludes that breastfeeding is a more physiological feeding method for the preterm infant and bottle-feeding may be more stressful, There were 2 episodes of apnea (breath pause lasting more than 20 seconds) and 20 episodes of oxygen desaturation ($PaO2 < 90\%$) during bottle-feeding and none during breastfeeding

5.9.Different of Respiratory Rate in Differs of Feeding Methods

It is worthy of note that the report on breathing rates in the neonates with congenital heart defects (CHD) befor-aftere after feeding revealed interesting phenomena regarding the effect of feeding techniques on the essential physiological aspect .

The outcomes in table (4-9) show that there are no considerable breaches in respiratory rates among breastfeeding and bottle-feeding (p=

.352) air tube feeding also (p= .847). Lastly, they did not find any differences in respiratory rates either in the case of bottle feeding and breastfeeding (p= .352) or the case of tube feeding (p= .235) which is another key finding of the study. It is well known that the respiratory rates are not differ significantly tube-feeding and breastfeeding (p= .847) or bottle-feeding (p = .235).

Luca et al. (2022), highlighted the adaptability of respiratory control mechanisms. This implies that the body may modify its respiratory system without a significant and apparent change when a feeding pattern changes.

However, the fact that there are not any differences in respiratory rates between tube-feeding and breast feeding (p= .847) and also bottle-feeding (p= .235) gives another reason to think that specific methods of feeding cannot be supposed to be better or worse for neonates with CHD.

This disputes studies on the subject that came out before and that reported some respiratory benefits of breastfeeding to the detriment of others. For example, research done by Di Filippo et al. (2022), suggested that breastfeeding might also have the capacity to enhance respiratory performance, which possibly is associated with the particular sucking patterns and respiratory rhythm that are displayed in breastfeeding.. This study's results seem to indicate that, for neonates with congenital heart defects, directly after feeding, respiratory rates do not significantly change based upon the feeding method being used.

5.10.Relationship between SPO2, PR, RR and neonates clinical data

5.10.1. Gestational age and SPO2 Saturation

This finding of the study in table (4-10.1) has indicated that there is positive correlation between the oxygen saturation levels before feeding in neonates with congenital heart disease (CHD) and the gestational age (r = 0.300). It follows that as the gestational age goes on, there is a tendency of the oxygen saturation level to also increase before feeding in born neonates with CHD

Study focused on the sensitivity of pulse oximetry in detecting congenital heart defects among newborns. It found that oxygen saturation levels were generally lower in preterm infants, indicating a direct relationship between gestational age and SpO2 levels. This correlation is critical for early diagnosis and management of congenital heart defects (Singh & Chen, 2022)

The study regarding gestational age and lung development have pointed a relationship between them, which suggests that the increase in alveolar surface area and pulmonary capillary density with the prolongation of gestational age has an impact on the gas exchange capacity (Hamilçıkan and Can, 2018). Moreover, the heart and vascular system grow up, including the creation of a more effective mechanism of cardiac output control, which may lead to the elevation of oxygen saturation rates (González-Andrade et al., 2018).

5.10.2. Gestational age and Pulse Rate

The study's results in Table 4-11.1 show that the neonates with the diagnosis of congenital heart defects (CHD) have an inverse correlation between the gestational age and the heart rate. The negative correlation between the gestational age and the cardiac functions of infants with CHD is observed across the feeding intervals-before feeding, immediately after feeding, 30 minutes post-feeding, and 1 hour post-feeding, The negative correlation coefficients ($r = -0.393$, $r = -0.364$, $r = -0.389$, $r = -0.404$) emphasize the strength of this relationship, indicating that as gestational age decreases, the pulse rate tends to increase. This statistical significance is noteworthy, as it provides a quantitative measure of the observed association. The p-values of less than 0.01 further affirm the robustness of these findings, suggesting that the likelihood of obtaining these results by chance is extremely low.

A study highlighted that preterm infants with congenital heart defects often exhibit compromised cardiac function compared to their term counterparts. The findings suggest that as gestational age decreases, cardiac output and overall cardiac function are adversely affected(Singh & Chen, 2022)

Another study examined the relationship between gestational age and various cardiac parameters, finding that lower gestational age was associated with poorer left ventricular structure and function. Specifically, preterm infants demonstrated smaller cardiac chamber sizes and reduced cardiac mass, indicating that gestational age negatively impacts cardiac development in infants with CHD (Du, et al 2023).

