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The effect of preoperative carbohydrate loading on pediatrics clinical conditions: Systematic Review

Pengaruh carbohydrate loading pra bedah terhadap kondisi klinis pediatrik pasca bedah: Systematic Review

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Abstract

Preoperative fasting was implemented to reduce the gastric residual volume (GRV) and mitigate the risk of pulmonary aspiration and hyperglycemia. Hyperglycemia can contribute to systemic infections and surgical wounds in pediatric patients, potentially extending the duration of hospitalization. Preoperative carbohydrate loading within the Enhanced Recovery After Surgery (ERAS) protocol has demonstrated efficacy in reducing the risk of postoperative complications in both adult and pediatric patients. However, scientific studies focusing on pediatric patients remain limited. This study aimed to provide a comprehensive synthesis of the effects of preoperative carbohydrate loading on preoperative GRV and pre- and postoperative blood glucose levels in pediatric surgical patients. Literature was extracted using the PRISMA method, identifying relevant studies from ScienceDirect, PubMed, Sage Journal, and ProQuest databases, using predefined keywords. Articles were screened and reviewed if they included pediatric surgical patients, were randomized controlled trials (RCTs), and had a prospective design following the PICOs model, published between 2014 and 2024. The findings indicate that preoperative carbohydrate loading does not significantly affect preoperative GRV, as evidenced by the absence of residuals (0–12,7 mL), and contributes to the stabilization of pre- and postoperative blood glucose levels (<99 mg/dL). In conclusion, preoperative carbohydrate loading is safe for pediatric patients and may serve as an optimal strategy for improving postoperative outcomes. This approach is expected to support the implementation of preoperative dietary protocols for pediatric patients in hospital settings.

Keywords: Blood glucose, GRV, pediatric, preoperative carbohydrate

Abstrak

Puasa pra pembedahan dilakukan untuk mengurangi volume residu lambung (GRV) agar mencegah aspirasi paru dan hiperglikemia. Hiperglikemia menyebabkan infeksi sistemik dan luka pembedahan pada anak yang akan memperpanjang waktu rawat inap. Preoperative carbohydrate loading dalam metode Enhanced Recovery After Surgery (ERAS) mengurangi resiko komplikasi pasca pembedahan pada pasien dewasa dan pediatrik, namun kajian ilmiah pada pasien pediatrik masih terbatas. Penelitian bertujuan memberikan sintesis komprehensif terkait preoperative carbohydrate loading terhadap GRV pra pembedahan dan kadar glukosa pra dan pasca pembedahan pasien bedah pediatrik Literatur yang digunakan diekstrasi dengan metode PRISMA, yaitu diidentifikasi dari database ScienceDirect, PubMed, SageJournal dan ProQuest menggunakan kata kunci yang ditentukan. Artikel diskrining dan dikaji apabila menggunakan sampel pasien bedah pediatrik, randomized controlled trial (RCT) dan bersifat prospektif sesuai dengan model PICOs, yang terbit dari tahun 2014 sampai 2024. Hasil, bahwa *preoperative carbydrate loading* tidak signifikan mempengaruhi GRV

pra pembedahan, terlihat dari tidak adanya residu (0-12,7 ml) dan dapat menstabilkan kadar glukosa darah pra dan pasca pembedahan (<99 mg/dL). Kesimpulan, *preoperative carbohydrate loading* aman untuk pasien pediatrik dan dapat menjadi alternatif optimalisasi kondisi pasien pediatrik pasca bedah. Hal tersebut diharapkan dapat menjadi rekomendasi implementasi protokol diet pra pembedahan pediatrik di rumah sakit.

Kata Kunci: Glukosa darah, GRV, preoperative carbohydrate, pediatrik

Introduction

Hyperglycemia often occurs in postsurgical patients due to postsurgical physiological trauma. Based on study results Wu et al. (2013), 68,4% of pediatric patients had blood glucose levels >110 mg/dl and 18,8% had blood glucose levels >200 mg/dl after gastrointestinal surgery. Hyperglycemia occurs due to increased activity of pituitary hormones, which causes increased secretion of glucagon and decreased secretion of insulin in the pancreas. The glucagon hormone causes an increase in glycogenolysis and gluconeogenesis while the failure of insulin secretion results in catabolism which causes blood glucose levels to increase (Fitri et al., 2020). Hyperglycemia is also significantly associated with an increase in the total length of hospital stay and the occurrence of infections, systemic infections, and surgical wounds. Besides that, Agus et al. (2014) also stated that the incidence of hyperglycemia increases mortality and morbidity rates.

