

The Effects of Preoperative Carbohydrate Loading on Postoperative Nausea and Vomiting-

An Integrative Review

Jennifer Meyer, BSN, SRNA

Bryan College of Health Science

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jenmeyer272@gmail.com

Abstract:

Background: Postoperative nausea and vomiting (PONV) is a very common problem among surgical patients. Despite improved methods of risk identification, the incidence of PONV remains as high as 20–40%.¹ It can increase hospital length of stay and greatly reduce patient satisfaction.¹ The purpose of this integrative review is to examine the effects of both oral and IV preoperative carbohydrate loading on the incidence of postoperative nausea and vomiting in surgical patients. **Methods:** A review the literature was completed by searching for the terms related to preoperative carbohydrate loading and PONV. **Results:** Twenty studies met the criteria and were analyzed for this review. Twelve publications showed that PONV or antiemetic usage was reduced by either oral or IV preoperative carbohydrate intake.²⁻¹³ Seven publications showed that PONV was not changed significantly by these interventions.¹⁴⁻²⁰ One study had no patients with PONV.²¹ There was a low rate of complications discussed among the research with only one case of aspiration. **Conclusion:** There is a need for more research to be done in this area. However, preoperative carbohydrate loading shows evidence of some decreased PONV with low instance of complications.

Keywords: Carbohydrate Loading, PONV, Nausea, Vomiting, IV Dextrose

Introduction:

Postoperative nausea and vomiting (PONV) is a common problem among surgical patients. Despite improved methods of risk identification, the incidence of remains as high as 20–40%.¹ It can increase hospital length of stay and greatly reduce patient satisfaction.¹

Antiemetic medication, PONV prediction models, and decision support models have all been heavily researched to help prevent PONV.²² These interventions help predict patients that are high risk for PONV and help direct medical decisions to help reduce their chance of having PONV.²³

Currently, many enhanced recovery after surgery (ERAS) protocols advocate the use of carbohydrate loading prior to surgery to decrease rates of insulin resistance, headache, anxiety, and feelings of thirst, and hunger.⁴ Preoperative carbohydrate loading is an additional intervention that is showing some benefit to help reduce PONV. Preoperative carbohydrates can be administered in several different forms either through oral ingestion or intravenous (IV) infusion of 5% dextrose in a solution such as lactated ringers (D5LR). The purpose of this integrative review is to examine the effects of both oral and IV preoperative carbohydrate loading on the incidence of postoperative nausea and vomiting in surgical patients.

Methods:

A review the literature was completed by searching for the terms: preoperative carbohydrate loading, preoperative carbohydrate, carbohydrate, preoperative carbohydrate rich drinks, and intravenous dextrose. These terms were cross referenced with nausea, vomiting, and PONV. The research databases that were used include PubMed, Google Scholar, and the Cochrane Library. The research exclusion criteria included: multi-step interventions such as

ERAS protocols, articles greater than eight years old, and articles not published in the English language.

Review of Literature:

A total of 11,711 people from 20 publications fit the inclusion criteria and were evaluated as a part of this review (See Appendix A). The research ranged widely in the geographic location that they were performed in, with only one study being completed in the United States. Most of the research included in this review was performed under general anesthesia. However, there were two studies that were performed using spinal anesthesia.^{13,16} One source did not specifically state what type of anesthesia was used for their study.²¹

A majority of the patient populations in this review were considered American Society of Anesthesiologist (ASA) class I-II. Patients with more comorbidities and a higher ASA rating may have a higher aspiration risk. Only five studies included ASA status greater than two.^{4,8,13,18,19} Cakar et al⁴ had a population that included ASA I-III. There was a significant change in vital signs between the three ASA groups. Yang et al¹⁸ and Harsten et al¹³ also included ASA I-III. They had no significant changes between their ASA groups. McCracken et al⁸ had ASA I-IV. This study was retrospective and very large. Feguri et al¹⁹ was performed on CABG surgeries (ASA III-IV), but none of the patients had high risk factors for aspiration such as gastroesophageal reflux disease or diabetes mellitus.