5.10.3. Chronological age and Pulse Rate

The research that seeks to assess the relationship between chronological age and pulse rate in neonates suffering from congenital heart disorders, has presented interesting results. The data in table (4-11.2) revealed a strong significant positive correlation at all the tested time points; before feeding, immediately after feeding, 30 min post feeding, and 60 min post feeding. To be more specific, the correlation coefficients (r) were 0.404, 0.451, 0.472, and 0.460, respectively and p-values were less than 0.01, which demonstrates that a statistically significant relationship exists.

Moreover, this chronological age-pulse rate relationship suggests that as babies age and develop their congenital heart defects, there is a gradual increase in their pulse rate. The association is, however, particularly seen during and after feeding, which may be due to the fact that the body’s physiological responses to nutrient intake might influence the observed association. This finding corroborates with previous research that have revealed the feedback and metabolic demands on heart rate regulation in neonates (Lan et al., 2022).

Moreover, the overtaxing stress of feeding, that raises the necessity of a high cardiac output to pay metabolic needs, could further strengthen the relationship between accurent age and congenital heart defects (Toma et al., 2023).

These results of pulse rate monitoring in neonates with congenital heart defects are of a particular clinical importance, since they emphasize the necessity of close observation during and immediately after feeding. The detection of abnormalities in pulse rate at an early stage will be a chance to perform prompt interventions, and as a result, to enhance the quality of patient care. Beyond this, the correlation between chronological age and pulse rate could possibly act as a clinically significant marker for following up the cardiovascular diseases in the risk group of this age population.

Conclusions and Recommendations

5.11. Conclusion:

In light of the results interpretations and its discussion, our study concludes that:

Oxygen saturation shows statistically significant variations across different feeding periods, with a notable decrease immediately after feeding compared to other time points. Pulse rate does not exhibit significant variations across distinct feeding periods, suggesting relative stability in this physiological parameter during different feeding intervals. 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.

The research reveals statistically significant differences in oxygen saturation between breastfed and bottle-fed neonates, emphasizing the potential benefits of breastfeeding in improving oxygen levels for infants with congenital heart disease.

Significant impact of feeding methods on the heart rates of neonates with CHD. Breastfeeding proves to have a distinct physiological effect on heart rates compared to artificial feeding, emphasizing its importance in improving cardiovascular health. There are no significant differences in respiratory rates before and after feeding among breastfeeding, bottle-feeding, and tube-feeding.

Additional research is essential in order to determine the best feeding practice for a vulnerable population of infants with CHD who struggle with feeding success and attaining optimal nutrition.

The major limitation of this study is that it was studied during a single feeding occurrence Comparison cannot be made to subsequent feedings with the same infant. Additionally, a small number of cases with different health issues were used, which makes it difficult to compare. However, our findings provide support for continued research

A comparison of the physiologic response to bottle feeding versus breastfeeding needs to be further investigated in order to determine the best feeding practice.

As nurses, it is imperative to be educated regarding signs of distress and feeding readiness, correlated physiologic data, which can be observed on patient monitors, and infant cues during a feeding. Implementing better practices to improve the feeding experience of infants with CHD can lead to long-term improvements in growth and development.

5.12. Recommendations:

In light of the conclusions reached by the study, the researcher recommends the following:

The Ministry of Health may initiate wide-ranging knowledge and support program for newly mothers that are aimed at enhancing and supporting the breastfeeding of the neonate. This can entail training healthcare professionals, equipping people with useful knowledge, and organizing breastfeeding support groups.

The directions may enlighten on the positive effects of breastfeeding and devise a way to stabilize the observed respiratory rates among neonates with a congenital heart defect so that the babies can enjoy complete health.

Encouraged researchers for Further studies with large samples are needed to evaluate the effect of feeding methods on neonates with CHD and find the best one for a more comfortable neonate for the best care.

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Appendices

Appendix A

Ethical Consideration

Ministry of Higher Education and Scientific Research
University of Karbala / College of Nursing
Scientific Research Ethics Committee

UOK.CoN.23.002
Ethical Committee Code:
Date: 5 / 11 /2023

Research Ethical Approval Form

Title of the research project	
In the English language	In the Arabic language
Effect of Feeding Methods on Oxygen Saturation, Pulse Rate And Respiratory Effort in Neonate with Congenital Heart Defect.	تأثير طرق التغذية على تشبع الاوكسجين ومعدل النبض والجهد التنفسي عند حديثي الولادة المصابين بعيب خلقي في القلب.

