

Preoperative Fluid Bolus and Reduction of Postoperative Nausea and Vomiting in Patients Undergoing Laparoscopic Gynecologic Surgery

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We conducted a randomized clinical trial of patients undergoing laparoscopic gynecologic surgery to determine the effect of a calculated preoperative fluid bolus on postoperative nausea and vomiting (PONV).

For the study, 46 women were randomly assigned to an experimental group, group 1, or a control group, group 2. Group 1 received up to 1,000 mL of replacement fluid preoperatively, using the 4-2-1 formula. Group 2 received the anesthesia provider's routine replacement fluids. Neither group received antiemetics preoperatively or intraoperatively. All patients were assessed for PONV by nurses blinded to patient group assignment. Group 1 patients experienced significantly lower occurrences of PONV than did group 2 patients ($P = .046$).

The preoperative fluid bolus seemed to be a significant factor in preventing PONV in group 1. Demographic and other factors reported to cause PONV, such as the length of surgery and major manipulation of the bowels, were similar in both groups. There was no significant difference between groups in reception of postoperative opioid, a known cause of PONV. Drops in blood pressure were thought to affect PONV, but group 1 patients had larger decreases in blood pressure than did group 2 patients.

Keywords: Laparoscopic gynecologic surgery, postoperative nausea and vomiting reduction, preoperative fluid bolus.

Postoperative nausea and vomiting (PONV) is an undesirable complication of general surgery resulting in prolonged recovery time, delayed patient discharge, patient dissatisfaction and discomfort, increased morbidity and mortality, and increased healthcare costs. The overall incidence of PONV for all surgeries has been estimated to be 25% to 30% and up to 70% in high-risk groups. Laparoscopic surgery, gynecological laparoscopic surgery in particular, is linked to an increased incidence of PONV.^{1,2}

Studies conducted by Ho and Chiu,² Nelson,³ Push et al,⁴ and Hagemann et al⁵ identified dehydration and relative hypovolemia as factors contributing to the incidence of PONV. Preoperative dehydration occurs following mandatory bowel preparation and preoperative fasting. Preoperative dehydration can result in hypotension at the time of anesthesia. Ho and Chiu² noted that a greater than 35% reduction in systolic blood pressure on anesthesia induction was associated with an increase in PONV.

All patients enter the preoperative area with a fluid deficit due to fasting. A pilot study suggested that PONV may be prevented by nonpharmacologic methods such as adequate reduction of the fluid deficit.⁶ In that study, 45 patients undergoing gynecologic laparoscopic surgery were given 1,000 mL of normal saline preoperatively, and the occurrence of PONV was compared with that in 45

patients given the usual lactated Ringer's solution in an amount determined by the anesthesia provider. An analysis of variance showed the results were significant ($P < .05$); however, neither hours of fasting nor use of antiemetics were controlled.

Magner et al¹ reported the effects of an intravenous infusion of 30 mL/kg compared with that of 10 mL/kg given intraoperatively to 2 groups, each including 35 patients undergoing gynecologic laparoscopic surgery. An independent *t* test demonstrated that the occurrence of vomiting was less in the group receiving 30 mL/kg than in the group receiving 10 mL/kg (8.6% vs 25.7%; $P = .01$).

Another study of 80 patients undergoing gynecologic laparoscopic surgery reported the effect of a large volume of intravenous fluids on the occurrence of PONV.⁷ The control group received 3 mL/kg of compound sodium lactate, and the experimental group received 2 mL/kg of compound sodium lactate times the number of hours since the last intake. Each group received its fluid bolus before induction of anesthesia. Of the control group participants, 87% had PONV in the first 72 hours, whereas only 57% of participants in the experimental group experienced PONV.