Control Groups

The effectiveness of preoperative carbohydrate loading can be compared with several control groups. These include: traditional fasting for at least six to eight hours, a placebo drink that has a similar appearance and taste of the preoperative carbohydrate drink without the added carbohydrates, and IV fluids that do not contain carbohydrates. Some sources in this analysis

compared both traditional fasting, the placebo drink, and/or IV dextrose to preoperative carbohydrate loading, and were reviewed under multiple subheadings below.³⁻⁶ While others only compared one control group to preoperative carbohydrate loading.^{2,7,13,14,16-19,21} Twelve studies evaluated traditional fasting to oral preoperative carbohydrate intake.^{2-8,14-17,21} Five studies evaluated a placebo drink to oral preoperative carbohydrate loading.^{3,5,13,18,19} Five studies evaluated IV fluids with and without IV carbohydrate intake.^{9-12,20} Only Cakar et al⁴ compared oral preoperative carbohydrates, IV dextrose, and traditional fasting.

Fluid intake

Oral administration of preoperative carbohydrates varied between studies. The typical dose for an intervention carbohydrate drink ranged from 400-800 ml of 12.5% carbohydrate twelve hours before surgery, and 400 ml of 12.5% carbohydrate drink two hours before surgery.^{2,4-7,13,14,17-19,21} Asakura et al¹⁵ used 18% carbohydrate and 2.5% carbohydrate respectively. The IV carbohydrate used in most of the studies was 5% dextrose in lactated ringers or water. Typically, 250-500 ml was given at the end of the procedure and continued until finished in the recovery room.^{9,10,12,20} However, Atashkhoei et al¹¹ used 10ml/kg/h of D5LR that started 5 min prior to surgery and then ran throughout the procedure.

Oral Preoperative Carbohydrate Intake Versus Traditional Fasting

There were seven sources of twelve that showed a significant statistical decline in PONV or antiemetic usage with oral preoperative carbohydrate loading when compared to traditional fasting.^{3-5,7,8} Singh et al³ showed mean PONV scores at 0-4 hours were significantly lower than the fasting groups for laparoscopic cholecystectomy cases. Cakar et al⁴ found that only postoperative vomiting scores were significantly decreased when oral preoperative carbohydrates were compared to their fasting group. Sada et al⁵ divided their sample size by the type of surgery

being performed. They found that nausea scores were decreased significantly in cholecystectomy patients but not in colorectal patients. The authors discussed that the length of operation and increased time to replace fluid deficit in the colorectal procedure patients may contribute to decreased nausea rates in the colorectal fasted patients.⁵ Libiszewski and colleagues⁷ also found that PONV was significantly reduced with preoperative carbohydrates as compared to the fasted control group with thyroidectomy cases.

McCracken et al⁸ performed a large retrospective review on 9,916 patients after a policy change was implemented that allowed any type of clear liquids up to two hours before surgery. PONV rates were significantly reduced when compared to the fasting group.⁸ Carbohydrate drinks were not specifically used in this intervention. Water and other clear liquids were encouraged up until 2 hours before surgery. They had a significant decrease in the rate of PONV 24 hours post-surgery.

Ajuzieogu et al⁶ showed both decreased antiemetic consumption as well as lower PONV in the preoperative carbohydrate group at 24 hours in abdominal myomectomy cases. Yilmaz et al² did not show a decrease in PONV. However, they did find a significant reduction in the amount of antiemetics used in the first 24 hours after surgery.