Data About the Main Researcher /Student:

Full Name	Scientific Title	Mobile Number	Email
Zainab Ibrahim Rashid	Bachelor's degree in nursing	07722292590	zainabalkafaji014@gmail.com

Data About the Co-author /Supervisor:

Full Name	Scientific Title	Mobile Number	Email
Zeki Sabah Musihb	Ass. Prof.	07709249070	Zaki.s@uokerbala.edu.iq

Study objectives

1. To evaluate the feeding methods of neonatal with congenital heart defect.
2. To determine the effect of Feeding Methods on Oxygen Saturation, Pulse Rate And Respiratory Effort in Neonate with Congenital Heart Defect.
2. To find out the relationship between the neonate demographical characteristic and the oxygen saturation , pulse rate and respiratory effort with feeding method .

Time and Setting of the Study

September 2023 - August 2024
Karbala Health Department / (Imam AL-Hassan AL-Mujtaba Hospital and Karbala Teaching Hospital)

Study Design

Prospective observational study

Sampling method and sample size

Nonprobability Convenience sampling / 50 neonate

Statement of Ethical Commitment

I am Zainab Ibrahim Rashid pledge to conduct the research in accordance with what was mentioned in the protocol above and to commitment that all rules set by the ethical policy are followed in my research process. I also make a commitment to abide by ethical principles, moral values, law and instruction of the institutions. My research carries no bias for ethnicity, gender, regional aspects and is totally impartial and objective. I will have taken an informed consent from participants, and to provide clarifications and information about the study to the sample members. I deal with the data of the sample members in complete confidentiality.

Name and signature of the researcher

Recommendation of the College's Research Ethical Committee

☑ Agreement to conduct the study ☐ Disagreement to conduct the study

Instructor Dr. Sajidah Saadoon Oleiwi
Member

Ass. Prof. Dr. Zeki Sabah Musihb
Member

Ass. Prof. Dr. Ghazwan Abdalhussein
Member

Ass. Prof. Dr. Hassan Abdullah Athbi
Chairman of the Committee

اختصاص تمريض صحة البالغين

Appendix B

Administrative Agreements

Republic of Iraq
Ministry of higher education & scientific research
University of Karbala
College of Nursing
Graduate studies Division

جمهورية العراق
وزارة التعليم العالي والبحث العلمي
جـــامعة كربلاء
كـلية التـمريـض
شعبة الدراسات العليا

التاريخ: 5 / 11 / 2023

العـدد : د.ع/ 330

الى / دائرة صحة كربلاء المقدسة ــ مركز التدريب و التنمية البشرية

م/ تسهيل مهمة

تحية طيبة...

يرجى التفضل بالموافقة على تسهيل مهمة طالبة الدراسات العليا / الماجستير (زينب إبراهيم رشيد) في كليتنا للعام الدراسي (2023-2024) لغرض جمع العينات الخاصة برسالتها الموسومـــة :

"تأثير طرق التغذية على تشبع الاوكسجين ومعدل النبض والجهد التنفسي عند حديثي الولادة المصابين بعيب خلقي في القلب "

"Effect of Feeding Methods on Oxygen Saturation, Pulse Rate And Respiratory Effort in Neonate with Congenital Heart Defect"

**** مـــع التقديـــر ****

أ.م.د. سلمان حسين فارس الكريطي
معاون العميد للشؤون العلمية و الدراسات العليا
5/ 11/ 2023

جامعة كربلاء - كلية التمريض - شعبة الدراسات العليا

نسخة منه الى :
- مكتب السيد المعاون العلمي المحترم .
- شعبة الدراسات العليا .

العنوان : العراق - محافظة كربلاء المقدسة ـ حي الموظفين - جامعة كربلاء
Mail: nursing@uokerbala.edu.iq
website:

Appendix B1

وزارة الصحة
دائرة صحة كربلاء
مركز التدريب والتنمية البشرية
لجنة البحوث

استمارة رقم ٢٠٢١/٠٣
رقم القار : ٢٠٢٣٢١٥
تاريخ القرار ٢٠٢٣/١١/٨

قرار لجنة البحوث

درست لجنة البحوث في دائرة صحة كربلاء مشروع البحث ذي الرقم (٢٠٢٣٢١٥) المعنون

لانجاز بحثها الموسوم

((Effect of feeding methods on Oxygen saturation pulse rate and respiratory effort in neonate with congenital heart defect))

والمقدم من الباحثة:- **(زينب ابراهيم رشيد)**

الى شعبة ادارة المعرفة / وحدة ادارة البحوث في مركز التدريب والتنمية البشرية في دائرة صحة كربلاء بتاريخ ٢٠٢٣/١١/٨ وقررت:

قبول مشروع البحث اعلاه كونه مستوفيا للمعايير المعتمدة في وزارة الصحة والخاصة بتنفيذ البحوث ولا مانع من تنفيذه في مؤسسات الدائرة.

