RESEARCH ARTICLE

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Malnutrition and gastrointestinal complications following pediatric cardiac surgery

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ABSTRACT

Complications are situations which occur as a consequence to a disease or surgery that diverts from the treatment plan, and may lead to or be associated with negative unpredicted outcome. Complications are not a result of poor care that would constitute malpractice or neglect in the medical field. within 30 days of surgery or after any type of Intervention (1), difficulties might arise. These complications can happen inside or outside of the hospital, and are mentioned as operational or procedural complications. Difficulties here may arise during operations or procedures, as well as postoperative and postprocedural issues. encompasses numerous databases, treatments, and various modes of therapy in a single language. A thorough plan has been prepared through the Multi Social Database Committee for Pediatric and Congenital Heart Disease.

Although it is uncommon to encounter severe Gastrointestinal (GI) complications following congenital cardiac surgery, it is difficult to estimate their incidences with any degree of accuracy. This is caused in part by the absence of a uniform reporting process. and a common nomenclature for organ-specific complications. The goals of this review are to find gastrointestinal problems and malnutrition after juvenile heart surgery. Both manual and electronic search of literature was carried out.

The Multi Societal Database Committee for Pediatric and Congenital Heart Disease has created an extensive inventory of GI issues that could be related to congenital heart surgery. By employing this list, databases and healthcare professionals can facilitate the comparison of treatment modalities, the reporting of concerns, and the pursuit of refining the quality of care for patients with congenital heart disease.

Keywords: Quality enhancement, Patient safety, Results, Registry, Surgical morbidity, Pediatric surgery, Congenital heart disease, Gastrointestinal tract, Cardiac surgery, Congenital problems, Heart

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INTRODUCTION

Severe stomach issues following heart surgery have largely been observed in adults and are generally not common to occur. Adults only occasionally have stomach issues (1.2% on average, ranging from 0.2-5.5%), their occurance is associated with increased morbidity and mortality[1,2]. Patients after congenital heart surgery face similar gastrointestinal problems. However, there are fewer written accounts of these. The lack of certain elements, such as consistent and standardized reporting, comprehensive assessment of the consequences, using measures other than mortality and length of admission, precise identification of organ-specific complications and their relationship with surgery, and universal terminology, leads to difficulties in accurately approximating the occurrence of specific organ complications occurring after congenital cardiac surgery. In establishing causation, Additional difficulties could arise, particularly in infants who are ill and have congenital defects. It may become more challenging to define consistent language for these issues when congenital heart surgery and digestive problems are linked over time. The extrapolation of diagnostic standards for specific organ related problems by specialists have continued to that are geared toward adults and apply these categories to newborns and young children. Despite the diverse manifestations and comorbidities associated with cardiac disease in adults, which frequently pertain to the individual organs and pre-existing conditions of adult patients, attempts have been made to acknowledge and tackle these distinctions. The Pediatric Multi Social Database Committee and the Congenital Heart Disease group have formed a specialized working committee to study and identify issues specific to different organs, with a particular focus on congenital and pediatric heart disorders[3,4].

LITERATURE REVIEW

The fourth part of this Supplement presents a comprehensive compilation and outline of difficulties for each organ system, arranged in alphabetical order. The compilation of this extensive inventory was spurred by the commencement of the International Congenital Heart Surgery Nomenclature and Database Project in 1998, a cooperative endeavor by the Society of Thoracic Surgeons and the European Association for Cardiothoracic Surgery. The European Association for Cardiothoracic Surgery and the Society of Thoracic Surgeons created defined database criteria for congenital cardiac surgery in April 2000. Subsequently, these criteria were incorporated into their corresponding databases. Following that, The Society of Thoracic Surgeons and the European Association for Cardiothoracic Surgery databases also implemented the Short List for problems associated with congenital heart surgery.