However, several studies have reported that hypoglycemia can be a form of stress after surgery. Unstable blood glucose levels after surgery are one of the effects of inappropriate preoperative methods. Increased and decreased blood glucose levels in pediatric surgical patients require attention. Prolonged fasting can lead to insulin resistance and nutrient metabolism (Alberta et al., 2021). However, Indonesia still does not have a consensus on the presurgical diet in pediatric patients.

Since 2000, Indonesia has developed and gradually implemented the Enhanced Recovery After Surgery (ERAS) method. This method is a standardized approach that optimizes pre-, peri, and post-surgical preparations to reduce post-surgical stress, reduce morbidity, and speed up patient healing. One component of the pre-surgical ERAS protocol is administering a liquid carbohydrate diet (carbohydrate loading) one or two hours before surgery to prevent metabolic stress due to prolonged fasting (Jiang et al., 2018a). Optimal body condition after fasting is expected to speed up trials of enteral administration in patients and reduce the use of drains or A nasogastric tube (NGT) tubes post-surgery thereby shortening the hospital stay (La et al., 2022). This method can be used in both gastrointestinal and non-gastrointestinal surgical patients. ERAS can now not only be applied to adult patients but also to pediatric patients (Ha et al., 2023). However, administering a liquid carbohydrate diet or ERAS has not been widely adopted in pediatric surgery due to limited research data and requires development regarding safe doses of carbohydrate liquids in pediatrics, so a universal pediatric ERAS protocol is not yet available (Jiang et al., 2018).

The preoperative diet should consider the possibility of preoperative aspiration. Preoperative aspiration occurs when stomach contents (food or fluid) enter or return to the respiratory tract. Aspiration was prevented by preoperative fasting (Anesthesiology, 2017). Preoperative fasting is performed to reduce gastric residual volume (GRV) during anesthesia induction (Carvalho et al., 2020). Study Bozoglu et al. (2024) showed that there was no difference in GRV between the control group that had fasted since the evening and the treatment group that was given liquid carbohydrate food two hours before surgery, so it can be concluded that the risk of aspiration does not increase with the provision of a liquid carbohydrate diet and reduced fasting time (Bilku et al., 2014).

Based on the description above, the researcher intends to conduct a systematic review with the aim of reviewing all studies on the provision of pre-operative liquid carbohydrate diet or ERAS on the safety of administration as seen from the pre-operative gastric residual volume (GRV) and glucose levels in pre- and post-operative pediatric surgical patients.