The present study was conducted to test the hypothesis that the administration of a preoperative intravenous fluid bolus, individually calculated by the 4-2-1 rule⁸

Body weight (kg)	Fluid rate (mL/kg)	Weight category (kg)	Fluid maintenance rate (mL/h)
0-10	4	10	40
11-20	2	10	20
21+	1	50	50
Total		70	110

Table 1. Calculation of Replacement Fluids for a 70-kg Patient Using the 4-2-1 Rule⁸

To calculate the fluid deficit, multiply the maintenance fluid rate times the number of hours since the patient's last oral intake. Once the patient's maintenance rate using the 4-2-1 rule has been calculated, multiply the maintenance rate times the number of hours since the patient's last oral intake. For example, for a maintenance rate of 110 mL/h when the patient has had nothing by mouth for 8 hours: 8 hours x 110 mL/h = 880 mL. The fluid deficit for a 70-kg patient who has had nothing by mouth for 8 hours is 880 mL.

(Table 1) could decrease the incidence of PONV in patients recovering from general anesthesia for laparoscopic gynecologic surgery.

Materials and Methods

A controlled, prospective blinded study evaluated the incidence of PONV in an experimental group of patients (group 1) undergoing laparoscopic gynecologic surgery who received a fluid bolus up to 1 L preoperatively and a similar control group (group 2) given the anesthesia provider's standard fluid replacement at the provider's choice of time.

On the day that samples for preoperative blood work were obtained, patients were informed of the research study. On the day of surgery, the researcher approached each potential participant, discussed participation in the study, and obtained informed consent. The institutional review boards of Erlanger Medical Center and the University of Tennessee, Chattanooga, approved this process.

Participants were 18 years of age or older, not pregnant, and undergoing ambulatory, nonemergency, gynecologic laparoscopic procedures in the southeastern public-supported 760-bed hospital complex. They had all complied by self-administering 1 Fleet's enema the evening before and by fasting from midnight before surgery. Participants were excluded from the study if there was a history of hypertension, congestive heart failure, valvular heart disease, diabetes mellitus, epilepsy, or mental disability. Prisoners, patients who had received antiemetics in the prior 24 hours, and patients with a history of PONV were also excluded.

Participants were assigned randomly to group 1 or group 2. Anesthesia providers, if other than the researcher (K.G.L.), agreed to use the protocols assigned by the researcher. The participants and their postoperative caregivers were unaware of the group assignment.

The original sample consisted of 54 women, ASA physical status I or II. After their surgeries, the data for 6 participants were removed from the final sample due to noncompliance of the anesthesia staff to the study protocol, leaving 23 patients in each group.

In the preoperative area, the baseline blood pressure (BP) was recorded. Group 1, according to the 4-2-1 rule,⁸ was given lactated Ringer's solution, up to 1,000 mL, during a 1-hour period. If the formula determined that more replacement was needed, it was given during the procedure to prevent large volume side effects. Group 2 was given the anesthesia provider's routine amount of lactated Ringer's solution as replacement at the time the provider usually administered it. Both groups received midazolam, 2 mg, intravenously immediately before going to the operating room suite.

A general routine induction technique was used for anesthesia. Fentanyl, up to 5 µg/kg lidocaine, 1 mg/kg; propofol, 2 mg/kg; and vecuronium, 0.1 mg/kg, were used. In addition, 50% oxygen, 50% nitrous oxide, and isoflurane at a minimum alveolar concentration were administered. The BP for patients in both groups was recorded immediately following induction, the time recognized as the lowest in intraoperative procedures.⁹ An oral gastric tube was inserted once patients were anesthetized, and gastric contents were removed. On completion of surgery, patients were given glycopyrrolate, 0.01 mg/kg, and neostigmine, 0.05 mg/kg. Patients were then given oxygen by simple mask at 10 L for transport to the postanesthesia care unit (PACU) for postoperative care.