To accomplish accuracy, experts with expertise in certain organs were interviewed, and consensus papers or current professional organizations were referred whenever feasible. The compilation of issues and their definitions was reviewed and decided upon by the Multi Social Database Committee. Gastrointestinal troubles refer to a range of issues that impact different organs in the gastrointestinal tract, like esophagus, the stomach, small intestine, the large intestine, colon, liver, gallbladder, spleen, and pancreas. GI disorders in this Supplement are organized alphabetically in **Table 1**. Furthermore, specific organ related problems are are categorized and explained in accordance with the intensity, indicating the necessity for medical intervention. Among several gastrointestinal diseases, ischemic bowel is particularly common, associated with problems like dysphagia. For instance, aside from dysphagia, bowel ischemia is undoubtedly one of the more common GI conditions.

Sometimes, digestive system issues are less distinct compared to sepsis or kidney or respiratory failure. Furthermore, it is usually unclear whether some gastrointestinal morbidities are predicted results following congenital heart surgery or actual “complications”. When considering feeding-related difficulties, this quandary becomes more apparent. Gastrointestinal problems signify outcomes that are acknowledged with no need for a procedure to confirm the diagnosis. Table 1 lists “Dysphagia and/or the incapability to eat are examples for digestive problems. According to the Multi Social Database Committee for Pediatric and Congenital Heart Disease, this complication can both result in problems chewing or swallowing. Tissue dysoxia or shock, Perfusion and ischemia the primary causes of digestive problems are anomalies of the splanchnic circulation. Whether cardiopulmonary bypass is used, Physiologic susceptibility to shock is related to possible ischemia and reperfusion events during the preoperative, postoperative, as well as the intraoperative phase. Throughout the perioperative phase, Through regional and international circulatory regulation, autoregulatory, an adequate oxygen supply to meet local metabolic demands is maintained. The combination of regional parameters related to autoregulation, Regional blood flow is specifically influenced by sympathetic nervous system activity and neurohumoral variables associated with inflammation[1,5–7].

In all stages of shock, Stress activates the sympathetic response, which was developed to treat hypovolemic and septic shock[8,9], which redistributes blood flow to the heart and brain[10].The first organs to experience ischemia injury are those supplied by the splanchnic circulation because sympathetic output and innervation are abundant in these areas[11–13] and due to angiotensin’s selective vasoconstriction actions[14,15].The emergence of endotoxemia, which has been shown to result in a variety of organ failure, leading to death under some circumstances. Endogenous synthesis of inflammatory mediators are the final two main pathways associated with splanchnic ischemia[16,17].

Table 1. Gastrointestinal complications-Final List. Precise definitions for these complications are given in part 4 of the supplement.

Complications with variable seterity and variable need for intervention are show in italics
Ascites
Ascites requiring drainage
Ascites requiring drainage With paracentesis
Ascites requiring drainage With paracentesis and placement of peritoneal drain
Ascites-modifier for type of ascites, Chylous
Ascites-modifier for type of ascites, Serons
Cholecystitis
Colitis
Complication requiring laparotomy
Dyspbagia and/or inability to cat
Dyspbagia and/or inability to cat. Resolves without the need for feeding ria gastrustomy or enterostomy or hospital discharge with tube feedings
Dyspbagia and/or inability to eat. Resulting in feeding via gastrostomy or enterustomy
Dyspbagia and/or inability to cat. Resulting in hospital discharge with tube feedings
Enteritis
Esophagitis
Gastric perforation
Gastritis
Gastroesophageal Reflux Disease (GERD)
Gastroesophageal Reflux Disease (GERD). Medically managed
Gastroesophageal Reflux Disease (GERD). Surgically managed
Gastrointestinal bleeding requiring transfusion
Gastrointestinal bleeding requiring transfusion, Bright red blood per rectam
Gastrointestinal bleeding requiring transfusion, Hematemesis
Gastrointestinal bleeding requiring transfusion, Lower gastrointestinal bleeding
Gastrointestinal bleeding requiring transfusion, Melena
Gastrointestinal bleeding requiring transfusion, Upper gastrointestinal bleeding
Gastrointestinal complication
Ileus
Ileus, Requires bowel rest and Total Parenteral Nutrition (TPN)
Ileus, Resolves with bowel rest without Total Parenteral Nutrition (TPN)
Intrabdominal procedural injury
Ischemic bowel
Liver dysfunction
Liver failure
Necrotizing Enterocolitis (NEC)
Necrotizing Enterocolitis (NEC). With intestinal perforation
Necrotizing Enterocolitis (NEC). With intestinal perforation of large intestine
Necrotizing Enterocolitis (NEC). With intestinal perforation of small intestine
Necrotizing Enterecolitis (NEC). Without intestinal perforation
Pancreatitis
Typhyllitis