الدكتور
نعيم عبيد المشهداني
طبيب اختصاص
مقرر لجنة البحوث
08/11/2023

المرفقات:
-Choose an item.

وزارة الصحة
دائرة صحة كربلاء المقدسة
لجنة البحوث

ملاحظات:

- تم تخويل عضو لجنة البحوث (د.تقوى خضر عبد الكريم) او مقرر اللجنة (د.نعيم عبيد طلال) للتوقيع على هذا القرار استنادا الى النظام الداخلي للجنة البحوث.
- الموافقة تعني ان مشروع البحث قد استوفى المعايير الاخلاقية والعلمية لإجراء البحث والمعتمدة في وزارة الصحة، اما التنفيذ فيعتمد على التزام الباحث بتعليمات المؤسسة الصحية التي سينفذ فيها البحث.

Appendix B2

Holy Karbala governorate Karbala Health Department Training and Human Development Center Research and knowledge management division	جمهورية العراق	محافظة كربلاء المقدسة دائرة صحة كربلاء المقدسة مركز التدريب والتنمية البشرية شعبة ادارة البحوث والمعرفة العدد: ٢٢٢٣ التاريخ: ٨ / ١١ / ٢٠٢٣

دائرة صحة كربلاء المقدسة
مستشفى كربلاء للأطفال
الصادرة / الواردة
العدد ٢٤٢٦
التاريخ ٢٠٢٣/١١/١٦

الى / جامعة كربلاء/ كلية التمريض

الموضوع /تسهيل مهمة

تحية طيبة....

كتابكم المرقم د.ع / ٣٣٠ في ٢٠٢٣/١١/١٥

نود إعلامكم بأنه لا مانع لدينا من تسهيل مهمة طالبة الماجستير (زينب ابراهيم رشيد) لإنجاز بحثها الموسوم:

((Effect of feeding methods on Oxygen saturation pulse rate and respiratory effort in neonate with congenital heart defect))

في مؤسستنا الصحية / مستشفى الإمام الحسن (ع) المجتبى / وبأشراف الدكتور (حسنين محمد الموسوي) على ان لا تتحمل دائرتنا اي نفقات مادية مع الاحترام .

التدريب والبحوث

التدريب والبحوث
الاضبارة

الدكتور
احمد توفيق عباس
٢٠٢٣/١١/١٩

الدكتورة
تقوى خضر عبد الكريم
مدير مركز التدريب والتنمية البشرية
٢٠٢٣/١١/ ١٦

نسخة منه الى
- مستشفى الامام الحسن(ع) المجتبى / لإجراء اللازم مع الاحترام .
- مستشفى كربلاء للأطفال التعليمي / لإجراء اللازم مع الاحترام.
- مركز التدريب والتنمية البشرية / شعبة ادارة البحوث والمعرفة مع الاوليات .

Appendix C

Questionnaire of the Study

Scale for study :

<u>Section one :</u>

Demographic and Clinical Data of neonate with congenital heart defect.

Demographic data		
1.	**Age**	
	• Gestational age	
	• Current postnatal age	
2.	**Gender**	
	• Female	
	• Male	
3.	**weight**	
	• Birth weight	
	• Current weight	
4.	**Feeding method**	
	• Breastfeeding	
	• Bottle-feeding (formula)	
	• Tube feeding	
5.	**Diagnosis**	
	• Type of cardiac defect (diagnosis)	
	A. Cyanotic lesions	
	B. Acyanotic lesions	

Section two :

Physiological Parameters at different time points for feeding method of neonate with CHD

<table>
<tr><th colspan="2">Physiological parameters of neonates</th><th>Before feeding</th><th>after feeding
Immediately</th><th>after feeding
30 min</th><th>after feeding
1 hour</th></tr>
<tr><td colspan="2">Oxygen saturation (SPO2)</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Pulse rate (PR)</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Respiratory efforts</td><td>Respiratory rate (RR)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Present of Nasal flaring</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Present of Chest retraction</td><td></td><td></td><td></td><td></td></tr>
</table>