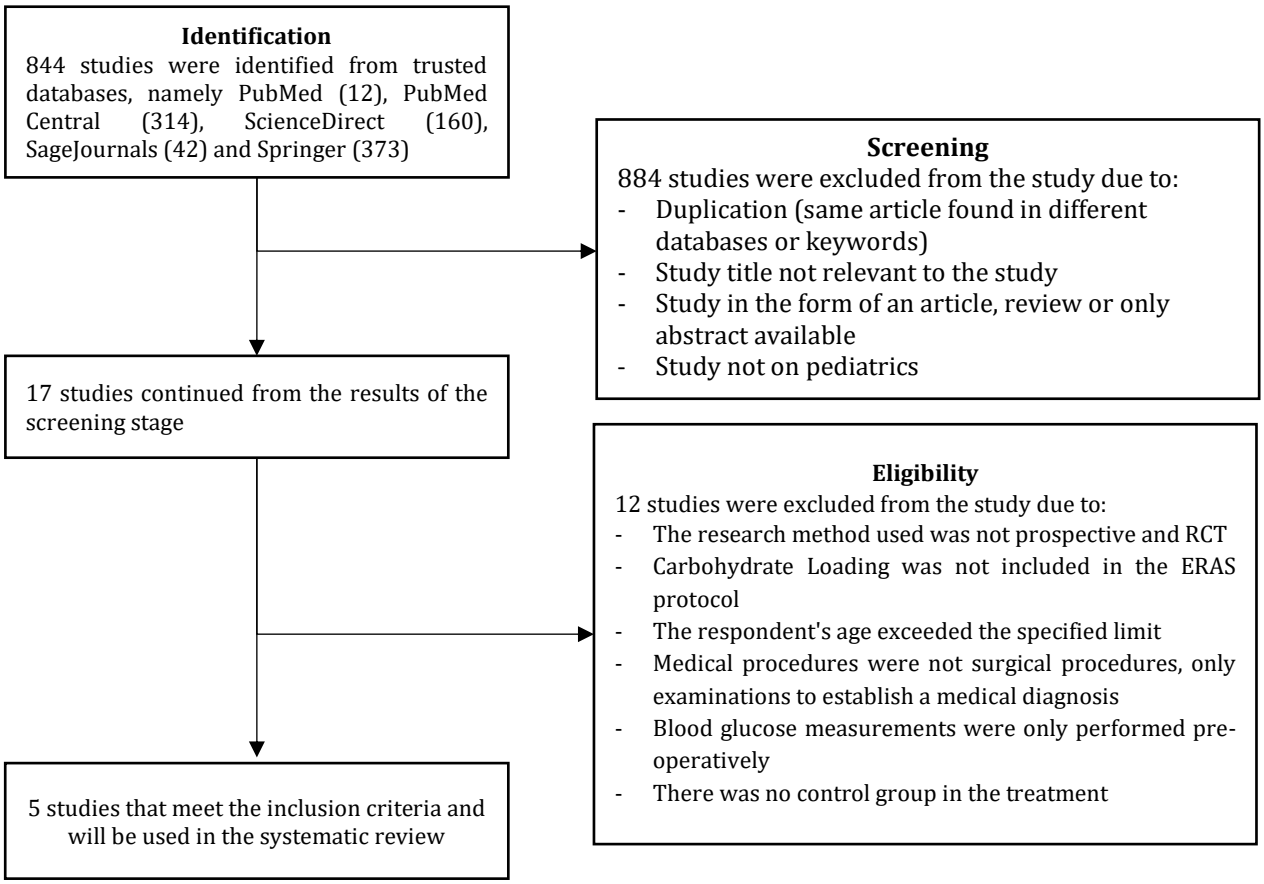

Figure 1. Study selection flowchart used in systematic review research

Methods

This study used a systematic review method, without a meta-analysis. Secondary data were obtained from several trusted journal databases such as ScienceDirect, PubMed, Sage Journal, and ProQuest. The number of databases used varied owing to the limited number of studies discussing the administration of carbohydrate loading in pediatric patients; therefore, relevant studies were difficult to find. In addition, the selection of the five databases considered the validity of the database and received accreditation from SCOPUS.

Relevant keywords used in this study were in English and had considered MeSH Terms, namely "Preoperative oral carbohydrate" OR “Carbohydrate Loading” OR “Carbohydrates Loading Diets” OR "Pre-operative Oral Carbohydrate" OR “ERAS” AND "Pediatric" OR “Child” AND “Clinical Outcomes” OR “Blood Glucoses” OR “Gastric Emptying.” The search strategy and research questions were arranged according to the PICOS method as follows:

P (Population*)*
Children aged 0-18 years who underwent elective surgery. The types of elective surgeries performed are both gastrointestinal and non-gastrointestinal. The types of surgery included ophthalmology surgery, unilateral or bilateral inguinal herniorrhaphy, pull through in Hirschsprung’s disease, sacrococcygeal teratoma, biliary atresia, or congenital anal atresia stage II. In addition, the respondents did not experience pre-surgery eating disorders or have any complications.

I (Intervention)
Provision of clear liquid food containing carbohydrates as a preoperative diet for the digestive tract.

