A Prospective Randomized Double-Blinded Study of the Effect of Intravenous Fluid Therapy on Adverse Outcomes on Outpatient Surgery

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This study investigated the impact of perioperative fluid status on adverse clinical outcomes in ambulatory surgery. Two hundred ASA grade I-III ambulatory surgical patients were prospectively randomized into two groups to receive high (20 mL/kg) or low (2 mL/kg) infusions of isotonic electrolyte solution over 30 min preoperatively. A standardized balanced anesthetic was used. A minimal amount of fluid was given during the intraoperative and postoperative periods. Adverse outcomes were assessed by an investigator blinded to the fluid treatment group at 30 and 60 min after surgery, at discharge, and the first postoperative day. The incidence of thirst, drowsiness, and dizziness was significantly lower in the high-infusion group at all intervals. We recommend perioperative hydration of 20 mL/kg for patients undergoing general anesthesia for short ambulatory surgery.

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Ambulatory surgery is practiced worldwide. The shortage of nurses and the limitations of bed space, as well as the popularity of ambulatory surgery with patients, have encouraged the growth of ambulatory surgery and the emphasis on its efficacy (1). Since 60% of surgery in North America is done on an ambulatory basis (2), the study of adverse clinical outcomes after ambulatory anesthesia is essential.

Adverse outcomes, such as nausea, vomiting, dizziness, drowsiness, thirst, myalgia, sore throat, and delayed recovery have been reported after general anesthesia in ambulatory surgery patients (3–6). Their incidence varies among studies. Fahy and Marshall (3) reported a 44.9% incidence of drowsiness, headache, and vomiting in outpatients. Dawson and Reed (4) found that the most common postoperative complications were nausea (30%), emesis (20%), and hypotension (10%). These adverse clinical outcomes may be associated with perioperative management, anesthetic technique, surgical procedure, duration of surgery, and fluid status of the patient. However, there is very little data about adverse clinical outcomes after the patient is discharged from the ambulatory center.

Since there is no prospective double-blinded randomized study of the effect of intravenous (IV) fluid therapy on adverse outcomes after ambulatory surgery, we studied the impact of perioperative IV fluid on adverse outcomes both at the hospital and at home after ambulatory anesthesia.

Methods

After obtaining institutional clinical ethics committee approval, and informed consent we studied 200 (ASA grade I-III) patients aged 18–55 yr, scheduled for ambulatory gynecologic, orthopedic, and general surgical operations. Exclusion criteria were history of valvular heart disease, previous congestive heart failure, preoperative nausea, vomiting or dizziness, intraoperative hypotension, and excessive blood loss. Demographic data, medical, social, and drug histories, and baseline hemodynamics were recorded prospectively. All patients fasted overnight; no sedative premedication was given.

Patients were randomly allocated to either a high- or low-infusion group. In each patient, an 18-gauge IV cannula was inserted under local anesthesia and 1% lidocaine. The high-infusion group of patients received IV Plasmalyte 148 isotonic (sodium chloride,

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526 mg/100 mL; sodium gluconate, 502 mg/100 mL; sodium acetate, 368 mg/100 mL; potassium chloride, 37 mg/100 mL; magnesium chloride, 30 mg/100 mL) solution (20 mL/kg bolus) 30 min preoperatively in the ambulatory surgical unit; the low-infusion group received the same solution (2 mL/kg bolus) 30 min preoperatively. Once the desired volume of IV bolus was given, a new 1-L Plasmalyte 147 isotonic solution was started. Both the high- and low-infusion groups received 1 $mL \cdot kg^{-1} \cdot h^{-1}$ during the intraoperative and postoperative periods. The IV cannula was removed 30 min after the operation in the post anesthetic care unit (PACU).

The investigator who assessed the symptoms and signs postoperatively, the attending anesthesiologist, and the PACU nurses were blinded to the patient-allocation group and to the amount of fluid infused preoperatively in the ambulatory surgical unit.

The total amount of fluid infused was documented. Patients treated with more than 1 $mL \cdot kg^{-1} \cdot h^{-1}$ fluid intraoperatively and postoperatively because of hypotension or excessive blood loss were excluded from the study.

