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Efficacy of Therapeutic Suggestions for Improved Postoperative Recovery Presented during General Anesthesia

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There have been claims that the postoperative course of patients may be improved by presentation during general anesthesia of therapeutic suggestions which predict a rapid and comfortable postoperative recovery. This study evaluated the effectiveness of such therapeutic suggestions under double-blind and randomized conditions. A tape recording predicting a smooth recovery during a short postoperative stay without pain, nausea, or vomiting was played during anesthesia to about half the patients (N = 109), while the remaining, control patients were played a blank tape instead (N = 100). The patients were primarily undergoing operations on the fallopian tubes, total abdominal hysterectomy, vertical banding gastroplasty, cholecystectomy, and ovarian cystectomy or myomectomy. The anesthesia methods consisted of either isoflurane with 70% nitrous oxide in oxygen to produce end-tidal concentrations of 1.0, 1.3, or 1.5 MAC; or 70% nitrous oxide in oxygen combined with high or low doses of opioids. Assessments of the efficacy of the therapeutic suggestions in the recovery room and throughout the postoperative hospital stay included: the frequency of administration of analgesic and antiemetic drugs; opioid doses; the incidence of fever; nausea, retching, and vomiting; other gastrointestinal and urinary symptoms; ratings of pain; ratings of anxiety; global ratings of the patients' physical and psychological recoveries by the patients and their nurses; and length of postoperative hospital stay. There were no meaningful, significant differences in postoperative recovery of patients receiving therapeutic suggestions and controls. These negative results were not likely to be due to insensitivity of the assessments of recovery, as they showed meaningful interrelations among themselves and numerous differences in recovery following different types of surgery. Widespread utilization of therapeutic suggestions as a routine operating room procedure seems premature in the absence of adequate replication of previously published positive studies. (Key words: Anesthesia, depth: Awareness, Memory, Recall, Learning.)

THERE IS SOME EVIDENCE that a modest amount of cognitive processing and acquisition of information occur under anesthesia.[1–2] Sensitive memory tests that rely on application of signal detection analysis of recognition performance, or tap non-declarative or implicit type memory are needed to confirm the faint registration of information and its subsequent fragile storage.[3] Declarative or explicit memory is measured by recall and recognition tests which require conscious recollection by subjects. Implicit memory is measured by facilitation of performance on completion, identification, and other such tests that do not require conscious or intentional recollection.[4] Patients who suffer from organic amnesias have severely defective explicit memory but largely spared implicit memory. There is therefore some analogy in memory capabilities between the anesthetized patient and the organic amnesic one.

Research on learning and memory under anesthesia needs ultimately to address important basic questions such as identification of the neural correlates of learning and effects of anesthetics on the neural systems that serve declarative and nondeclarative memories. However, such research has immediate important clinical applications. There have been claims that the postoperative course of patients may be improved by presentation during anesthesia of therapeutic suggestions that predict a rapid and comfortable postoperative recovery.[5–8] If true, the beneficial implications would be enormous. If therapeutic suggestions administered under anesthesia help to reduce common sequelae to numerous surgical operations like pain, nausea, vomiting, ileus, and urinary retention, it might be possible to enhance the well-being of the patient and shorten the duration of stay in the hospital after surgery. Length of stay is a major factor affecting the cost of surgery[9] and might be reduced easily and inexpensively without concerns such as toxicity, intolerance, and side effects of drugs. Only a cassette player with headphones would be needed.

Therefore, we studied whether clinically significant benefits could be produced by playing to patients under anesthesia a tape recording that suggested a rapid and comfortable postoperative recovery. Numerous measures of recovery were assessed for a large sample of patients.

Materials and Methods

PATIENT RECRUITMENT

The study was approved by the Institutional Review Board of the University of Iowa. For about 20 months, the names and addresses of patients scheduled to undergo operations on the fallopian tubes for treating infertility, total abdominal hysterectomy, vertical banding gastroplasty for treating morbid obesity, cholecystectomy (simple, without choledochotomy), and ovarian cystectomy or myomectomy at the University of Iowa Hospitals and Clinics were obtained. Patients were sent a letter describing the study, followed a few days later by a telephone call soliciting their participation. To enhance patients' cooperation, we compensated them financially for partici-

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pation. Initially we accepted a wider variety of surgeries before settling mainly on those mentioned above (table 1). These surgeries had sufficient frequencies to provide enough patients and produced sufficiently high incidences of the target symptoms addressed by the therapeutic suggestions—*e.g.*, pain, nausea, vomiting, and ileus. Patients also stayed in the hospital for a few days after these surgeries, giving us the opportunity to examine the effect of suggestions on the duration of the hospital stay.

Several of the surgeries were done almost exclusively by two surgeons; *i.e.*, one surgeon did 100% of the operations on the fallopian tubes and 56% of the ovarian cystectomies and myomectomies, and another did 87% of the vertical banding gastroplasties. This limited the variability in patients' postoperative courses because of different surgical styles, techniques, and skills and because of the different hospital discharge criteria adopted by individual surgeons.

It has been reported that awareness during anesthesia may be commoner in obese individuals[10] and women.[11-12] Both types of patients were amply represented in our sample. We reasoned that if learning during anesthesia is more likely in these patients, they might be more apt to show effects of the therapeutic suggestions.