C (Comparison)
Comparison between the control group undergoing surgery with a traditional or conventional protocol, namely fasting from midnight on the day before surgery or 6 hours before surgery, and the intervention group given carbohydrate loading in pre-surgery (ERAS),

namely by fasting from solid or liquid foods completely since midnight and given clear fluid foods containing carbohydrates before surgery.

O (Outcome)
Effect of preoperative liquid carbohydrate diet on preoperative GRV and pre- and postoperative glucose levels.

S (Type of Study)
The study used as a data source in this study used prospective research methods and RCT.

The inclusion criteria used in this study were that the study must be relevant to the research question, the method used was RCT and prospective, fully accessible, using English, indexed by Scopus, and the year of publication between 2014 and 2024. In addition, the exclusion criteria were studies with press/manuscript-accepted status, studies duplicated in other databases, and pediatric patients undergoing emergency surgery. The studies were identified, filtered, and extracted using the PRISMA method, as shown in Figure 1. The identification process, journal screening, and critical appraisal were carried out using Excel 2021 software, and the literature list was compiled using Mendeley software.

Result and Discussion

Based on the results of the review of several studies related to the effect of preoperative liquid carbohydrate feeding on preoperative GRV and pre- and post-operative blood glucose levels, 844 relevant journals were found, and 5 journals were suitable as data sources. Several of these studies are summarized in Table 1.

Carbohydrate Loading Time

The results of a review of 5 studies showed that liquid carbohydrate foods were administered 1 or 2 h before surgery. This is in line with research Wang et al. (2024), administration of liquid carbohydrate food within 2-4 hours before surgery does not significantly affect blood glucose levels. The difference in administration time occurred because of the different guidelines used for the ERAS protocols.

The American Society of Anesthesiologists recommends fasting from solid food or formula for 6 hours, fasting from breast milk for 4 hours and administration of liquid carbohydrate 2 hours before anesthesia for surgery (American Society of Anesthesiologists, 2017), while the European Society of Anesthesiology. Recommends that liquid carbohydrate foods be given 1 hour before surgery (Disma et al., 2019). In addition, the European Society of Anaesthesiology and Intensive Care (ESAIC) recommends the 6-4-3-1 technique, namely solid food up to 6 hours, formula milk up to 4 hours, breast milk up to 3 hours and liquid carbohydrate food 1 hour before surgery (Frykholm et al., 2022).

Table 1. Summary of studies meeting the research inclusion criteria

Researchers and Years	Research Title and Subject	Measured Parameters	Methods and Interventions	Results and Conclusions
Bozoglu et al. (2024)	Title: The Effect of Oral Fluid Administration 1 Hour before Surgery on Preoperative Anxiety and Gastric Volume in Pediatric Patients Subjects of the Study: Pediatric surgical patients aged 5 – 12 years who will undergo elective surgery at the department of surgery and ophthalmology with ASA anesthesia score I and II at Ceyhan	- Anxiety score - GRV - Preoperative blood glucose level - Gastric antral cross sectional area (CSA)	Research methods: Prospective, Randomized Trial Research Intervention: 90 children were divided into 3 research groups, namely - F (30 people): children were fasted since 6 hours before surgery - W (30 people): children were given 5 ml/kgBW of water 1 hour before surgery	Result Anxiety score of group C was lower than W and H although not significant ($p<0,001$). CSA, GRV and preoperative blood glucose in C and W had significant differences to F, namely CSA, GRV and preoperative blood glucose in F were higher than the other two groups ($p<0,05$). Conclusion Consumption of carbohydrate clear fluid