An instructional meeting had been held with each participating PACU and same-day surgical care unit (SACU) nurse to increase understanding and compliance in accurately recording postoperative data. The nurses were instructed not to ask participants about feelings of nausea but to record the patients' reports if they complained of nausea. To increase interrater reliability, the variables of nausea and vomiting were precisely described. *Nausea* was defined as an "unpleasant, but not painful, sensation referred to the pharynx and upper abdomen, associated with the desire to vomit or the feeling that vomiting is imminent."¹⁰ *Retching* was defined as labored, spasmodic, rhythmic contractions of the muscles, including the diaphragm, chest wall, and abdominal wall muscles, without the expulsion of gastric contents.¹¹ *Vomiting* was

	Amount of preoperative fluid (mL)	Percentage of systolic BP decrease	Age (y)	Length of procedure (min)
Mean	995.65	27.22	31.70	82.57
Median	1,000.00	25.00	32.00	63.00
Minimum	900.00	2.00	20.00	33.00
Maximum	1,000.00	54.00	46.00	238.00

Table 2. Preoperative Fluid Administration, Decrease in Systolic BP, Patient Age, and Length of Procedure in the Experimental Group (n = 23)

There were no missing data.
BP indicates blood pressure.

	Amount of preoperative fluid (mL)	Percentage of systolic BP decrease	Age (y)	Length of procedure (min)
Mean	473.91	22.65	33.00	70.17
Median	400.00	21.00	32.00	54.00
Minimum	100.00	3.00	18.00	29.00
Maximum	1,000.00	38.00	72.00	192.00

Table 3. Preoperative Fluid Administration, Decrease in Systolic BP, Patient Age, and Length of Procedure in the Control Group (n = 23)

There were no missing data.
BP indicates blood pressure.

	Occurrences of nausea and vomiting		
	No nausea	Nauseated	Vomited, no nausea
Experimental group (n = 23)	18 (78)	5 (22)	0 (0)
Control group (n = 23)	13 (57)	9 (39)	1 (4)

Table 4. Occurrences of Nausea and Vomiting in the Experimental and Control Groups 1 and 2

Data are given as number (percentage).

defined as “the forceful expulsion of upper gastrointestinal contents via the mouth.”¹⁰

Recording on a data collection tool began on admission to the PACU and continued until the patient was discharged to the hospital or to the SACU, where the recording continued until discharge. Nurses also documented any rescue emetics administered to patients complaining of nausea or experiencing vomiting. The researcher (K.G.L.) collected the data worksheets from the PACU and SACU areas each day and recorded the preoperative fluid information on the data collection tool after the patient was discharged from the PACU or SACU. These data included the patient identification number, the baseline BP before administration of any extra fluids and the BP following induction. Chart review identified incidences of administration of ephedrine to increase the BP and the use of postoperative opioids, and these were recorded.

- *Statistics.* A power analysis of 0.80, with a critical effect of 0.50, and *P* value of .05 or less indicated the need

for 22 experimental and 22 control subjects. The Statistical Package for the Social Sciences, version 13 (SPSS, Chicago, Illinois), was used for descriptive, correlational, and parametric statistics.

Results

Patients ranged in age from 18 to 72 years with an average age of 32 years. The patients in group 1 had a mean age of 32 years, and the mean age in group 2 was 33 years. The length of procedures ranged from 29 to 238 minutes. In group 1, the average length of surgery was 83 minutes; group 2 had an average length of 70 minutes (Table 2 and Table 3).

The average amount of preoperative fluid administered to the 46 study patients was 735 mL (range, 100-1,000 mL). The average amount of fluid administered to group 1 preoperatively was 996 mL and to group 2 was 474 mL (see Tables 2 and 3).

The percentage of systolic BP decrease that occurred on induction ranged from 2% to 54%. Group 1 had an

average decrease of 27%, and Group 2 experienced a 23% average decrease (see Tables 2 and 3).

PONV was experienced by a total of 16 patients (Table 4). Group 1 had 5 episodes of nausea, and group 2 experienced 11 episodes of nausea and 1 episode of vomiting without nausea. In other words, the experimental group experienced a 22% occurrence of PONV as compared with 52% of PONV in the control group.