Patients were excluded if they were younger than 18 yr or older than 55 yr. Older patients were excluded because of possible age-related declines in memory and/or hearing acuity. Patients were also excluded if they had any of the following health problems: ASA physical status 4 or 5 (because the severity of existing systemic disorders might make patients' cooperation in the postoperative period difficult and might preclude administration of high concentrations of nitrous oxide and isoflurane, *i.e.*, 1.3 and 1.5 MAC); hearing or visual impairment (because of interference with effective presentation of the tape recording and/or administration of test material); mental impairment, untreated affective disorder, or other major psychiatric disorder (because of potential problems with testing); and middle ear disease (because it increases the incidence of nausea and vomiting). Patients were excluded also if we anticipated that they might require heavy preoperative or postoperative sedation or if they were using drugs that might interfere with memory (*e.g.*, benzodiazepines). To avoid interference with the evaluation of the efficacy of the therapeutic suggestions in reducing pain, patients were excluded if they were intolerant to opioids or if we anticipated that postoperative pain would be treated by methods other than systemic administration of opioids.

TABLE 1. Patient, Anesthetic, and Surgical Information

	Control Patients		Patients Receiving Therapeutic Suggestions	
	Mean	SE	Mean	SE
Age (yr)	34.7	0.9	36.0	0.8
Education (yr)	12.5	0.2	13.2	0.3
Weight (kg)	87.2	3.5	83.7	3.0
Duration of surgery (min)	121.1	4.7	128.0	5.8
Duration of anesthesia (min)	148.9	4.8	156.4	6.2
Health index score*	8.3	0.1	8.4	0.1
Preoperative trait anxiety[13]	37.9	0.9	38.3	0.9
Preoperative state anxiety[13]	41.1	1.0	42.3	1.1
	Frequency Distributions (%)†			
	Control Patients		Patients Receiving Therapeutic Suggestions	
Sex				
Female	90		93	
Male	10		7	
Race				
White	100		98	
Black	0		2	
ASA physical status				
1	54		55	
2	41		38	
3	5		7	
Type of surgery				
Operations on the Fallopian tubes for infertility	30		31	
Vertical banding gastroplasty for morbid obesity	24		19	
Total abdominal hysterectomy	17		15	
Cholecystectomy	9		10	
Ovarian cystectomy or myomectomy	8		7	
Other small groups‡	12		17	
Type of anesthesia§				
N_2O and isoflurane, 1.0 MAC	21		29	
N_2O and isoflurance, 1.3 MAC	15		12	
N_2O and isoflurane, 1.5 MAC	28		25	
N_2O and low-dose bolus opioids	21		19	
N_2O and high-dose bolus opioids	6		6	
N_2O and opioid infusion	9		8	

* Sum of preoperative ratings of severity of disease of seven organ systems (respiratory, cardiovascular, nervous, renal, digestive, endocrine/metabolic, and muscle/skin/bone). The physiologic and functional integrities of each system were classified into three grades of impairment (1 = none; 2 = some; and 3 = severe).[14] The range of possible sums is 7 to 21.

† Percentages may not add to 100% because of rounding error.

‡ Include bowel resection, ileostomy, takedown of intestinal fistula, stomach resection, repair of abdominal hernia or abdominoplasty, excision of lymph nodes, mastectomy, and vaginal hysterectomy and other gynecologic surgery.

§ The type of anesthesia did not fit any of the six types specified in the table for one other patient receiving therapeutic suggestions.

PROCEDURE

Preoperative Screening

After agreeing to participate, patients were visited the day before surgery. They completed Spielberger *et al.*'s State–Trait Anxiety Inventory[13] and were instructed in the use of visual analogue scales for rating pain. Detailed information was obtained about demographic factors (age, weight, sex, race, education, and occupation); physical

health (ASA physical status and Health Index score[14]); postanesthetic and surgical histories (particularly history of postoperative nausea and vomiting and awareness during anesthesia); history of motion sickness; preoperative physical symptoms; and current medications.

Anesthesia Procedures

Anesthesia for all cases was administered by one of two anesthesiologists. Patients who needed premedication were given morphine 9.6 mg (mean) intramuscularly (25% of patients) with or without glycopyrrolate 0.2 mg (mean) intramuscularly (11% of patients) at 0.5–1 h before induction. After the patient's arrival in the operating room, a peripheral intravenous infusion was established through which 5% dextrose in lactated Ringer's solution was administered. Thiopental was administered until loss of consciousness. A nondepolarizing muscle relaxant was injected to facilitate endotracheal intubation and to provide adequate muscle relaxation during surgery. About 90% suppression of muscle twitch as observed using a nerve stimulator was maintained. Patients were assigned to one of five anesthetic methods (as many as three of which were studied concurrently) and to administration of therapeutic suggestions in their order of recruitment according to random tables prepared in advance. The distribution of patients among anesthetic methods is shown in table 1. The methods fell into two main groups.

1. Nitrous oxide and isoflurane group: Isoflurane with 70% nitrous oxide in oxygen was delivered to the patients to produce combined end-tidal concentrations of 1.0, 1.3, or 1.5 MAC. The anesthetic concentrations in the expired gas, as measured by a mass spectrometer, were maintained for at least 15 min before the recordings were started, to optimize equilibration among alveolar, arterial, and brain anesthetic partial pressures. If supplementation of 1.0 MAC anesthesia was needed, bolus doses of 0.75 μg/kg fentanyl or its equivalent of sufentanil were administered when systolic blood pressure or heart rate increased more than 15% above preanesthetic control levels or the patient moved.