Researchers and Years	Research Title and Subject	Measured Parameters	Methods and Interventions	Results and Conclusions
	State Hospital, Adana		- C (30 people): children were given 5 ml/kgBW of carbohydrate clear fluid 1 hour before surgery The maximum total volume of fluid given to patients was 250 ml and the carbohydrate clear fluid given was apple juice with an energy content of 44 kcal and 11 grams/100 ml of carbohydrates.	before surgery can reduce anxiety in children and conventional fasting protocols (6 hours before surgery) have not been shown to reduce GRV which is thought to cause pulmonary aspiration.
Carvalho et al. (2020)	Title: Metabolic and inflammatory benefits of reducing preoperative fasting time in pediatric surgery Subjects of the Study: Pediatric surgical patients at Santa Casa de Misericórdia Hospital in Cuiabá aged 2 – 6 years who will undergo elective unilateral or bilateral inguinal herniogrhaphy surgery	- Albumin levels - IL-6 - C-reactive protein (CRP) - Insulin resistance (IR-HOMA index) - Preoperative blood glucose levels	Research methods: Prospective, RCT Research Intervention: 47 patients were divided into 2 treatment groups, namely the fasting group (fasting since midnight before surgery) and the carbohydrate (CHO) group (fasting from solid foods since midnight and given liquid carbohydrate food 2 hours before surgery in the form of 12,5% maltodextrin dissolved in 150 ml of water)	Result There was no significant difference between the two treatment groups in IL-6, albumin, IR-HOMA index and blood glucose levels before and after pediatric surgery, but 4 children from the fasting group experienced pre-operative hyperglycemia (>99 mg/dL). CRP in the CHO group was also lower than fasting. Conclusion There are no harmful side effects by reducing fasting time and can improve the child's metabolic response. Liquid carbohydrate foods are also safe to give before surgery.
Tang et al. (2020)	Title: Application of enhanced recovery after surgery during the perioperative period in infants with Hirschsprung's disease – A multi-center randomized clinical trial Subjects of the Study: Infant patients with a diagnosis of Hirschprung's Diseases	- Postoperative length of stay (LOS) - Postoperative leukocytes (WBC) - Postoperative CRP - Pre- and postoperative glucose levels - Time to first bowel movement - Time to start	Research methods: Multicenter, Prospective, randomized Research Intervention: 148 children were grouped into 3 pullthrough methods (transanal endorectal pull-through, aparoscopic-assisted pull-through and then randomly assigned to 2 treatment groups,	Research result: The length of hospitalization in the ERAS group was shorter, which was 7,5 days, while in the TRAD group it was 9,5 days. In addition, intraoperative fluid volume and CRP levels were lower in the ERAS group. There were no significant differences in leukocyte levels and child growth and development after surgery. Blood

Researchers and Years	Research Title and Subject	Measured Parameters	Methods and Interventions	Results and Conclusions
	(HSCR) who will undergo pullthrough surgery and are >6 months old in 3 hospitals (Children's Hospital of Nanjing Medical University, Anhui Provincial Children's Hospital, and Xuzhou Children's Hospital of Xuzhou Medical University).	regular diet - Postoperative nutrition plasma markers - Mean intraoperative fluid volume - Time to cessation of intravenous infusion - Incidence of postoperative complications - Cost of hospitalization - Parental satisfaction - Child growth during 6 months	namely traditional (TRAD) and ERAS. One of the different protocol components is preoperative fasting, namely patients fasted since midnight before surgery in the traditional group (73 people) and patients were asked to consume formula milk 6 hours or breast milk 4 hours and liquid carbohydrate food 2 hours before surgery in the form of 10% glucose (10 ml / kgBW) in the ERAS group (75 people)	glucose levels in the ERAS group were higher pre-anesthesia but lower post-surgery. The time to first bowel movement, starting a regular diet and stopping intravenous infusion were also faster in the ERAS group. Conclusion: The ERAS protocol is safe to perform on infants or children who will undergo pullthrough procedures and can optimize the child's condition after surgery and reduce the patient's length of hospitalization.
Jiang et al. (2018)	Title: Safety and benefit of pre-operative oral carbohydrate in infants: a multi-center study in China Subjects of the Study: Infants aged 0 to 1 year who underwent elective surgery for Hirschsprung's disease, sacrococcygeal teratoma, biliary atresia, or congenital anus atresia stage II at the Department of Pediatric Surgery at Children's Hospital of Nanjing Medical University, Anhui Provincial Children's Hospital, Xuzhou Children's Hospital, Children's Hospital of Soochow University, Changzhou Children's Hospital, and Wuxi Children's Hospital between March 1, 2014 and January 31, 2017.	- Pre- and post-operative blood glucose levels - GRV - Length of patient stay - Crying incidence ratio	Research methods: Multicenter, Prospective, randomized Research Intervention: 1200 infants were grouped into 1 control group and 3 treatment groups of 300 infants each. Control group (A). Group A was required to fast for 6 hours before surgery. B, C and D were given liquid food containing 10% carbohydrates as much as 5 ml/kgBW, 10 ml/kgBW and 15 ml/kgBW 2 hours before surgery.	Research result: There was no significant difference between preoperative fasting protocol and length of stay of patients. Crying ratio in group A was higher compared to group B, C and D. Blood glucose levels in group B, C and D were higher than group A preoperatively and A, B, D were higher than C postoperatively. Gastric residue was also almost found, only found in 15 children in group D. Conclusion: Liquid carbohydrate food with 10% is safe to be given 2 hours before the baby undergoes surgery. Based on research, the tolerance for giving liquid carbohydrate food is 10 ml/kgBW.
Gawecka & Mierzewska-Schmidt	Research Title Tolerance of, and metabolic effects of,	- Blood glucose levels - Serum Insulin	Research methods: Prospective, RCT	Research result: There was no significant difference in pre- and