A standardized general anesthetic was administered. Orthopedic and laparoscopic patients were induced with 2—2.5 mg/kg of propofol and 1.5 μg/kg of IV fentanyl after precurarization with 3 mg of *d*-tubocurarine. Endotracheal intubation was accomplished with 1.5 mg/kg of succinylcholine. Anesthesia was maintained with a nitrous oxide (70%) and oxygen mixture (30%) with end-tidal isoflurane (0%–0.5%) in a semiclosed circle system. Vecuronium (0.1 mg/kg IV) was used for muscle relaxation and normocapnia was maintained. Neuromuscular block was reversed with glycopyrrolate (0.01 mg/kg) and neostigmine (0.05 mg/kg). Gynecologic patients were induced with 1 μg/kg of IV fentanyl and 2.5 mg/kg of IV propofol. Anesthesia was maintained with an infusion of 0.05–0.15 $mL \cdot kg^{-1} \cdot min^{-1}$ IV propofol; patients were breathing spontaneously with a nitrous oxide (70%) and oxygen (30%) mixture. Electrocardiogram, blood pressure, heart rate, oxygen saturation, temperature, end-tidal CO_2, airway pressure, tidal volume, minute volume, and end-tidal concentration of the inhaled anesthetic were monitored.

Heart rate, blood pressure in standing and supine position, and symptoms of nausea, vomiting, thirst, dizziness, and drowsiness were recorded by a blinded investigator at 30 and 60 min after surgery, and at discharge. Strict definitions were followed for the assessment of these symptoms. Nausea was defined as a volunteered complaint of nausea; vomiting, as active retching requiring antiemetic; dizziness, as faintness; vertigo, as gait disturbance 30 min after surgery; drowsiness, as sleepiness; and thirst, as a desire to drink. The time to first urination after arrival to PACU was noted. The time, dose, and route of all postoperative medications administered were noted. Home readiness was assessed with the postanesthesia discharge scoring system (PADSS; 7). This scoring system has five groups of physiologic variables: vital signs, activity and mental status, pain or nausea or vomiting, surgical bleeding, and intake and output. Each variable is scored from 0 to 2 (Appendix I). Patients were discharged when a score ≥9 was reached. The time to achieve PADSS ≥9 was recorded. Patients were interviewed by telephone on the first postoperative day: a standardized questionnaire was used (Appendix II).

The data was stored in dBase IV (Logical Training Systems, Inc., Rochester, NY) and was analyzed for statistical significance with Student's *t*-test and χ^2 analysis, as appropriate. Results were expressed as means ± SD; $P < 0.05$ was considered statistically significant.

Table 1. Demographic and Perioperative Medications

	High infusion (n = 100)	Low infusion (n = 100)
Age (yr)	29 ± 10	29 ± 8
Sex (M/F)	8/92	7/93
Weight (kg)	62 ± 14	61 ± 15
ASA grade I/II/III	84/11/5	88/8/4
Surgery		
Dilation and curettage	85	87
General	4	3
Laparoscopy	2	4
Orthopedics	9	6
Total fluid (mL)	1215 ± 30	164 ± 28
Duration of anesthesia (min)	29 ± 2	28 ± 2
Propofol (mg)	167 ± 17	168 ± 16
Fentanyl (μg)	58 ± 2	57 ± 1
Postoperative morphine		
Incidence	13/100	18/100
Dose (mg)	2.3 ± 0.1	2.4 ± 0.1
Postoperative dimenhydrinate		
Incidence	12/100	17/100
Dose (mg)	1.9 ± 0.2	1.8 ± 0.3

Results are mean ± SD. There was no difference in values between the two groups by unpaired Student's *t*-test.

Results

Two hundred patients (15 males, 185 females) were randomly allocated to either the high-infusion (n = 100) or the low-infusion group (n = 100). The patients had a total of 15 orthopedic, 6 laparoscopic, 7 general surgical, and 172 dilation and curettage procedures. There was no significant difference between the high-infusion and low-infusion groups in age, sex, weight, and ASA classification, or type of surgery (Table 1). No patient in the study received any extra fluid intraoperatively or in the PACU. Ninety-two percent of