2. Nitrous oxide and opioids group: Two doses of opioids (fentanyl, sufentanil, or alfentanil) with 70% nitrous oxide and oxygen were used. In the "high-dose" condition, opioids were given either as bolus doses or as a continuous infusion. For those receiving bolus doses, fentanyl 7.5 μg/kg (or its equivalent of other opioids) was given during induction, followed by administration of thiopental until loss of consciousness. Patients were ventilated with 70% nitrous oxide in oxygen, with additional doses of 2.5 μg/kg fentanyl administered to supplement anesthesia when systolic blood pressure or heart rate increased more than 15% above preanesthetic levels or when the patient moved. In the continuous-infusion method, alfentanil 50 μg/kg (or its equivalent of other opioids) was given as a priming dose, followed by an infusion at a rate of 1–3 $\mu g \cdot kg^{-1} \cdot min^{-1}$. The rate of infusion was varied according to the patient's hemodynamic responses, movement, and other signs of excessively "light" anesthesia. In the "low-dose" condition, the induction dose of fentanyl was 5 μg/kg, and maintenance bolus doses of 0.75 μg/kg were administered when indicated.

Normocapnia and normothermia were maintained. Glycopyrrolate and edrophonium or neostigmine were administered to reverse the effects of muscle relaxants at the end of surgery.

Recording Presentation

A recording of therapeutic suggestions was played to roughly half of the patients (n = 109). The other patients (n = 100), who served as a control group, were played a blank tape.

The therapeutic suggestions, which lasted 6 min, were recorded at a deliberate rate of speech by a woman not involved with the study. The tape was played at a normal but relatively loud listening volume. (Before the tape was begun, the recorder's volume was adjusted by the anesthesiologist or research assistant, using an unrelated musical recording.) The patient was addressed directly, with statements such as "You are relaxed. . . . The operation is going great. . . . You will feel fine after the operation. . . ." The suggestions predicted a smooth, rapid recovery during a short postoperative stay; no pain, nausea, or vomiting; rapid return of bowel and bladder function; rapid healing and mobility; comfort; relaxation; and good appetite, sleep, mood, and feeling. (A transcript is available from the first author.) The tape was modified from that of a previous study that reported beneficial effects of therapeutic suggestions.[5]

Multiple, coded copies of the therapeutic suggestions and blank tapes were used. The patients, anesthesiologists, and research assistants were blinded to the identity of the tape. The identity was known only to one person, who was not involved with the conduct of the study. The therapeutic suggestions or blank tape were played through the headphones of a cassette player, starting 5 min after the surgical incision. For the first 59 patients, the tape was played only once. For the remaining 150 patients, it was continuously, automatically repeated until the specified end-tidal anesthetic concentrations were decreased near the end of surgery. The conversations and sounds in the operating room were recorded by a machine situated beside the patient's head, from the time the patient lost consciousness during induction until the end of anesthesia, except when the tape was being played.

For the first 134 patients, the tape contained additional verbal materials for subsequent memory tests assessing the possibility of learning under anesthesia. These patients were tested in three series using different combinations of memory tests for assessing learning under anesthesia and for examining possible effects of anesthetic methods and frequency of repetition of verbal materials on learning. No such additional verbal materials for memory tests were included for the remaining 75 patients. In all series, patients were randomly assigned to be played the tape containing therapeutic suggestions or the blank tape. Consequently, patients receiving therapeutic suggestions and the control patients were well distributed among the anesthetic methods, the series of memory tests, and the single or multiple administration of the therapeutic suggestions; chi-square tests were nonsignificant in all cases. Because preliminary analyses after about one fourth of the patients had been tested did not suggest that anesthetic methods influenced the efficacy of the therapeutic suggestions, we decided that it was not crucial to use a single anesthetic method for all subsequent patients. Moreover, we found that anesthetic methods and presentation of the tapes once as compared to multiple times did not influence learning under anesthesia in the other memory tests.[1]

Assessments of the Efficacy of Therapeutic Suggestions

Assessments in the Recovery Room

The anesthesiologist assessed the patient's orientation to place, day, month, and year every 15 min. Beginning when the patient was oriented and could coherently answer simple questions, pain, nausea, retching, and vomiting were assessed every 30 min. Pain was assessed orally on a scale from 0 to 10. Preliminary attempts to obtain the patient's written response on a visual analogue scale proved to be unreliable because of difficulty focusing the eyes in the early postoperative period. The presence or absence of nausea, retching, and vomiting were recorded, as was the presence or absence of a nasogastric tube. The doses and times of administration of analgesics and antiemetics were recorded.

Assessments During the Postoperative Hospital Stay

Pain diary ratings: The patients were given diaries of visual analogue scales marked with days and times for rating pain. Each scale was a 100-mm line labeled "worst pain ever" at one end and "no pain" at the other end. The "no pain" label appeared on the right side of half of the scales and on the left side of the remainder. Patients were instructed to mark the scale at whatever position best represented how they were feeling at the time of the rating. Patients were asked to make ratings every 2 h on the day of surgery after discharge from the recovery room and the following day, and every 4 h on subsequent days of their hospital stay while awake. The research assistants reminded the patients daily about making these ratings, to ensure compliance.

Dosages of opioids and other drugs: The research assistants recorded the doses of opioids, other analgesics, and antiemetics used in each 24-h period.

Nausea and vomiting: The presence or absence of retching, nausea, and vomiting were recorded every 24 h.

Gastrointestinal and urinary symptoms: The presence or absence of a nasogastric tube, passage of flatus, bowel movement, intake of fluids, intake of solids, and urination were recorded daily, as was the presence or absence and frequency of urinary catheterization.

Temperature: The patients' temperatures were recorded as frequently as they were charted by the nurses—every 4 h during the first 2 days after surgery and subsequently less often, if the temperature was within normal limits.