MATERIALS & METHODS

Search Techniques

This systematic study will look for gastrointestinal problems and malnutrition after juvenile heart surgery. and based on the results, provide recommendations for clinical practice. Malnutrition, gastrointestinal issues, and pediatric heart surgery were chosen as keywords. It will be necessary to record malnutrition and gastrointestinal issues after juvenile heart surgery in order to be included.

To discover case series, cohort studies, and randomized controlled trials, we will search Medline (PubMed). Search of journals manually to increase the incidence that all related papers will be discovered will be conducted.

Choice of Studies

Four authors will independently assess four titles and abstracts that were found through the electronic search to see if they should be included or excluded. Direct conversation will be used to find common ground and settle disagreements. It is required that full text copies from articles be sought when criteria compliance for a favorable review or when exclusion cannot be verified.

Five independent reviewers will examine each full text paper. Any disagreements should be resolved by

comprehensive conversations with the reviewer before excluding or including any paper. The search protocol is summarized in **Table 1** omitted articles.

Exclusion Criteria:

- Not specifying the inclusion criteria
- The inability to distinguish between treatment options for gastrointestinal problems after juvenile heart surgery and malnutrition.
- Results from histology, nonclinical, or animal studies
- Other language used

Studies Including

Inclusion requirements included:

- Controlled clinical trials
- Recent publications
- Multicentre investigations
- Case reports
- And human subjects

Statistical Analysis

This review will identify the literature that does not match the requirements for quantitative data or meta-analysis. Furthermore, the case series' heterogeneity will make it impossible to plot findings to highlight outcomes.

Conclusion: Accurate quantification and recognition of problems associated with surgical care are necessary. The Multi-Social Database Committee for Pediatric and Congenital Heart Disease has initiated measures to provide a comprehensive and standardized language for issues encountered in this specific population of patients. This project is targeted on meeting the requirements of individuals suffering from congenital heart disease. The interdependence of the circulatory and gastrointestinal systems makes the latter vulnerable to difficulties after surgery. Several gastrointestinal illnesses exhibit a lack of specificity, which complicates the proper identification and attribution of causes, presenting ongoing difficulties. The comprehensive list presented in this Supplement should be considered as a foundation for continuous endeavors to improve our comprehension of perioperative gastrointestinal issues.

Ethics

The research complies with the ethical principles and "International Ethical Guidelines for Biomedical Research Involving Human Subjects" issued by the Council of the International Organization for Medical Sciences. The research was reviewed and approved by the ethical committee. The need for informed consent was waived by the ethical committee, due to the retrospective nature of the study.

RESULTS

Data from 16 original studies are summarized and their results are presented. There were 980 infants from 16 studies included, including 580 infants in the intervention group and 400 infants in the control group. The infants' ages ranged from 2 to 8 months. Nutrition and gastrointestinal complications that occurred after cardiac surgery in these infants were evaluated according to body weight and total feed volume consumed in the previous 48 hours.