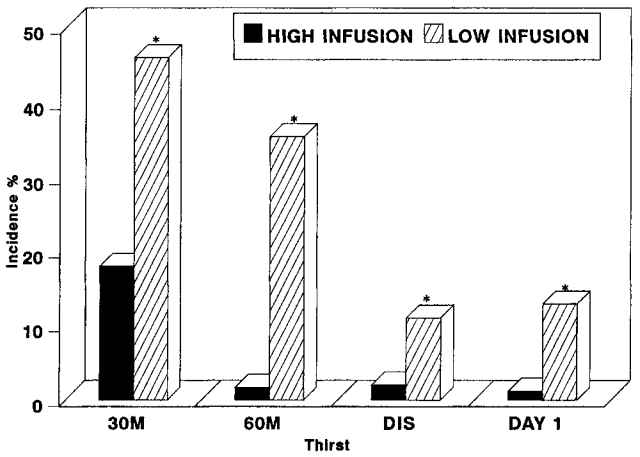

Figure 1. The incidence of postoperative thirst. 30M = 30 min postoperatively; 60 M = 60 min postoperatively; DIS = at discharge; DAY 1 = first postoperative day. *$P < 0.05$ between the high- and low-infusion groups by χ^2 analysis.

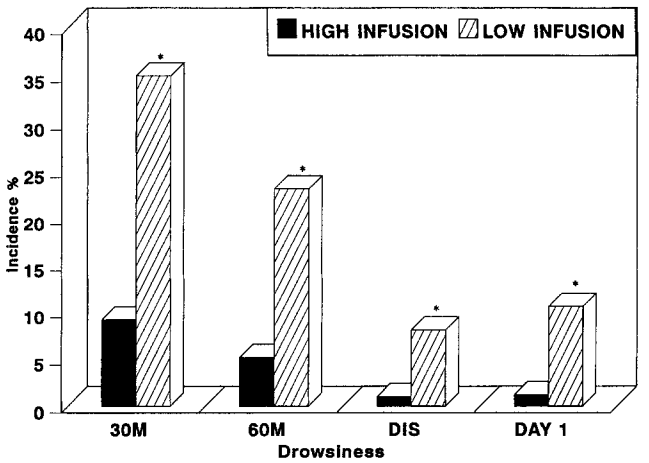

Figure 2. The incidence of postoperative drowsiness. 30M = 30 min postoperatively; 60 M = 60 min postoperatively; DIS = at discharge; DAY 1 = first postoperative day. *$P < 0.05$ between the high- and low-infusion groups by χ^2 analysis.

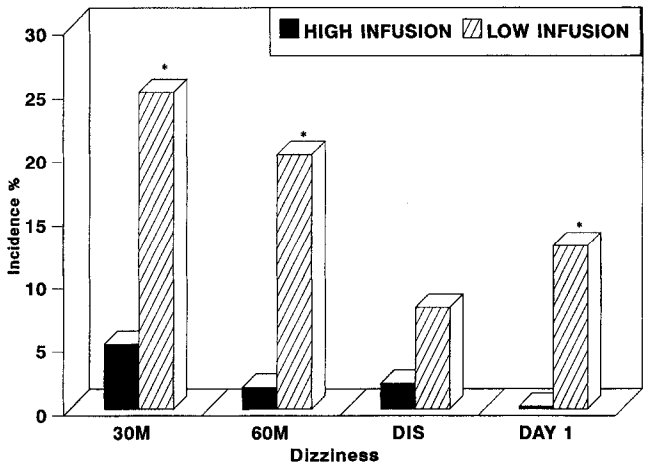

Figure 3. The incidence of postoperative dizziness. 30M = 30 min postoperatively; 60 M = 60 min postoperatively; DIS = at discharge; DAY 1 = first postoperative day. *$P < 0.05$ between the high- and low-infusion groups by χ^2 analysis.

patients were successfully contacted for the 24-h postoperative telephone interview.

Total fluid infused was 1215 ± 30 mL in the high-infusion group and 164 ± 28 mL in the low-infusion group. There were no statistically significant differences between the two groups in the duration of anesthesia, the amount of anesthetic given, the number of patients who required postoperative pain medication, the amount of morphine given, or the postoperative requirement for antiemetic medication (Table 1).

The incidence of thirst was significantly lower in the high-infusion group at all times than in the low-infusion group ($P < 0.05$; Figure 1). The incidence of drowsiness was significantly lower at all intervals in the high-infusion group (Figure 2). Dizziness was significantly lower at all times except at discharge in the high-infusion group (Figure 3). Nausea was significantly lower on the first postoperative day in the high-infusion group ($P < 0.05$; Figure 4). We did not find any significant difference in nausea at 30 min, 60 min, or at discharge between the two groups. There was no significant difference in vomiting between the two groups at 30 min, 60 min, at discharge, and 24 h postoperatively (not shown).