Of the twelve studies that analyzed preoperative carbohydrate loading to traditional fasting, five studies showed that there were no significant differences between these interventions.^{14-17,21} Dilmen et al¹⁴ found that PONV rates were not significantly different for micro-lumbar discectomy cases. They only had five patients of forty-five in their study that had nausea. Canbay et al²¹ had no nausea or vomiting reported in either their fasted group or their carbohydrate group. This study was completed on patients undergoing radical prostatectomy and made up of a population of older men. Asakura et al¹⁵ reported PONV rates were not

significantly changed from the control fasted group.¹⁵ It should be noted that their population was also mainly made up of older men, with 94 men and 40 women in their sample size. Raksakietisak et al¹⁶ found PONV rates were not significantly decreased from their fasting group. This study was performed on total knee replacement under spinal anesthesia with midazolam. Itou et al¹⁷ showed PONV rates were decreased but not significantly compared to their control group. The study was completed on two thirds women, 199 out of 300. Surgery varied from otorhinolaryngological, orthopedic/plastic, gynecological, breast, thyroid, and thoracic surgeries.

Oral Preoperative Carbohydrate Intake Verses Oral Placebo Intake

Of the five studies comparing oral preoperative carbohydrate drinks to a placebo drink, three studies showed a significant decline in PONV.^{3,6,13} Singh et al³ and Ajuzieogu et al⁶ both reported PONV was significantly less in their preoperative carbohydrate drink group when compared to their placebo drink group in laparoscopic³ and myomectomy surgeries.⁶ Ajuzieogu and colleagues⁶ showed their preoperative carbohydrate drink group had less antiemetic usage when compared to placebo drink at 24 hours. Harsten et al¹³ stated they found lower rates of nausea in the carbohydrate drink group than in the placebo group immediately before surgery and at 36 and 48 hours postoperatively. This was done on total hip arthroplasty patients under spinal anesthesia.

There were two studies of five that showed that there was no benefit to providing a drink that contained carbohydrates when compared to a placebo drink.^{18,19} Yang and colleagues¹⁸ reported PONV was not significantly reduced between their carbohydrate drink group and their placebo drink for radical distal gastrectomy surgery. It should be noted that only four people total between the two groups (n=60) had nausea in this study. Feguri et al¹⁹ also showed that PONV

was not significantly reduced between their preoperative carbohydrate group and their placebo drink. This study also had a small sample size of 40 people and was completed on CABG procedures that went to the ICU intubated post operatively.

IV Carbohydrate Fluid Verses Non-Carbohydrate IV fluids

The last group of studies reviewed examined IV fluids that contained carbohydrates or placebo fluids that contained no carbohydrates in their solution.⁹⁻¹² Four studies showed significant decline in PONV or antiemetic usage when patients were given IV fluids that contained carbohydrates. Mishra et al,⁹ Firouzian et al,¹⁰ and Atashkhoei et al⁶ all reported PONV was significantly reduced in the IV carbohydrate group when compared to placebo fluids. All three of these studies were performed on laparoscopic cases. Dabu-Bondoc et al¹² reported their antiemetic medication was significantly decreased between the IV carbohydrate group and the LR group. They also reported their postoperative nausea scores were lower, but not significantly. This study was a small study (n=62) completed on high risk female PONV patients with 47% of their patient population having prior PONV.¹²

Patel et al²⁰ found PONV rates were not significantly changed between IV carbohydrate fluids and placebo IV fluids. This study was completed on multiple types of surgeries including gynecological, urologic, and breast surgeries.²⁰ There were relatively high rates of nausea (82 of 162 people) associated with this study. The authors noted that as surgery time increased, so did the rate of PONV. Only 20% of patients experienced PONV within the first 2 hours after surgery if their surgery was < 1 hour, compared to 45% of when surgery duration was 1 to 2 hours, and 57% of patients when surgery duration was greater than 2 hours.²⁰ The authors noted that the optimal dose and timing of IV dextrose administration remains unclear and warrants further study.²⁰

Cakar et al⁴ was the only study that compared oral preoperative carbohydrate, IV dextrose, and traditional fasting. They only found a significant decline in PONV when comparing oral carbohydrates to traditional fasting. Cakar et al⁴ did not find any significant difference between IV dextrose and traditional fasting. The timing of the IV dextrose given in the Cakar et al⁴ study was different compared to the other^{9-12,20} IV dextrose studies. One liter of IV dextrose was given between midnight and two hours before surgery, instead of towards the end of the surgical case as the other significant statistical studies⁹⁻¹² did. This would also suggest that timing of IV dextrose is important to its effect on PONV.