All 46 patients received preoperative and intraoperative opioids, but postoperative opioids were administered to only 32 patients. Group 1 had 17 patients who received postoperative opioids, and group 2 had 15 patients who received postoperative opioids.

Review of the anesthesia records to see whether vaso-pressors may have been used with decreases in BP on induction, thus influencing the effect of the BP decrease, revealed that group 1 had 1 person who received ephedrine, 5 mg, and group 2 had 1 person who received ephedrine, 10 mg.

It was important to establish whether and how strong-pairs of variables were related to gain a greater understanding of the data. A Pearson product moment correlation showed a significant relationship between the percentage of systolic blood pressure decrease and the occurrence of nausea and vomiting in group 2 ($P = .006$) but not in group 1 ($P = .458$). Neither group showed a significant correlation between the length of the procedure and the occurrence of nausea and vomiting (group 1, $P = .439$; group 2, $P = .474$).

The hypothesis was that there is a lower occurrence of PONV in patients undergoing laparoscopic gynecological surgery under general anesthesia who receive up to 1,000 mL of preoperative fluid replacement using the 4-2-1 rule than in patients receiving routine fluid replacement. An independent t test was used to analyze and compare the mean scores of the 2 groups. Group 1 experienced significantly lower occurrences of PONV than did group 2. Thus, the null hypothesis was rejected ($t = -1.72_{44}$; $P = .0465$).

In group 1, 17 patients had surgery with major bowel manipulation (diagnostic laparoscopy or laparoscopic-assisted vaginal hysterectomies), as did 16 patients in group 2. Of the 17 patients in group 1, 4 had PONV, whereas 8 of the 16 patients in group 2 had PONV. A t test showed this difference was not statistically significant ($P = .06$).

Discussion

The purpose of this study was to investigate the effect of a calculated reduction of preoperative fluid deficit on the incidence of PONV in patients undergoing laparoscopic gynecological surgery. The influence of the administration of a preoperative fluid bolus on PONV was statistically significant ($P = .047$) and supported the hypothesis.

It was thought that fluid replacement would sustain BP in group 1, but group 2 actually had a smaller decrease in

BP. The decreases in BP experienced by group 2, however, were significantly correlated with PONV. So, although the preoperative bolus of fluids did not seem to overcome the decrease in systolic BP on induction in group 1, perhaps it affected other areas responsible for PONV.

Magner et al¹ explained that the use of insufflation of the abdomen and Trendelenburg positioning with laparoscopic surgery could cause a decrease in perfusion to the intestinal mucosa, but *all* patients in this study experienced this positioning. The duration of the positioning could be another cause of PONV, with longer procedures causing more occurrences of PONV. However, the procedures in group 1 were longer on average than in group 2 (83 vs 70 minutes).

The use of postoperative opioids was thought to cause PONV. In this study, 17 patients in group 1 received postoperative opioids, as did 15 patients from group 2, so the use of postoperative opioids would not seem to be associated with the increased occurrence of PONV in group 2.

It was thought that patients who may have had more manipulation of the bowel may have had more PONV. Because 17 women in group 1 and 16 in group 2 had major bowel manipulation, that factor could also be ruled out as a cause of the difference in incidence of PONV between groups. Factors that were not recorded for the study were smoking status, history of motion sickness, and weight. As indicated by other researchers,^{3,12} these should be considered in all future studies of PONV.

The exact mechanism of how preoperative hydration decreases the incidence of PONV is uncertain. However, the occurrence of PONV was decreased during this study. Preoperative intravenous fluid administration is a simple, non-time-consuming, cost-effective means to reduce the occurrence of PONV. It warrants consideration as routine therapy.

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ACKNOWLEDGMENT

We thank Linda Hill, CRNA, DNP, DNSc; Virginia Keatley, RN, DNS; and Susan Davidson, RN, EdD.