Anxiety and global ratings: The patients completed the State–Trait Anxiety Inventory[13] on the 3rd day after surgery. They also made global ratings of their physical and psychological recoveries on scales ranging from "excellent" to "poor." The day and evening nurses made the same ratings for their patients.

Length of the postoperative hospital stay and reasons for delaying discharge: The date of discharge from the hospital was recorded, as were any reasons for delaying discharge.

Statistical Analyses

Two-factor analyses of variance were done for the following: pain ratings in the recovery room when the patient become oriented and 30, 60, and 90 min later; opioid doses in the recovery room; mean pain ratings and opioid doses on successive postoperative days; length of postoperative hospital stay; half-days of fever exceeding 37.3° C; first day of micturition, passage of flatus, bowel movement, intake of fluids, and intake of solids; and preoperative and postoperative state and trait anxiety ratings. The two factors were group (therapeutic suggestions tape *vs.* control tape) and type of surgery. Similar analyses were done to test the balancing of the groups for variables such as age.

Chi-square tests were done to determine if therapeutic suggestions and type of surgery affected any of the following: the frequency of symptoms (nausea, retching, vomiting, insertion of a nasogastric tube) in the recovery room, on the 1st postoperative day, and on all postoperative days combined; insertion of a catheter on the 1st postoperative day and on all postoperative days combined; and ratings ("excellent," "good," or "fair") of physical and psychological recovery of the patients on the 3rd postoperative day by the patients themselves and by their

day and evening nurses. (Since there were only five "poor" ratings, these were pooled with "fair.") Chi-square tests were also done to compare the groups on the numbers of patients receiving analgesic and antiemetic drugs in the recovery room and during the whole postoperative stay and the numbers of patients for whom reasons for delaying discharge from the hospital were noted, and to test balancing of the groups on variables such as sex. Fisher's Exact Tests were used instead of chi-square tests when characteristics were shown only by controls or patients receiving therapeutic suggestions, but not both.

Pearson product–moment correlations and point biserial correlations were used to examine interrelations between selected variables.

Results

In addition to the 209 patients for whom results are presented in this report, there were four patients entered into the study (two receiving therapeutic suggestions and two controls) who were subsequently dropped: one was discharged from the hospital on the day of surgery; one was positive for the human immunodeficiency virus, and nursing and hospital precautions made his follow-up different from other patients; one was found to have cancer, which changed the magnitude of the operation performed; and one needed a second operation on the 5th postoperative day and was hospitalized for more than a month.

There were no significant differences between controls and patients receiving therapeutic suggestions in sex, ASA status, or types of surgeries according to chi-square tests, in race according to Fisher's Exact Test, or in age, weight, duration of surgery, duration of anesthesia, health index score, preoperative trait anxiety, or preoperative state anxiety according to two-factor analyses of variance (table 1). There was a chance difference in years of education—12.5 yr for controls and 13.2 yr for patients receiving therapeutic suggestions, $P < 0.01$. However, the difference was small and unlikely to have affected the outcome of therapeutic suggestions; *e.g.*, years of education did not correlate significantly with length of the postoperative hospital stay, $r = -0.136$, $P > 0.05$.

Selected data for the major assessments of the efficacy of the therapeutic suggestions are shown in tables 2–4. Table 2 shows the percentages of patients who received different antiemetic and analgesic drugs postoperatively. Patients receiving therapeutic suggestions and controls showed no significant differences in frequency of treatment with any drug. Table 3 shows length of postoperative hospital stays, opioid doses, pain ratings, incidence of fever, some indices of bowel and bladder functions, and anxiety ratings. Table 4 shows incidence of postoperative nausea, retching, and vomiting and patients' ratings of their recoveries. In all the assessments analyzed, including those shown in tables 3 and 4, the only significant overall effects of therapeutic suggestions were a decreased opioid dose on the 8th postoperative day—at which time few patients remained hospitalized (data not shown)—and an increased frequency of retching on the 1st postoperative day and during all postoperative days (table 4), $P < 0.05$. Considering the large number of analyses, these seem likely to be type I errors. This also seems the most probable interpretation for two significant interactions of type of surgery with therapeutic suggestions: for first day of bowel movement and postoperative trait anxiety, the difference between patients receiving therapeutic suggestions and controls showed opposite patterns for different types of surgery (table 3), $P < 0.05$.

Reasons for delaying discharge from the hospital were noted for 17 patients, of whom 10 received therapeutic suggestions and 7 did not. A chi-square test indicated that the incidence of delays did not differ for patients receiving therapeutic suggestions and controls, $P > 0.05$.

Since the patients undergoing varied surgeries ("other small groups" in table 1) were not as well distributed as the five main types of surgery for administration of therapeutic suggestions, the analyses were repeated with these patients excluded to see whether this altered the results. The changes were negligible. Specifically, one effect of therapeutic suggestions was no longer significant (for opioid doses on the 8th postoperative day), and one ad-

TABLE 2. Percentages of Patients Who Received Analgesic and Antiemetic Drugs Postoperatively

Class	Drug	Control Patients	Patients Receiving Therapeutic Suggestions
Drugs administered in the recovery room			
Antiemetic	Droperidol	29	34
Opioid Analgesic	Meperidine	8	12
	Morphine	75	77
Drugs adminstered during the postoperative hospital stay			
Antiemetic	Hydroxyzine	16	18
	Prochlorperazine	14	14
	Promethazine	31	33
Opioid Analgesic	Codeine	61	63
	Meperidine	22	23
	Morphine	93	89
Nonopioid Analgesic	Acetaminophen	57	64
	Ibuprofen	31	37

Omitted above are the following drugs, which were administered to fewer than 2% of the patients: 1) in the recovery room: acetaminophen, codeine, fentanyl, hydroxyzine, metoclopromide, morphine in the form of opium, prochlorperazine, and promethazine; 2) during the postoperative hospital stay: droperidol, mefenamic acid, and morphine in the form of opium.