Discussion:

Eight of the fifteen articles included in this review showed that a preoperative drink of either a placebo or carbohydrate liquid is superior to traditional fasting.^{2-8,13} These articles showed there were significantly lower rates of PONV or antiemetic usage. Patients also experienced less hunger and thirst,¹⁷ had shorter PACU stays,¹² decreased their insulin resistance,⁷ and many other positive experiences (See Appendix A).

Of the seven studies that did not provide significant results, two were primarily completed on low risk PONV patients including total knee arthroplasty using spinal anesthesia and populations made up of mainly older men.^{15,16} Canbay et al²¹ found no PONV among their patient population. Yang et al¹⁸ only reported 4 of 60 patients that presented with PONV. Feguri et al¹⁹ was completed on patients undergoing a CABG procedure who went to the ICU intubated. Itou et al¹⁷ did show a lower rate of PONV, though, the findings were not statistically significant.

There may be some debate as to the superiority of oral preoperative carbohydrate drinks versus placebo drinks such as water. The McCracken et al⁸ study, which was a large retrospective review (n=9,916), did not specifically administer oral preoperative carbohydrates.

They only implemented a policy change that allowed nonspecific clear liquids until 2 hours before surgery. They had success in reducing their rates of PONV significantly. Yang et al¹⁸ and Feguri et al¹⁹ also showed no difference between preoperative carbohydrates and placebo drinks. This would suggest that there may be debatable difference between preoperative carbohydrate drinks and placebo drinks like water.

Four articles of five that examined IV carbohydrates found IV carbohydrate was superior to non-carbohydrate IV fluids in reducing PONV.⁹⁻¹² These fluids were typically given at the end of the procedure and continued until finished in the recovery room.^{9,10,12,20} Patel et al²⁰ suggested that timing of IV dextrose administration could play a role on the incidence of PONV, and therefore also could have contributed to the non-significant results they found. Cakar et al⁴ would support this finding, as they compared IV dextrose that was given preoperatively and found non-significant results.

There were almost no anesthesia complications describe in the literature, apart from PONV. There was only one case of aspiration that was reported, and it was in an extension of the McCracken et al⁸ retrospective review, which would be representative of 1 in 22,198 people that had an aspiration complication. This is less than the "normal" rate of aspiration which is 1:8000.⁸ Itou et al¹⁷ actually showed that gastric fluid volumes immediately after anesthesia were reduced, which is on trend with other research described in their paper. These findings suggest that oral preoperative carbohydrate loading, and IV dextrose administration is relatively safe and beneficial among low risk patient populations.

There were several limitations for this review. Many of the research articles included in this synthesis had a small sample size except for McCracken et al⁸ that had a population size of over 9,000 patients. The anesthesia performed in this review was also not consistent throughout

each study, with some being performed under spinal anesthesia while many were performed under general anesthesia. The patient population was also not consistent throughout all of the studies. Canbay et al²¹ and Asakura et al¹⁵ were both performed on older men who have a lower risk of PONV, while Itou et al,¹⁷ Dabu-Bondoc et al,¹² Mishra et al,⁹ and Atashkhoei et al¹¹ were mainly completed on women aged 20-40 years old that presented for gynecologic or laparoscopic surgery and were at a high risk of PONV. Finally, the studies included in this synthesis also had various methods of evaluating PONV such as VAS scores, patients' rates of nausea and vomiting, and antiemetic usage.