Appendix D
Expert's Panel

قائمة اسماء لجنة الخبراء

ت	اسم الخبير	اللقب العلمي	التخصص	سنوات الخبرة	مكان العمل
1.	د. نهاد محمد قاسم	استاذ	تمريض اطفال	38 سنة	جامعة بابل/ كلية التمريض/فرع الاطفال
2.	د. فاطمة مكي محمود	استاذ	تمريض بالغين	28 سنة	جامعة كربلاء/ كلية التمريض/فرع البالغين
3.	د. خميس بندر عبيد	استاذ	تمريض اطفال	25 سنة	جامعة كربلاء/ كلية التمريض/فرع الاطفال
4.	د. ساجدة سعدون عليوي	استاذ مساعد	تمريض نسائية	28 سنة	جامعة كربلاء/ كلية التمريض/فرع النسائية
5.	د. حسام عباس داود	استاذ مساعد	تمريض بالغين	22 سنة	جامعة كربلاء/ كلية التمريض/فرع البالغين
6.	د. حسن عبد الله عذبي	استاذ مساعد	تمريض بالغين	21 سنة	جامعة كربلاء/ كلية التمريض/فرع البالغين
7.	د. محمد باقر حسن	استاذ مساعد	تمريض اطفال	20 سنة	جامعة الكوفة/ كلية التمريض/فرع الاطفال
8.	د. زيد وحيد عاجل	استاذ مساعد	تمريض اطفال	16 سنة	جامعة بغداد/ كلية التمريض/فرع الاطفال
9.	د. محمد طالب عبد هادي	مدرس	تمريض اطفال	10 سنة	جامعة بابل/ كلية التمريض/فرع الاطفال
10	د. حقي اسماعيل منصور	مدرس	تمريض صحة مجتمع	7 سنة	جامعة كربلاء/ كلية التمريض/فرع صحة مجتمع
11	د. حسنين محمد ابراهيم	استشاري	اختصاص دقيق جراحة القلب	24 سنة	وزارة الصحة/ م. الأمام الحسن المجتبى/ شعبة جراحة القلب المفتوح
12	د. رياض حسن خلف	استشاري	اختصاص اطفال	23 سنة	وزارة الصحة/ م. ابن سيف للأطفال
13	د. جعفر وفي جنك	استشاري	اختصاص اطفال	12 سنة	وزارة الصحة/ م. ابن سيف للأطفال
14	د. نغم نبيل عبد الرزاق	استشاري	اختصاص فسلجه طبية	11 سنة	وزارة الصحة/ م. ابن سيف للأطفال
15	سحر توفيق مرعي	ممرض جامعي	ممرض NICU	8 سنة	وزارة الصحة/ مستشفى الامام زين العابدين

Appendix E

Monitor neonate oxygen saturation, pulse rate, respiratory rate for neonates


JUMPER


JUMPER


JUMPER

Appendix F
Statistical expert's approval

Republic of Iraq
Ministry of higher education & scientific research
University of Karbala
College of Nursing
Graduate studies Division

جمهورية العراق
وزارة التعليم العالي والبحث العلمي
جـــامعة كربلاء
كـلية التـمريـض
شعبة الدراسات العليا

إقرار الخبير الإحصائي

أشهد بأن الرسالـة الموسومـة :

"تـأثير طـرق التغذيـة علـى تشبع الاوكسجين ومعدل النبض والجهـد التنفسي عنـد حديثي الـولادة المصابين بعيـب خلقي فـي القلـب"

" Effect of Feeding Methods on Oxygen Saturation, Pulse Rate And Respiratory Effort in Neonate with Congenital Heart Defect "

قد تـم الإطـلاع علـى الإسلوب الإحصائـي المتبـع في تحليل البيانـات و إظهـار النتائـج الإحصائيـة وفـق مضمـون الدراسـة و لأجلـه وقعت .

توقيع الخبير الإحصائي :

الإسم و اللقب العلمي : أ.م.د. ياسر عبد كاظم

الإختصاص الدقيق : إحصاء تطبيقي

مكان العمل : جامعة كربلاء / كلية الإدارة والاقتصاد

التاريخ : ٢١ / ٤ / 2024

العنوان : العراق ـ محافظة كربلاء المقدسة ـ حي الموظفين ـ جامعة كربلاء
Mail: nursing@uokerbala.edu.iq website: nursing.uokerbala.edu.iq

Appendix G
Approval of the linguistic expert

Republic of Iraq Ministry of higher education & scientific research University of Karbala College of Nursing Graduate studies Division		جمهورية العراق وزارة التعليم العالي والبحث العلمي جـــــامعة كربلاء كـلية التـمريــض شعبة الدراسات العليا

إقرار الخبير اللغوي

أشهد بـأن الرسالـة الموسومـة :

" تأثير طرق التغذية على تشبع الاوكسجين ومعدل النبض والجهد التنفسي عند حديثي الولادة المصابين بعيب خلقي في القلب "

" Effect of Feeding Methods on Oxygen Saturation, Pulse Rate And Respiratory Effort in Neonate with Congenital Heart Defect "

قد جرى مراجعتـها من الناحيـة اللغويـة بحيث أصبحت بإسلوب علمـي سليم خـالٍ من الأخطـاء اللغويـة و لأجلـه وقعت .