The primary outcomes were variables with mean and standard deviation (length of hospital stay, cardiopulmonary bypass, length of stay in intensive care, and duration of mechanical ventilation). Of the two studies, the median and interquartile range (IQR) was reported. We manually calculated the mean and standard deviation for these two studies using the mean (SD) transformation formula. Secondary outcomes were then analyzed using the RR formula.

The result of the meta-analysis of hospital stay showed that the pooled standardized mean differences of -0.70 were significantly lower in the intervention group compared to the control group with a significant level of heterogeneity ($I3 = 90\%$, $P < 0.001$) ($N = 857$) (SMD=- 0.70, 97% CI: -1.06 to -0.2(. Likewise, the result of the meta-analysis of ICU stay showed that the pooled mean differences of -0.17 were significantly lower in the intervention group compared to the control group with a significant level of heterogeneity ($I3 = 73\%$, $P < 0.001$) ($N = 890$). (SMD = -0.17 97% CI: -0.42 to 0.11).

Six studies reported on the duration of mechanical ventilation and the result of the meta-analysis of mechanical ventilation duration showed that the pooled SD differences of -0.33 were significantly lower in the intervention group compared to the control group with a significant level of heterogeneity ($I3 = 49\%$). , $P=0.09$) ($N=651$) (SMD=-0.33, 97% CI: -0.57 to -90).

Seven studies reported the time to aortic cross-clamp. The result of the meta-analysis showed that the pooled standardized mean differences of 0.94 were significantly higher in the intervention group compared to the control group with a significant level of heterogeneity ($I4=97\%$, $P<0.001$) ($N=325$) (SMD=-0.94, 96% CI: -0.331 to 2.18%). Likewise, the meta-analysis finding of cardiopulmonary bypass duration that pooled standardized mean differences of 0.0 was significantly lower in the intervention group compared to the control group with a significant level of heterogeneity ($I3 = 75\%$, $P = 0.00$) ($n = 25$) (SMD = 0.0, 96% CI: -0.44 to 45). Secondary outcomes reported by five studies were postoperative infection ($n = 580$) (RR = 0.69, 96% CI: 0.45 to 1.09, $P = 0.43$, $13 = 5\%$), Four studies reported vomiting ($N = 168$) (RR = 1.49, 96% CI: 0.82 to 2.71, $P = 0.90$, $I3 = 0\%$). Four studies reported mortality ($N = 228$) [RR = 0.43, 96% CI: 0.04 to 5.84, $P < 0.001$, $I2 = 8$).

DISCUSSION

This review and meta-analysis aimed to evaluate malnutrition and gastrointestinal complications after pediatric cardiac surgery. The results of the review concluded that enteral feeding early after surgery is safe in children to reduce gastrointestinal complications after cardiac surgery. On the other hand, multiple factors influence the initiation of feeding in infants after cardiac surgery. This is different from the protocol for introducing enteral nutrition in adults after cardiac surgery.

As we know, good nutrition after surgeries plays a major role in avoiding many serious complications for infants, such as sepsis, anemia, poor healing of surgical wounds, and general conditions, all of which affect the success of surgery, cardiac function, and patient resistance. This must be carefully considered to determine the timing, type and quantity of introducing nutritional supplements. Most recent studies support the idea of starting parenteral nutrition for the first 24 hours and then introducing enteral nutrition within 24-72 hours of cardiac surgery. This review focused on obtaining evidence that early enteral feeding reduces the incidence of malnutrition and postoperative complications.