Conclusion:

There is evidence that PONV is reduced by preoperative carbohydrate loading. However, there is a need to have more research completed in this area. Of the twenty studies analyzed in this synthesis, twelve publications showed that PONV or antiemetic usage was reduced by either oral or IV preoperative carbohydrate intake.²⁻¹³ While, seven studies showed that PONV was not changed significantly by these interventions.^{14-16,17-20} Several of these articles were mainly completed on low risk PONV patients^{13,15} or had low rates PONV among their patient population.^{18,21} One study had no patient with PONV.²¹ There is some debate as to the superiority of oral preoperative carbohydrate loading compared to a placebo drink such as water.^{8,18,19} The timing of IV carbohydrate administration also seems to play a key role in the reduction of PONV.^{4,20} Overall, there was a low rate of complications associated with preoperative carbohydrate loading among these studies, with only one case of aspiration in all the articles that were reviewed.⁸ Preoperative carbohydrate loading shows benefits in other areas such as decreased gastric fluid volumes¹⁷ pain scores,³ insulin resistance,⁷ hunger,²¹ thirst²¹ and

increased patient satisfaction.⁴ This suggests, that with the low complication rate and evidence of decreased PONV, the benefit to risk ratio for preoperative carbohydrate loading is very high.

Appendix A

<i>Author</i>	<i>Sample (n), Population, & Location</i>	<i>Intervention</i>	<i>Results</i> <i>-If not denoted by * scores were not significant</i>	<i>Effect on PONV</i>	<i>Other statistically significant results (see article)</i>
<i>Yilmaz et al.² (2012)</i>	n= 40 (20/20) -Laparoscopic Cholecystectomy -GA -Ankara, Turkey	<u>Intervention:</u> 400 ml CHO given 2h before surgery. <u>Control:</u> Fasted 8h before surgery.	PACU VAS score: (.17/.24) 24h VAS score (.13/.27) PACU antiemetic medication consumption (.18/.23). 24h antiemetic medication consumption (.14/.27). p <0.001* (Intervention /Control) -Scores represent 20% changes from baseline	-PONV was decreased but not significantly -Antiemetic use decreased significantly at 24 h	Patient satisfaction was significantly higher in intervention group.
<i>Singh et al.³ (2015)</i>	n=120 (40/40/40) -Laparoscopic Cholecystectomy -GA -India	<u>Intervention:</u> Group 1: 400ml of 12.5% CHO given between 2000-2200 and 200 ml at 0600 prior to surgery Group 2: 400ml of placebo drink given between 2000-2200 and 200 ml at 0600 prior to surgery <u>Control:</u> Fasted at midnight	0-4 h rates of nausea (21/22/32); rate of vomiting (7/17/19) 4-12h rates of nausea (22/27/30); rate of vomiting (3/5/13) 12-24h rates of nausea (10/17/14) rate of vomiting (0/1/1) *Significant scores between G1 vs G2 and control for nausea and vomiting at 0-4h p=0.001 and p=0.004, respectively) (G1/G2/control)	PONV was decreased significantly at 0-4 hours when compared to placebo drink and fasting.	Mean pain scores were significantly decreased for group 1.
<i>Cakar et al.⁴ (2017)</i>	n=90 (30/30/30) - Thyroidectomy -GA -Istanbul, Turkey	<u>Intervention:</u> Group 1: 800 ml 12.5% CHO at 12 am and 400ml CHO at 2h before surgery Group 2: 1000 ml Intravenous 5% dextrose	PACU VAS nausea scores: (1.0/1.12/1.56) PACU VAS vomiting scores: (1.0/1.07/1.58) p=0.015* for G1 vs control	Postoperative vomiting decreased significantly when compared to the control group	The intervention groups experienced less pain than the control group. -Significant difference found in vital