TABLE 3. Postoperative Hospital Stay, Opioid Doses, Pain Ratings, Incidence of Fever, Bowel and Bladder Functions, Fluid Consumption, and Anxiety Ratings

	Fallopian		VBG		AH		Chole.		OC/M		Other	
	C	T	C	T	C	T	C	T	C	T	C	T
Postoperative stay	3.3 (0.1)	3.4 (0.1)	5.3 (0.3)	5.5 (0.4)	5.1 (0.4)	5.1 (0.4)	4.9 (0.5)	4.1 (0.3)	4.1 (0.4)	3.4 (0.2)	4.3 (0.6)	5.5 (0.7)
Opioids*												
Recovery room	7 (1)	6 (1)	7 (2)	10 (1)	7 (1)	8 (1)	8 (2)	12 (2)	10 (2)	7 (2)	3 (1)	6 (2)
Day 1	43 (4)	39 (4)	43 (3)	52 (3)	44 (5)	41 (5)	31 (8)	40 (6)	43 (6)	40 (7)	31 (7)	33 (5)
Day 2	20 (4)	17 (3)	28 (3)	29 (3)	16 (3)	20 (5)	14 (4)	19 (6)	21 (6)	17 (5)	19 (8)	18 (5)
Pain ratings												
Recovery room †	61 (5)	61 (4)	58 (7)	71 (7)	57 (7)	59 (8)	68 (10)	71 (10)	68 (12)	59 (12)	36 (9)	47 (8)
Day 1	41 (4)	39 (3)	49 (4)	54 (2)	36 (4)	37 (5)	57 (10)	53 (5)	45 (3)	42 (6)	42 (6)	37 (5)
Day 2	29 (4)	34 (4)	37 (4)	44 (4)	30 (4)	31 (4)	46 (11)	35 (5)	42 (6)	28 (6)	28 (9)	25 (5)
Fever	3.6 (.2)	3.1 (.3)	4.2 (.5)	4.4 (.4)	4.8 (.7)	4.5 (.9)	2.8 (.4)	2.3 (.5)	3.8 (.7)	3.3 (.6)	2.5 (.5)	2.3 (.5)
Urine	1.4 (.1)	1.4 (.1)	1.1 (.1)	1.0 (0)	1.6 (.2)	1.4 (.2)	1.1 (.1)	1.1 (.1)	1.6 (.2)	1.6 (.2)	1.7 (.4)	2.0 (.4)
Flatus	2.4 (.1)	2.3 (.1)	3.0 (.2)	3.3 (.2)	3.0 (.2)	2.7 (.3)	2.2 (.2)	2.9 (.4)	3.1 (.2)	2.5 (.3)	1.7 (.3)	2.3 (.3)
Bowel‡	3.3 (.2)	2.9 (.2)	3.6 (.2)	4.1 (.2)	3.7 (.3)	3.6 (.3)	3.4 (.4)	3.8 (.4)	4.5 (.5)	3.0 (0)	2.0 (.7)	3.6 (.4)
Fluid	1.6 (.1)	1.7 (.1)	1.7 (.2)	1.2 (.1)	1.6 (.2)	2.3 (.5)	1.7 (.3)	1.9 (.2)	1.4 (.2)	1.7 (.2)	1.5 (.5)	1.6 (.6)
Anxiety												
Trait‡	32.1 (1.4)	34.4 (1.4)	40.0 (1.8)	38.4 (2.4)	34.9 (2.3)	43.8 (2.6)	40.6 (2.1)	34.8 (2.9)	34.3 (1.8)	36.6 (2.9)	40.1 (3.2)	36.0 (1.9)
State	29.0 (1.2)	31.6 (1.3)	37.4 (2.3)	36.8 (2.1)	34.9 (2.6)	34.6 (2.2)	40.3 (4.7)	36.1 (2.7)	35.5 (2.7)	26.4 (2.3)	33.8 (3.1)	35.5 (2.8)

Data are mean and standard error (in parentheses).

C = control group; T = group receiving therapeutic suggestions; Fallopian = operations on the Fallopian tubes for infertility; VBG = vertical banding gastroplasty for morbid obesity; AH = total abdominal hysterectomy; Chole. = cholecystectomy, OC/M = ovarian cystectomy or myomectomy; Other = other small groups.

Postoperative stay = length of stay (days); Opioids = opioid doses in the recovery room and on the 1st and 2nd postoperative days; Pain Ratings = mean ratings for the recovery room at the time the patient became oriented and for the 1st and 2nd postoperative days; Fever = half-days of fever during the postoperative stay; Urine = day of first postoperative urination without catheter; Flatus = day of first postoperative passage of flatus; Bowel = day of first postoperative bowel movement; Fluid = day of first postoperative consumption of fluids; Anxiety = scores[15] on the 3rd postoperative day; Trait = trait anxiety; State = state anxiety.

* Mean doses are shown in units such that 1 unit = 1 mg morphine administered parenterally. Since morphine was the most commonly used opioid, other opioids were converted to equianalgesic[30] doses of morphine; *e.g.*, parenteral meperidine, oral meperidine, and oral codeine were estimated as having roughly 0.13, 0.06, and 0.05 the potency of parenteral morphine, respectively.