Researchers and Years	Research Title and Subject	Measured Parameters	Methods and Interventions	Results and Conclusions
(2014)	preoperative oral carbohydrate administration in children-a preliminary report Subjects of the Study: Pediatric patients aged > 1 year who will undergo elective abdominal and thoracic surgeries	- Insulin resistance (IR-HOMA Index) all were performed pre- and post-surgery, the afternoon after surgery and the next day	Intervention: Pediatric patients were divided into 2 treatment groups, namely group 1 and group 2. Group 1 was given commercial carbohydrate clear fluid (preOp, Nutricia, Holland) containing 12,6% carbohydrates with a dose of 10 ml/kgBW 2 hours before the procedure. Meanwhile, group 2 underwent standard preoperative fasting.	post-operative blood glucose levels in the two treatment groups, although blood glucose levels in group 1 were always higher, while insulin resistance was higher in group 2. Conclusion: Preoperative liquid carbohydrate feeding in children has been proven to be safe and does not cause dangerous complications during anesthesia and can improve carbohydrate metabolism by reducing insulin resistance. The benefits of liquid carbohydrate feeding in pediatrics are the same as in adults.

The time of administration of carbohydrate fluids 1 or 2 h before surgery can be used depending on the digestive condition of the patient who will undergo surgery, namely the presence or absence of accompanying diseases (Bilku et al., 2014). According to Mesbah & Thomas (2017), gastric emptying time after consuming clear fluid is 30 minutes. The addition of carbohydrates causes a longer gastric emptying time depending on the type of carbohydrate added (sucrose, fructose, and galactose are digested faster than glucose). Raval et al. (2023) also stated that the average time required to digest apple juice in children is 90-180 minutes. Reducing fasting time in children aims to reduce discomfort, such as hunger and need, and reduce postsurgical metabolic stress.

Carbohydrate Loading Dosage

The results of the review of five studies showed that several doses were used as presurgical diets. The doses administered ranged from 5 ml/kgBW to 15 ml/kgBW with a carbohydrate concentration of between 10% and 12,6% per 100-250 ml as listed in Table 2. Study Jiang et al. (2018) showed that liquid food with 10% carbohydrate content and a dose of 10 ml/kgBW provided good tolerance. Good tolerance was assessed on the basis of increased glucose levels. In addition, no gastric residue was found pre-anesthesia, and the risk of aspiration and other post-surgical metabolic disorders decreased.

Study Gawecka & Mierzewska-Schmidt (2014) and Tang et al. (2020) also used the same dose in administering liquid carbohydrate food to pediatric patients. However, the dose was different in the study Bozoglu et al. (2024) which uses a dose of liquid carbohydrate food administration of 5 ml/kgBW at 1 hour before surgery. Pediatric consensus regarding the amount or dose of preoperative carbohydrate loading administration has not been available to date, but there is a lot of study evidence that shows that reducing fasting time and providing liquid carbohydrate food as a preoperative diet can improve clinical outcomes of patients (Raval et al., 2023).