		with water between 12am and 2h before surgery <u>Control:</u> Fasted after midnight	(G1/G2/control) Adjusted VAS= 1-10 cm		signs between the groups.
<i>Sada et al.</i> ⁵ (2014)	n=142 (22/23/26) (22/23/26) -Open colorectal and open cholecystectomy -GA -Pristina, Kosovo	<u>Intervention:</u> Group 1- 800ml CHO at 2200 and 400ml CHO 2h before surgery Group 2- 800ml placebo drink at 2200 and 400 ml placebo drink 2h before surgery <u>Control:</u> > 8h fasting *Duplicated for colorectal & cholecystectomy pts	Colorectal pts: 0-24h VAS nausea scores 1/3/2.5 36-48h VAS nausea scores 1/2/2 Cholecystectomy pts: 0-24h VAS nausea scores 1/3/2.5 p< 0.05* 36-48h VAS nausea scores 1/2/2 -Median VAS scores with 1-10 scale (G1/G2/control)	PONV was decreased significantly between 0-24 hours for cholecystectomy patients.	-In colorectal operations the degree of thirst was decreased significantly at 36-48h. -In cholecystectomy pts VAS scores were better for thirst, hunger, mouth dryness, and weakness.
<i>Ajuzieogu et al.</i> ⁶ (2016)	n=88 (30/30/30) -Abdominal myomectomy -GA -Nasarawa, Nigeria	<u>Intervention:</u> Group 1- 800 ml CHO at 2200 and 400 ml at 2h prior to surgery Group 2- 800ml water (placebo drink) at 2200 and 400 ml at 2h prior to surgery <u>Control:</u> Fasted at midnight	PACU VAS scores: 7.5 /8.0/7.0 p=0.60 24h VAS scores: 4.0/7.0/6.0 p= 0.05* Metoclopramide (mg) PACU: 15/20/15 p=0.20 Metoclopramide (mg) 24h: 10/30/15 p=0.01* (G1/G2/control) VAS= 1-10 scale	PONV and antiemetic medications were decreased significantly with group 1 compared to group 2 and control	Pts in group 1 had higher satisfaction levels when compared to group 2 and control.
<i>Libiszewski et al.</i> ⁷ (2012)	n= 115 (71/44) - Thyroidectomy -GA -Lodz, Poland	<u>Intervention-</u> 800 ml 12.5% oral glucose 12h and 400 ml 3h before surgery <u>Control-</u> Fasted; last meal at 2pm, last fluids 10pm day prior to surgery.	Intervention- PONV observed 9 pts (12.8%) Control- PONV observed 18 pts (40.91%) (p<0.001) *	PONV decreased significantly	Postoperative insulin resistance was decreased in Measurement II and III
<i>McCracken et al.</i> ⁸ (2018)	n=9,916 (4724/5192) -pts receiving sedation,	<u>Intervention:</u> Policy change to allow clear liquid up to two	Rates of nausea in 24h post-surgery: 179(3.8%)/ 270 (5.2%) p<0.001*	PONV was significantly decreased	Only PONV rates reported

	general or regional anesthesia -Devon, UK	hours before surgery. Volume and timing of fluid was not recorded <u>Control:</u> Chart review of patients before policy change. Pts fasted for 8 hours prior to surgery.	Rates of vomiting in 24h post-surgery: 104 (2.2%)/ 146 (2.8%) p= 0.053* (Intervention/Control)	compared to control group	
<i>Harsten et al.</i> ¹³ (2012)	n=60 (30/30) -Total hip arthroplasty -Spinal anesthesia -Sweden	<u>Intervention:</u> 400ml 12.5% CHO at 1.5h before and 2h after surgery <u>Control:</u> 400ml flavored water at 1.5h before and 2h after surgery.	Nausea rate prior to surgery: 0/1* Nausea rate at 36h: 0/7* Nausea rate at 48h: 0/2* p<0.05 (Intervention/Control)	Intervention group was significantly less nauseated prior to surgery and at 36h and 48h postoperatively	Intervention group was less hungry and had less pain at 12h, 16h, and 20h.
<i>Dabu-Bondoc et al.</i> ¹² (2012)	n= 62 (30/32) - Hysteroscopic or gynecologic laparoscopic surgery -GA -Connecticut, USA	<u>Intervention:</u> 1000 ml over 30 min of D5LR immediately after surgery <u>Control:</u> 1000 ml over 30 min of LR immediately after surgery	-PACU nausea rates 14 (46.7%)/20 (62.5%) -PACU vomiting rates 4 (13.3%)/ 4(12.5%) -Rescue antiemetics needed 12 (40.0%)/ 18 (56.3%)* (intervention/control)	Antiemetic medication was significantly reduced by the intervention	Intervention group had significantly shorter stay in PACU
<i>Canbay et al.</i> ²¹ (2013)	N=50 (25/25) -Radical Prostatectomy -Anesthesia not specified -Turkey	<u>Intervention:</u> 800 ml 12.5 % CHO at 24h prior to surgery and 400 ml 12% CHO at 0400 and 2h prior to surgery. <u>Control:</u> Fasted at midnight prior to surgery	No nausea present in either group	No nausea present in either group	Intervention group experienced significantly less sense of hunger and thirst as compared to control group.
<i>Dilmen et al.</i> ¹⁴ (2017)	n=43 -Microlumbar discectomy -GA -Istanbul, Turkey	<u>Intervention:</u> 800 ml CHO the night before surgery and 400 ml CHO 2h prior to surgery	Rates of nausea: 3 pts/2 pts Rates of vomiting: 0 pt/ 0pts -Evaluated baseline, preoperatively,	PONV was not changed significantly	Preoperative carbohydrate loading does not attenuate development of insulin resistance in