† Pain ratings in the recovery room, which were assessed on a 0–10 scale, have been multiplied by 10 to make them comparable to pain ratings obtained during the subsequent postoperative stay, which were measured in millimeters on a 0–100 scale.

‡ Significant interaction of type of surgery with therapeutic suggestions by analysis of variance, $P < 0.05$ (see text).

ditional interaction became significant; *i.e.*, the difference between patients receiving therapeutic suggestions and controls in 1st day of fluid consumption varied, depending on the type of surgery involved (table 3).

The analyses of opioid doses were also done separately for patients receiving patient-controlled analgesia and conventional parenteral opioid regimens (52 and 48% of patients, respectively), to see whether this affected the results; like the analyses including all patients, however, these separate analyses showed no effects of therapeutic suggestions except on the 8th postoperative day. In addition, for patients receiving patient-controlled analgesia for whom printed charts were available, the ratios of the mean numbers of demands to deliveries on the 1st and 2nd postoperative days were analyzed. These analyses showed no effects of therapeutic suggestions. The ratios on the first postoperative day were 1.3 ± 0.1 (mean ± standard error) for controls and 1.5 ± 0.2 for patients receiving therapeutic suggestions. Corresponding values on the following day were 1.2 ± 0.1 for both groups.

The inability to detect beneficial effects of therapeutic suggestions probably was not due to the presentation of these suggestions only a single time to some patients. Table 5 shows some recovery data, *i.e.*, length of postoperative hospital stay and half-days of fever, for patients who received multiple presentations of the tape recordings. Separate analyses for patients receiving multiple *versus* single presentations indicated that neither mode of presentation showed beneficial effects of the therapeutic suggestions. When all patients were analyzed together with mode of presentation included as an additional factor, there were no beneficial effects of therapeutic suggestions, and their effects did not depend on (*i.e.*, interact with) mode of presentation.

The inability to detect beneficial effects of therapeutic suggestions probably was not due to insensitivity of the measures of recovery. These measures were sensitive enough to show numerous significant differences in recovery after different types of surgery. There were significant differences among types of surgery in the following: opioid dose requirements in the recovery room, later on the day of surgery, and on the 1st–5th postoperative days ($P < 0.05$ or less); pain ratings in the recovery room at the time the patient became oriented and 30 min later,

TABLE 4. Incidence of Postoperative Nausea, Retching, and Vomiting and Patients' Ratings of Recovery (Percentages of Patients)

	Fallopian		VBG		AH		Chole.		OC/M		Other	
	C	T	C	T	C	T	C	T	C	T	C	T
Nausea												
Recovery room	34	29	74	48	35	44	56	45	38	75	58	32
Day 1	77	76	71	57	76	81	56	73	62	100	67	72
All postoperative days	80	82	83	71	82	88	67	73	75	100	67	74
Retching												
Recovery Room	7	12	17	19	6	0	22	0	0	38	33	0
Day 1*	13	21	21	14	18	56	33	36	13	75	17	26
All postoperative days*	13	24	25	19	18	63	44	55	13	75	25	26
Vomiting												
Recovery room	3	6	9	14	0	0	22	0	0	38	25	0
Day 1	33	21	8	19	35	19	11	18	13	50	42	39
All postoperative days	33	26	8	24	41	38	11	27	13	50	50	37
Patients' ratings†												
Physical recovery												
Excellent	54	34	38	19	41	25	13	67	25	71	55	53
Good	46	56	42	67	53	63	50	0	63	29	45	41
Fair	0	9	21	14	6	13	38	33	13	0	0	6
Psychological recovery												
Excellent	42	47	33	29	59	50	13	44	25	57	64	41
Good	54	47	50	52	24	50	75	44	75	43	27	47
Fair	4	6	17	19	18	0	13	11	0	0	9	12

C = control group; T = group receiving therapeutic suggestions; Fallopian = operations on the Fallopian tubes for infertility; VBG = vertical banding gastroplasty for morbid obesity; AH = total abdominal hysterectomy; Chole. = cholecystectomy, OC/M = ovarian cystectomy or myomectomy; Other = other small groups.

Nausea, Retching, and Vomiting = percentages of patients reporting the specified symptom at any time in the recovery room, on the 1st postoperative day and on all postoperative days; Patients' Ratings = percentages of patients rating their physical recovery and psychological recovery as "excellent," "good," or "fair" on the 3rd postoperative day.

* Significant effect of therapeutic suggestions by chi-square test, $P < 0.05$ (see text).

† Similar ratings were obtained from patients' day and evening nurses but are omitted above because, like patients' self-ratings, they showed no significant differences between patients receiving therapeutic suggestions and patients who did not.

later on the day of surgery, and on the 1st, 2nd, 3rd, and 6th postoperative days ($P < 0.05$ or less); length of postoperative hospital stay ($P < 0.001$); half-days of fever ($P < 0.001$); first day of micturition ($P < 0.001$), passage of flatus ($P < 0.001$), bowel movement ($P < 0.01$), and intake of solids ($P < 0.01$); postoperative state anxiety ($P < 0.01$) and trait anxiety ($P < 0.01$); insertion of a nasogastric tube in the recovery room, on the 1st postoperative day, and during all postoperative days ($P < 0.05$); catheterization on the 1st postoperative day and during all postoperative days ($P < 0.001$); retching during all postoperative days ($P < 0.05$); and the patients' self-ratings of their physical recovery ($P < 0.05$).