Gastric Residual Volume (GRV) Pre Surgery

The results of this study (Table 2) showed that the provision of liquid carbohydrate food did not increase the risk of aspiration in the lungs. GRV in patients who were given liquid carbohydrate food 1 or 2 hours before surgery was not significantly different from the control group (almost no gastric residue was found), even the

study Bozoglu et al. (2024) showed that GRV in patients in the control group was higher compared to the treatment group. The study Tudor-Drobjewski et al. (2018) also showed that 68% of the group given preoperative carbohydrate liquid food had a lower GRV and a lower risk of postoperative vomiting. The GRV in the control group was an average of 0.41 ml/kgBW, whereas in the treatment group, it was an average of 0,28 ml/kgBW. The insignificant effect of preoperative carbohydrate liquid food on preoperative GRV also does not indirectly increase the risk of pulmonary aspiration during anesthesia.

This is in line with research Kwatra et al. (2020), Preoperative carbohydrate fluid administration does not significantly affect GRV also because the gastric emptying time for clear liquid foods is faster than formula milk and/or breast milk, which is less than one hour. Research has also shown that 43% of formula milk leaves the stomach within 1 h and 91% of formula milk within 3 hours in children aged <5 years. The younger the child, the faster the gastric emptying time, ranging from 1 to 3 h. In addition, gastric emptying is 19-73% in children aged ≤2 years and 53-89% in children aged>2 years.

However, GRV is still believed to be related to pulmonary aspiration; therefore, fasting before surgery is expected to reduce the volume of gastric residue and reduce the risk of aspiration. However, there is no consensus on the critical limit or maximum limit of gastric residue that will not cause aspiration. In addition, aspiration was observed in an empty stomach. This occurs due to regurgitation of fluid from the small and large intestines (Raval et al., 2023).

Table 2. Pre-operative GRV levels, pre- and post-operative blood glucose

Author and Year	Research Subject	Dose of Liquid Carbohydrates Used and Time of Administration	GRV	Blood Glucose Levels Before Surgery	Blood Glucose Levels After Surgery
Bozoglu Akgun et al. (2024)	There are 90 pediatric surgical patients aged 5-12 years who will undergo elective surgery.	Carbohydrate clear fluid 5 ml/kgBW 1 hour before surgery	12,7 ml	90 mg/dL	N/A
Carvalho et al. (2020)	Pediatric surgical patients aged 2-6 years who will undergo elective unilateral or bilateral inguinal herniorrhaphy surgery, totaling 40 patients	Liquid carbohydrate food 2 hours before surgery in the form of 12,5% maltodextrin dissolved in 150 ml of water.	N/A	86 mg/dL	91 mg/dL
Tang et al. (2020)	nfant patients with a diagnosis of Hirschprung's Disease (HSCR) who will undergo pullthrough surgery and are >6 months old in 3 homes totaling 148 children.	10% glucose solution (10 ml/kgBW) is given 2 hours before the procedure.	N/A	6,1 mmol/L	6,2 mmol/L
Jiang et al. (2018)	There were 1200 babies aged 0 to 1 year who underwent elective surgery.	10% carbohydrates as much as 5 ml/kgBW, 10 ml/kgBW and 15 ml/kgBW depending on the treatment group with a duration of 2	There was no residue in all treatments	5 ml/kgBB: 4,3 mmol/L 10 ml/kgBB: 4,4 mmol/L 15 ml/kgBB: 4,5 mmol/L	5 ml/kgBB: 11 mmol/L 10 ml/kgBB: 11,9 mmol/L 15 ml/kgBB: 12 mmol/L

Author and Year	Research Subject	Dose of Liquid Carbohydrates Used and Time of Administration	GRV	Blood Glucose Levels Before Surgery	Blood Glucose Levels After Surgery
		hours before the procedure.			
Gawecka & Mierzewska-Schmidt (2014)	Pediatric patients aged > 1 year who will undergo elective abdominal and thoracic surgeries, totaling 20 people	Commercial carbohydrate clear fluid (preOp, Nutricia, Holland) containing 12,6% carbohydrates with a dose of 10 ml/kgBW was given 2 hours before the procedure.	N/A	84,8 mg/dL	124,2 mg/dL