توقيع الخبير اللغوي :

الإسم و اللقب العلمي : أ.م.د. توفيق مجيد أحمد

الإختصاص الدقيق : علم اللغة التطبيقي

مكان العمل : جامعة كربلاء \ كلية

التاريخ : 13/ 5 / 2024

المستخلص

الخلفية : عيب القلب الخلقي هو الشذوذ الخلقي الأكثر شيوعا، حيث يؤثر على 9 من كل 1000 ولادة حية. يواجه ما يصل إلى 60% من الأطفال المصابين بتشوهات القلب الخلقية فشلًا في النمو وضعف زيادة الوزن، وينشأ التحدي المتمثل في الحفاظ على الاستقرار الفسيولوجي أثناء الرضاعة من عدم التنسيق بين المص والبلع والتنفس.

الهدف: تهدف هذه الدراسة إلى استكشاف الاختلافات في تشبع الأكسجين ومعدل النبض والجهد التنفسي عبر طرق التغذية المختلفة وتأثيرها على الولدان المصابين بأمراض القلب الخلقية على فترات زمنية مختلفة.

الطريقة: أجريت دراسة رصدية في مستشفى كربلاء التعليمي للأطفال في الفترة من 26 ايلول 2023 إلى 13 ايار 2024. تم اختيار خمسين حديثي الولادة الذين تم تشخيص إصابتهم بأمراض القلب الخلقية في مستشفى كربلاء التعليمي للأطفال في مدينة كربلاء المقدسة، والذين تقل أعمارهم عن 28 يومًا، بشكل ملائم.

النتيجة: البيانات التي تم جمعها والمعلمات الفسيولوجية التي تم قياسها على فترات زمنية مختلفة أثناء عملية تغذية الوليد المصاب بتشوهات القلب الخلقية تشمل تأثير عملية التغذية لمستويات تشبع الأكسجين (ذات دلالة احصائية = 0.017)، ومستويات معدل النبض (ذات دلالة احصائية = 0.565)، ومعدل التنفس (ذات دلالة احصائية = 0.027)، وتراجع الصدر (ذات دلالة احصائية = 1.000)، وحرق الأنف (ذات دلالة احصائية = 0.001). يختلف إحصائياً بين أولئك الذين يرضعون رضاعة طبيعية والرضاعة بالزجاجة (ذات دلالة احصائية = .001) والتغذية بالأنبوب (ذات دلالة احصائية = 0.045) في تشبع الأكسجين، مع وجود فروق ذات دلالة إحصائية بين الرضاعة الطبيعية والرضاعة بالزجاجة (ذات دلالة احصائية = 0.021) في معدل النبض.

الاستنتاج: يتقلب تشبع الأكسجين بشكل ملحوظ عبر فترات التغذية، في حين يبقى معدل النبض ثابتا. يرتبط الانتقال من الرضاعة الطبيعية إلى التغذية بالزجاجة والأنبوب بانخفاض تشبع الأكسجين وزيادة معدل النبض، ويظهر معدل التنفس اختلافات كبيرة عبر فترات التغذية، ولا توجد فروق ذات دلالة إحصائية في معدلات التنفس قبل الرضاعة وبعدها بين الرضاعة الطبيعية، والتغذية بالزجاجة، والتغذية بالأنبوب. تغذية.

توصيات : يمكن لوزارة الصحة إطلاق برنامج واسع النطاق للمعرفة والدعم للأمهات الجدد يهدف إلى تعزيز ودعم الرضاعة الطبيعية لحديثي الولادة المصابين بعيب خلقي في القلب.

جامعة كربلاء
كلية التمريض

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رسالة تقدمت بها

زينب ابراهيم رشيد

الى

مجلس كلية التمريض / جامعة كربلاء

وهي جزء من متطلبات نيل درجة الماجستير علوم في التمريض

إشراف

أ.م.د. زكي صباح مصيحب

نيسان 2024م **شوال 1445هـ**