If the inability to detect substantial effects of therapeutic suggestions was due to insensitivity of the measures of recovery, these measures would also be unlikely to show meaningful interrelations among themselves. To assess several expected interrelations, Pearson product–moment correlations were computed. Higher opioid doses administered on the 1st postoperative day were correlated with higher mean pain ratings on that day, $r = 0.29, P < 0.001$; with higher preoperative state anxiety, $r = 0.21, P < 0.01$, and trait anxiety, $r = 0.14, P < 0.05$; with lower age, $r = -.14, P < 0.05$; and with later days of first passage of flatus, $r = 0.31, P < 0.001$. Point biserial correlations indicated that the occurrence of vomiting on the 1st post-

TABLE 5. Postoperative Hospital Stay and Incidence of Fever for Patients Receiving Multiple Presentations of the Tape Recordings

	Fallopian		VBG		AH		Chole.		OC/M		Other	
	C	T	C	T	C	T	C	T	C	T	C	T
Postoperative Stay	3.4 (0.1)	3.4 (0.1)	5.4 (0.3)	5.5 (0.4)	5.2 (0.5)	5.3 (0.6)	4.7 (0.6)	4.0 (0.4)	4.1 (0.5)	3.3 (0.2)	3.3 (0.6)	3.2 (0.5)
Fever	4.0 (0.2)	3.4 (0.2)	4.7 (0.6)	4.4 (0.4)	5.1 (0.7)	4.6 (1.1)	2.5 (0.3)	2.3 (0.6)	4.1 (0.7)	3.5 (0.6)	3.5 (0.6)	2.2 (1.0)

Data are mean and standard error (in parentheses).

C = control group; T = group receiving therapeutic suggestions; Fallopian = operations on the Fallopian tubes for infertility; VBG = vertical banding gastroplasty for morbid obesity; AH = total abdominal hysterectomy; Chole. = cholecystectomy, OC/M = ovarian cystectomy or myomectomy; Other = other small groups.

Postoperative Stay = length of stay (days); Fever = half-days of fever during the postoperative stay.

operative day correlated with a history of postoperative vomiting, r = 0.17, $P < 0.05$, and a history of motion sickness, r = 0.19, $P < 0.01$. The occurrence of nausea on the 1st postoperative day correlated with the same two historic variables, r = 0.24, $P < 0.001$, and r = 0.17, $P < 0.05$, respectively.

To examine whether the inability to detect substantial effects of therapeutic suggestions was due to an inadequate sample size, power analyses[15] were done. These analyses indicated that the sample size for our study should have provided adequate power for detecting the effects of theoretical interest, had they been of clinically significant magnitude: *e.g.*, a difference between patients receiving therapeutic suggestions and controls of at least 1 day in postoperative stay or one half day in fever. Power analyses using estimates of variability based on the data actually observed for these variables indicated that effects of therapeutic suggestions of the specified magnitudes could have been detected with adequate power: power > 0.99, $\alpha = 0.05$ for postoperative stay and power = 0.93, $\alpha = 0.05$ for fever.

Discussion

We found no meaningful, significant differences in postoperative recovery between patients receiving therapeutic suggestions during anesthesia and controls. Several previous studies have tested the effects of presenting therapeutic suggestions during anesthesia, some reporting benefits[16,17] and some not.[18–20] Two uncontrolled studies[16,17] found that therapeutic suggestions improved patients' postoperative recovery. Pearson[7] found that patients who were presented during anesthesia with therapeutic suggestions were discharged from the hospital an average of 2.4 days sooner than those played music or a blank tape, but the experimental and control groups were not matched for type of surgery. The differences in hospital stay of patients undergoing different operations made comparisons between the groups difficult. Bonke *et al.*[5] also found shorter hospital stays after therapeutic suggestions among patients who had cholecystectomies, but only elderly patients, not younger ones, showed this effect. Moreover, there were two separate control groups and the shorter stays after therapeutic suggestions were evident mostly in comparison to one of these groups. A later study from the same institution[18] could not replicate the earlier beneficial effects. Among the reasons that were suggested for these discrepant results was the lack of an account in the earlier study for the surgical performance of choledochotomies, which entailed a longer hospital stay, for some patients. In two other studies[19,20] no beneficial effects of therapeutic suggestions were found, although these studies can be criticized because of their small sample sizes.

However, a recent study conducted by Evans and Richardson[6] under double-blind and randomized conditions in 39 hysterectomy patients obtained positive results. Patients who were played therapeutic suggestions during anesthesia involving a wide variety of anesthetic drugs had shorter postoperative stays and shorter periods of pyrexia and were rated by nurses as having made a better recovery.[6] These encouraging results left a few unanswered questions: were patients suffering from malignancy included, and were their numbers equal in the experimental and control groups? There was no information about the physical status of patients before surgery; patients with poor physical state are more likely to stay longer in the hospital. There were 13 Caucasians in the suggestion group *versus* 9 in the control group, and there were 6 Afro-Caribbeans in the suggestion group *versus* 11 in the control group; whether ethnic origin may have affected the results is unclear. It is also surprising that there were shorter periods of postoperative pyrexia in the suggestion group in the absence of relevant instructions on the tape recording, whereas there were no differences in pain intensity, nausea and vomiting, and urinary difficulties between the two groups despite the presence of explicit instructions on the tape concerning "... not troubled by any pain . . . not feel sick at all . . ." The authors suggested that large individual variabilities in the incidence and duration of pain, nausea, and vomiting and enhancement of immune function through a better psychological adaptation to the stress of surgery might account for these results. However, there were no differences in the mood and anxiety scores postoperatively between the two groups.