Pre and Post Surgery Blood Glucose Levels

The results of the study in Table 2 show that the provision of liquid carbohydrate food one or two hours before surgery does not significantly affect pre- and post-surgery blood glucose levels or is still within safe limits (<99 mg/dL). However, the preoperative blood glucose levels of the treatment group were higher than those of the control group, but the blood glucose levels of the treatment group were not significantly different and were even lower after surgery. Research results Carvalho et al. (2020) showed that 4 of 23 patients in the control group experienced hyperglycemia (blood glucose levels > 99 mg/dL) preoperatively and no patients experienced hyperglycemia in the treatment group. This is also in line with the results of the study Tang et al. (2020), Blood glucose levels in the control group were always higher when compared to the treatment group both pre- and post-surgery.

Reducing the amount of carbohydrates consumed preoperatively due to longer fasting time can cause postoperative insulin resistance, thereby increasing glucose catabolism, postoperative inflammation, and decreasing the rate of wound healing. It is characterized by a state of postoperative hyperglycemia, even with increased morbidity and mortality. However, the cause of increased blood glucose levels post-operatively can be multifactorial, such as disruption of body homeostasis due to post-operative pain or other comorbidities (Carvalho et al., 2020; Tudor-Drobjewski et al., 2018).

However, postsurgical hypoglycemia is rare. This is because the surgical condition causes an excessive response from inflammatory markers, such as IL-6, which causes a sudden increase in blood glucose and returns to normal–12-24 hours after surgery without insulin assistance (Verhoeven et al., 2020).

Recovery Duration and Post-Surgery Hospitalization

Administration of carbohydrate fluids and reduction in the duration of pre-operative fasting in adults has been shown to reduce the metabolic stress response, glycogen breakdown and accelerate the duration of recovery and hospitalization of patients (Jiang et al., 2018). This is in line with research Tang et al. (2020), The duration of hospitalization of patients undergoing the pre-operative ERAS protocol was shorter compared to patients who fasted from midnight before the day of surgery, namely 7.5 days and 9.5 days. However, a different thing happened in the study Jiang et al. (2018) showed that there was no significant difference in the duration of recovery and hospitalization between patients who were given pre-operative carbohydrate fluids and fasted for 10 hours.

The duration of patient recovery and hospitalization is not only influenced by post-surgical metabolic stress or blood glucose conditions, but is also influenced by several things such as the child's medical history, medications being consumed, the child's nutritional status, and wound care methods (Nurjanah et al., 2019). In addition, support from the patient's family or caregivers and nurses also greatly influences the success of implementing the ERAS protocol in optimizing the condition of post-surgery patients (Lam & Seemann, 2024).

Conclusion

Preoperative fasting aims to prevent the risk of pulmonary aspiration during anesthesia and postoperative metabolic complications. Based on the results of a systematic review, preoperative carbohydrate loading can improve clinical outcomes in pediatric surgical patients, one of which is more stable postoperative blood glucose levels, thus decreasing the risk of postoperative infection. In addition, carbohydrate loading 1 or 2 h before surgery has been proven to be safe and does not increase the risk of pulmonary aspiration. Carbohydrate loading can be a safe and effective alternative to maintain optimal patient conditions both pre- and post-surgery and can help reduce the duration of recovery and hospitalization of pediatric surgical patients.

It is recommended that further studies related to the safe dose of carbohydrate loading in children, organoleptic tests, and the acceptability of liquid carbohydrate foods be conducted to further determine the type and volume of carbohydrate fluids that are appropriate for pediatric pre-surgery diets. In addition, a universal formulation of ERAS protocols in children needs to be carried out to support the healing of pediatric surgical patients.

The limitations in finding carbohydrate loading studies in pediatric patients make this study still need further refinement. In addition, the studies conducted have not focused on a particular race or nation; therefore, the conclusions produced cannot be generalized to different populations.

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