There was no significant difference between the groups in the time to first urination after arrival to the PACU (1.2 ± 0.6 h vs 1.4 ± 0.5 h) or the time taken to achieve PADSS ≥ 9 (1.3 ± 0.8 vs 1.5 ± 0.4 h), or in the hemodynamic variables during the intra- or postoperative periods. Fifteen percent of patients in the high-infusion group complained of pain along the arm during infusion. There were no such complaints in the low-infusion group.

Discussion

The incidence of adverse outcomes, such as nausea, vomiting, dizziness, drowsiness, thirst, and speed of recovery after surgery, depends on the surgical procedure, anesthetic technique and fluid status of the patient. Very little work has been done to determine the correlation between perioperative fluid therapy and the well being of the patients in the postoperative period. Cook et al. (8) found a trend toward improvement in these symptoms with fluid administration, especially with added sugar, but their study was not double-blinded. Our prospective double-blinded randomized study demonstrated that the incidence of adverse outcomes, such as thirst, dizziness, and drowsiness, was significantly lower in the high-infusion than in the low-infusion group at 30 min and 60 min after surgery, at discharge, and on the first postoperative day.

Adverse outcomes such as nausea, vomiting, thirst, drowsiness, and dizziness can create great distress in

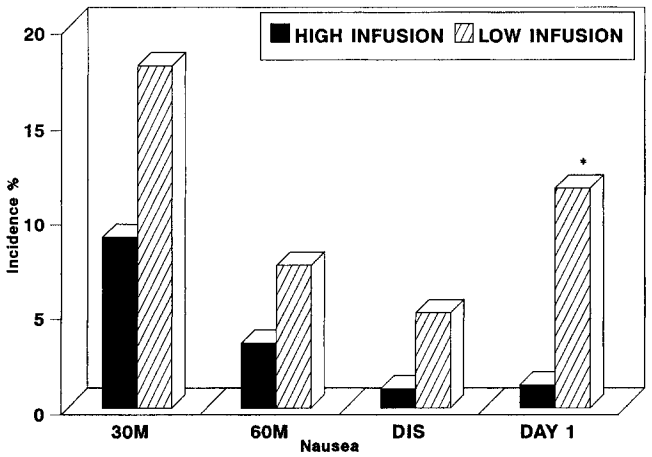

Figure 4. The incidence of postoperative nausea. 30M = 30 min postoperatively; 60 M = 60 min postoperatively; DIS = at discharge; DAY 1 = first postoperative day. *$P < 0.05$ between the high- and low-infusion groups by χ^2 analysis.

ambulatory patients. Nausea delays oral intake and worsens the general well being of patients. Retching because of nausea may increase pain and cause discomfort after minor abdominal surgery, such as laparoscopic procedures. Dizziness can precipitate nausea, vomiting, and restlessness and can delay ambulation. Postoperative drowsiness is potentially dangerous to patients if they cannot protect their airways. It also delays recovery and discharge.

These adverse outcomes delay early discharge and home readiness, thus increasing the workload of the nursing staff. Our findings indicate that these immediate adverse outcomes after ambulatory surgical procedures persisted for more than 24 h, but there was no significant difference between the two groups in the time to achieve PADSS. Hydrating the ambulatory surgical patient is therefore advantageous because it reduces the incidence of adverse clinical outcomes. Perioperative dehydration leaves a considerable deficit of fluid in surgical patients. Overnight fasting in a 70-kg patient undergoing surgery the next morning is likely to cause at least a 1-L fluid deficit (9). Normal insensible perspiration in an adult with a normal temperature amounts to a per-hour fluid loss of approximately 0.5 mL/kg body weight; which is approximately equal to the fluid lost by the body through urine. The study methodology was double-blinded. Neither the attending anesthesiologist nor the nursing staff was aware of the study group allocations. Therefore the extra IV fluid in the high-infusion group was given preoperatively. During a surgical procedure, however, the water lost through perspiration can increase considerably because of unhumidified anesthetic gases. Keane and Murray (9) found a statistically significant reduction in serum osmolality in a group of patients who received perioperative fluids (10). Furthermore, Shires et al. (11) reported that the functional extracellular fluid volume was reduced during minor as well as major surgical procedures. An increase in antidiuretic hormone secretion in response to dehydration and stimulation of osmoreceptors also partly contributes to a postoperative reduction in urine output (12).