It is interesting that until recently there were no reports that therapeutic suggestions influenced measures such as pain ratings, dosages of opioids administered, and incidence of nausea and vomiting. McLintock and colleagues[8] recently reported a 23% reduction in postoperative opioid requirement in patients receiving therapeutic suggestions, with no reduction in pain scores or incidence of nausea or vomiting.

Several points in the design of our study deserve comment because they differed from those of other studies. We studied patients who had more than one type of surgery to obtain a large sample size and to assess the possibility that beneficial effects of therapeutic suggestions would be restricted to certain types of operations. Had this been the case, interactions of therapeutic suggestions with type of surgery would have been significant in the overall analyses, and follow-up analyses would have indicated that they were attributable to beneficial effects of therapeutic suggestions for certain surgeries. This did not occur. The two types of surgeries involving the largest numbers of patients seemed particularly promising for demonstrating beneficial effects. It has been reported that

therapeutic suggestions presented during anesthesia are likely to be less successful with major and extensive surgery.[16-17] Certainly, surgery on the fallopian tubes and gastric stapling did not involve a great deal of tissue trauma and blood loss. Patients were motivated to have the surgery and to recover quickly; particularly motivated were those having operations on the fallopian tubes, who were very eager to become pregnant, and those having vertical banding gastroplasties, who wanted desperately to lose weight. The possibility of improving their well-being postoperatively at no cost through the effect of the therapeutic suggestions was appealing to patients.

We used several anesthetic methods in our study but controlled the agents and the doses of drugs. We could have used one standard anesthetic method but chose otherwise. If we had observed beneficial effects of therapeutic suggestions and these had occurred under all anesthetic methods, our results would have been more general, or, if we had observed beneficial effects of therapeutic suggestions under some anesthetic methods but not others, this would have been of substantial clinical significance.

In practice, we observed no beneficial effects of therapeutic suggestions, and there was no hint that anesthetic methods influenced the efficacy of the therapeutic suggestions. Interestingly, anesthetic methods also did not influence learning under anesthesia in the implicit memory tests we have used previously.[1] Patients anesthetized with nitrous oxide and opioids did not differ from those anesthetized only with inhalational agents. In general, implicit or unconscious memory occurs in patients regardless of anesthetic methods or dosages of drugs.[6,21-22]

For unknown reasons, we were unable to replicate the beneficial effects of therapeutic suggestions presented during anesthesia that were observed by Evans and Richardson[6] and by McLintock and colleagues.[8] We used an adequate sample size, and our assessment procedures were sensitive enough to show numerous significant differences in recovery after different surgeries. Many details may need to be considered in the design and presentation of the suggestion tape. Some researchers believe that the message should use the patient's preferred name, be presented slowly at normal listening volume, and be phrased in direct, grammatically simple and affirmative statements.[23] Clinical hypnotists stress the importance of using positive terms and avoiding the use of negative terms to maximize benefits to patients. These details should be tested for their possible significance.

The few significant effects of therapeutic suggestions in our study did not point toward a beneficial influence of these suggestions. We found, in fact, an increased frequency of retching (but not nausea or vomiting) in the experimental group. The multiple variables examined in this study increased the likelihood of significant differences arising by chance, such that the null hypothesis was rejected when it should have been accepted. This is the way we interpret the effect on retching—*i.e.*, as a type I error. We used in our therapeutic suggestions one negative or exclusionary sentence, "You won't feel nauseous or have to vomit", among several positive or affirmative statements, *e.g.*, "You will enjoy eating, drinking. . . . You will swallow to clear your throat and everything will go one way, straight down. . . . The food will taste good. . . . Your stomach will feel fine." We do not think that the negative sentence led to paradoxical results. Evans and Richardson‡ (personal communication) used in their therapeutic suggestions a negative sentence ("You will not feel sick"), which they repeated, yet the reported incidence of nausea and vomiting did not differ between the experimental and control groups.

Our inability to confirm beneficial effects of therapeutic suggestions does not preclude the possibility that some acquisition and storage of information may occur under anesthesia and that this information may later be unconsciously retrieved. Such cognitive events may not influence physiologic functions that affect recovery. At a conscious level, remembering the contents of a well-written article about the dangers of a high cholesterol diet, for instance, does not mean that the reader will modify his or her diet.

It is not apparent how beneficial effects, if they occur, are achieved. Because therapeutic suggestions administered to hypnotized subjects may be beneficial,[24-26] an analogy between hypnotized and anesthetized individuals has been evoked. A review of the physiologic effects of hypnotic suggestions[27] concluded that suggestions, if effectively communicated and accepted at a "deep" level, could influence cellular (especially vascular and immunologic) functioning to conform to the suggested alterations. Supposedly, by becoming deeply absorbed in the imagined physiologic change as a result of the suggestions, the feelings that accompanied the actual physiologic change would be reinstated, and these feelings would stimulate the cells to produce the actual change. A review[28] of the clinical uses of hypnosis concluded that hypnosis was more effective in treating nonvoluntary disorders, such as pain, than disorders involving self-initiated behavior, such as overeating. However, the analogy between the hypnotic and anesthetized states has little support, and it remains almost miraculous that suggestions can be helpful when administered to an unconscious patient.

Are we ready to "advertise" therapeutic messages to anesthetized patients, as a recent editorial in a leading medical journal suggested?[29] We think not, in light of our negative findings. We see no reason for a wholesale purchase of cassette players and taped messages for operating

‡ Evans C, Richardson PH: Personal communication.

room use in the absence of adequate replication of previously published positive studies.

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