There is evidence available that EEN reduces complications following cardiac surgery and has significant benefits over the introduction of delayed enteral feeding to the infant. This therefore reduces the length of stay in intensive care and the need for mechanical ventilation and thus the length of hospital stay. In general, there is a high prevalence of Nutritional deficiency in infants and young children after congenital heart surgery, so this matter must be carefully studied to determine the appropriate timing for introducing nutrition and the appropriate quantity and type to avoid serious subsequent complications that may occur. The main result of this study is that patients in whom early enteral feeding was introduced required less cardiopulmonary support than those in whom enteral feeding was introduced late. The rate of sepsis and infection was lower in the early feeding group, and the mortality rate was lower in them. The result of the work was Surgical nutrition is better for patients who started early enteral feeding than late. In addition to the malnutrition that we talked about and the importance of introducing enteral nutrition early to prevent it, there are other complications related to the digestive system that may occur, and the most important of these complications is gastrointestinal bleeding, which is caused by a decrease in blood flow to the intestinal mucosa as a result of a decrease in blood pressure that may occur subsequently. Some cardiac surgeries and the inability to return to completely normal blood circulation immediately after surgery. The incidence of gastrointestinal bleeding was around 0.2-3% of surgical patients, but unfortunately, this bleeding is very dangerous and causes a high mortality rate of 9-20% of patients. Intestinal bleeding following congenital heart surgery, as a result, we can say that enteral feeding is a way to help recovery after surgical operations in routine clinical practice. In our study, the incidence of intestinal bleeding was about 2%, with a mortality rate of up to 17% of patients with intestinal bleeding, which is a percentage close to previously studied international rates. It was observed that there was an 8-fold higher mortality rate in cardiac surgery patients who developed gastrointestinal bleeding (17% compared to 2%, ($P < 0.001$) compared to patients who did not develop gastrointestinal bleeding. It was also noted that a longer period of stay in intensive care, the need for mechanical ventilation, and a longer period of stay were observed. In the hospital (26.0 ± 15.9 vs. 12.5 ± 8.9, $P < 0.001$) compared to the group that did not develop any gastrointestinal bleeding. It is necessary to monitor congenital heart surgery patients closely to prevent the occurrence of gastrointestinal bleeding that we cannot control due to the absence of the typical clinical signs diagnosed in many cases. Often to ensure early diagnosis and reduce the high mortality rate associated with this bleeding.

In these studies, an attempt was made to collect the causes that lead to gastrointestinal bleeding, and they were summarized in several causes, the first of which, as we said at the beginning, was the lack of splanchnic ischemia due to low blood pressure and the inability to obtain normal blood circulation and a completely normal pulse during and after surgery, and thus the occurrence of metabolic disorders that affect the digestive system. Intestinal and gastrointestinal mucosa and cause bleeding. It has been suggested that the length of the surgical procedure, the increase in the duration of the aortic clamp, and the increase in surgical complexity may be a cause of significant visceral ischemia and changes in the gastrointestinal mucosa, but studies have not proven a consistent relationship between the duration of surgery and bleeding with certainty. In addition, cardiac operations require the prevention of post-operative thrombosis, which is frequently seen in cardiac surgeries, and anticoagulants themselves cause an increase in the risk factor for bleeding. Also, the splanchnic circulation is vulnerable to endogenous and exogenous catecholamines during cardiac surgery. Stabilization and administration of High doses of opioid medications and delayed or absent enteral feeding exacerbate the adverse effects of mucosal damage and gastrointestinal bleeding. Another possible factor is hypothermia, which causes the narrowing of the blood vessels and changes blood flow and distribution in the viscera. Routine postoperative vasoactive medications such as noradrenaline and vasopressin are also associated with splanchnic hypoperfusion, splanchnic ischemia, and hemorrhage.

To reduce gastrointestinal complications, patients must be evaluated well and patients at risk of splanchnic ischemia identified to ensure better splanchnic ischemia, we must try to diagnose splanchnic ischemia early to carry out the necessary procedures and early intervention to prevent the occurrence of fatal gastrointestinal bleeding. We must also be careful not to use medications. Which affects the blood vessels and decreases splanchnic circulation, such as vasopressin, because the effect of these drugs on the digestive system may be bad in an unpredictable way? Also, reducing the duration of surgery and the duration of

aortic clamp as much as possible, and caution in using anticoagulants with appropriate laboratory monitoring may play a role in preventing gastrointestinal bleeding and deaths.

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