Different intraoperative regimens of fluid administration have been proposed, depending on the type of surgery and third-space fluid loss. Jenkins et al. (13) suggested 12–15 mL/kg for the first hour and 6–10 mL/kg for the next 2 h. Fluid is administered to keep urine output at 1 $mL \cdot kg^{-1} \cdot h^{-1}$, or 50–100 $mL \cdot kg^{-1} \cdot h^{-1}$ for a major operation from the third hour onward. Davidson (14) indicated that if the preexisting fluid and electrolyte abnormalities have been corrected before the operation, fluid administration should maintain the urine volume between 0.5 and 1 $mL \cdot kg^{-1} \cdot h^{-1}$. Campbell et al. (15) observed that renal and cardiovascular stability is much better when crystalloids are given at the rate of 10–15 $mL \cdot kg^{-1} \cdot h^{-1}$ intraoperatively.

There has been no standardized fluid regimen available for clinical use in ambulatory patients. Patients selected for the study were usually studied during the morning session, and at worst would endure a fast of approximately 16 h, from 9 PM the previous night until 1 PM the afternoon after surgery. The fluid load of 20 mL/kg was based on a daily water requirement of approximately 30 mL/kg. We found that 20 mL/kg of isotonic electrolyte solution reduced the adverse clinical outcomes of thirst, nausea, dizziness, and drowsiness. Our patients had nothing to drink after midnight. Scarr et al. (16) have recommended that healthy patients be allowed to drink clear fluids until 3 h before their elective ambulatory surgery is scheduled. Further study to determine the optimal perioperative fluid replacement in ambulatory patients who drink up to 3 h preoperatively is warranted.

In conclusion, our results showed that alleviating dehydration with adequate fluid therapy reduced the incidence of postoperative adverse outcomes, such as thirst, nausea, dizziness, and drowsiness. We recommend perioperative hydration of 20 mL/kg for fluid-restricted patients undergoing general anesthesia in short ambulatory surgery.

Appendix I

Postanesthetic Discharge Scoring System (PADSS)

Vital Signs

2 Within 20% of preoperation
1 20%–40% of preoperation
0 40% of preoperation

Activity, mental status
- 2 Oriented and steady gait
- 1 Oriented or steady gait
- 0 Neither

Pain, nausea, vomiting
- 2 Minimal
- 1 Moderate
- 0 Severe

Surgical bleeding
- 2 Minimal
- 1 Moderate
- 0 Severe

Intake output
- 2 *Per os* fluids and voided
- 1 *Per os* fluids or voided
- 0 Neither

The total score is 10, with patients scoring ≥9 considered fit for discharge to home.

Appendix 2

Postoperative Evaluation Phone Call

Date and time of postoperative call __/__/__ __h

Problems since discharge:

Was there any bleeding significant enough for you to return to the hospital or to your doctor?	( ) Yes	( ) No
Do you have a sore throat?	( ) Yes	( ) No
Did you have any hoarseness of voice?	( ) Yes	( ) No
Did you feel you had a temperature?	( ) Yes	( ) No
Did you experience any pain at the operative area?	( ) Yes	( ) No
Did you experience any pain at the injection site?	( ) Yes	( ) No
Did you experience any pain in other areas?	( ) Yes	( ) No
Have you been nauseous or felt that you wanted to vomit?	( ) Yes	( ) No
Did you actually throw up?	( ) Yes	( ) No
Did you experience any headache?	( ) Yes	( ) No
Did you find yourself very sleepy or difficult to wake up?	( ) Yes	( ) No
Did you feel faint, or lightheaded?	( ) Yes	( ) No
Do you feel any form of generalized discomfort, or weakness?	( ) Yes	( ) No

Do you have any other complaints? _____

What medications did you take? _____

On a scale of 1 to 10, 1 being no activity and 10 being back to your normal activities, where would you rate yourself? (Score 0–10) _____

Did you have to go back to the emergency room or the hospital?	( ) Yes	( ) No
Did you have to call your doctor since discharge?	( ) Yes	( ) No

Reason: _____

Do you wish to make any additional comments? ___

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