		<u>Control:</u> Fasted 8 hours prior to surgery	and postoperatively at 6h and 12h		lumbar disk surgery.
<i>Asakura et al.</i> ¹⁵ (2015)	n=134 (46/43/45) -Surgical procedure on body surface -GA -Yokohama, Japan	<u>Intervention:</u> Group 1- 250 mL of 18% CHO at 0600 day of surgery. Group 2- 1000 mL 2.5% CHO at 2000, and 2h prior to surgery <u>Control:</u> Fasted at midnight prior to surgery	Group 1- PONV rates 4 pts (8.7%) Group 2- PONV rates 4 pts (9.3%) Control- PONV rates 4 pts (8.9%)	PONV was not changed significantly	Neither intervention group improved quality of recovery in patients in this study.
<i>Raksakietisak et al.</i> ¹⁶ (2014)	n= 98 (48/50) -Total knee replacement -Spinal anesthesia -Bangkok, Thailand	<u>Intervention:</u> 400 ml 10% CHO between 1800- midnight and 400ml 10% CHO 2h prior to surgery <u>Control:</u> Fasted at midnight	PACU PONV rates: 17 (35.4%)/ 18 (36.0%) PACU antiemetic usage: 8 (16.0%)/ 11 (22.0%) 24h PONV rates 39 (81.2%/ 36 (72.0%) (Intervention/Control)	PONV was not changed significantly	No significant results were identified between the intervention and control group.
<i>Itou et al.</i> ¹⁷ (2011)	n= 300 (1) -Elective morning surgery under general anesthesia -Japan	<u>Intervention:</u> 500 ml of CHO (solution of balanced glucose and electrolytes) between 2100 and the morning of surgery and 500 ml between time of waking and 2 hours before surgery. <u>Control:</u> Fasted starting at 2100 the night before surgery	Nausea rates night after surgery 27.8/24.6 Vomiting rates night after surgery 17.3/14.2 Nausea rates next day after surgery 15.3/20.3 Vomiting rates next day after surgery 9.2/14.2 (Intervention/Control)	PONV was not changed significantly	The intervention group had less thirst and hunger and increased fractional excretion of sodium and urea nitrogen showing they were better hydrated.
<i>Yang et al.</i> ¹⁸ (2012)	n=52 (24/24) -Radical distal gastrectomy -GA -Qingdao, China	<u>Intervention:</u> 500 ml of 10% CHO 2-3h prior to surgery <u>Control:</u> 500 ml of placebo drink 2-3h prior to surgery	Rate of PONV: 2 pts/2pts (Intervention/Control)	PONV was not changed significantly	The intervention group had significantly lower blood glucose, insulin resistance index scores immediately

					postoperatively.
<i>Feguri et al.</i> ¹⁹ (2012)	n=40 (20/20) -Coronary artery bypass graft surgery -GA -Cuiabá, Brazil	<u>Intervention:</u> 400 ml 12.5% CHO at 6h and 200 ml of 12.5% CHO 2hs prior to surgery. <u>Control:</u> 400 ml water at 6h and 200 ml and water at 2h prior to surgery.	ICU nausea rates: 6pts/8pts ICU vomiting rates: 3pt/4pts Post ICU nausea rates: 3pts/5pts Post ICU vomiting rates: 1pt/2pts (Intervention/Control)	PONV was not changed significantly	Glycemic control, length of hospital stay and length of time using dobutamine was shorter in the intervention group.
<i>Mishra et al.</i> ⁹ (2017)	n= 100 (50/50) -Laparoscopic cholecystectomy -GA -New Deli, India	<u>Intervention:</u> 250 ml of 5% IV dextrose started at 100 ml/h when gallbladder was taken out until finished <u>Control:</u> Normal saline 250 ml at 100 ml/h until finished at the time the gallbladder was removed.	PONV rates within 24 hours of surgery: 14(28%)/33(66%) p=0.001* Second rescue antiemetic (Ondansetron) 3pts/ 7pt (2pt in control group received ondansetron and metoclopramide.) (Intervention/Control) VAS scale 1-10	PONV and antiemetic medication was reduced significantly with 5% dextrose	Only PONV and antiemetic consumption reported
<i>Firouzian et al.</i> ¹⁰ (2017)	n=121 (61/60) -Laparoscopic cholecystectomy -GA -Sari, Iran	<u>Intervention:</u> 50 0ml of D5LR over 30 mins given 30 min after the induction of anesthesia <u>Control:</u> 500ml of LR over 30 mins given 30 min after the induction of anesthesia	VRS Nausea scores in PACU on arrival: 1 /5.2* VRS Nausea scores in PACU at 30 min: 0.83/4.3* VRS Nausea scores in PACU at 120min: 0.68/1.1* VRS Vomiting scores in PACU on arrival: 0.2 /.6* VRS Vomiting scores in PACU at 30 min: 0.1/0.3* VRS Vomiting scores in PACU at 120min: 0.05/0.01* Time trend of both groups showed significant downward trend p<0.0001 (Intervention/control)	PONV was significantly reduced with intervention	A low negative correlation was seen between blood glucose levels and nausea scores when arriving to PACU

			Verbal rating scale 0-10		
<i>Atashkhoei et al.</i> ¹¹ (2018)	n=70 (35/35) -Gynecologic laparoscopy -GA -Tabriz, Iran	<u>Intervention:</u> 10 ml/kg/h of D5LR infused 5 min prior to the induction of anesthesia and throughout the procedure <u>Control:</u> 10 ml/kg/h of ringer's solution with 0.9% normal saline infused 5 min prior to the induction of anesthesia and throughout the procedure	Rate of PONV: 8 (22.85%)/16 (45.71%) p=0.03* Severity of PONV, mean scores 1.14 ±0.32/ 2.50±0.27 p=0.03* Total dose in mg of Metoclopramide 60/100 p<0.001 (intervention/control)	PONV was significantly reduced with intervention	No significant differences found in Blood sugars between intervention and control group
<i>Patel et al.</i> ²⁰ (2013)	n=162 (87/75) -Gynecologic, urologic, or breast surgery -GA -California, USA	<u>Intervention:</u> 250ml Dextrose 5% in Lactated Ringers (LR) over 2 hours beginning at surgical closer <u>Control:</u> 250ml of LR over 2h beginning at surgical closer	Rate of PONV at 2h post-surgery: 47 (52.9%)/35 (46.7%) Vomiting episodes within 2h post-surgery: 4 (4.6%)/5 (5.6%) Patients given > 1 antiemetic medication 23(50.0%)/19 (54.3%) (Intervention/control)	PONV was not changed significantly	Only PONV rates were reported

VDS- Verbal descriptive scale for nausea or vomiting; h- hours; pts-patients, CH-carbohydrate drink, PACU- Post anesthesia care unit, G1- Group 1, G2- Group, GA- General anesthesia, * denotes significance, ^- Pts without conditions that can cause impaired gastric motility i.e. diabetes mellitus and obesity.

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