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Anesthesia for ambulatory surgery

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INTRODUCTION

Ambulatory surgery accounts for over 60% of all elective operative procedures performed in the United States. With the recent growth in major laparoscopic and office-based surgery, this percentage may increase to 70% in the future. When surgery is performed outside the conventional hospital environment, it can offer a number of advantages for patients, healthcare providers, third-party payers, and even hospitals[1]. Patients benefit from day-surgery because it minimizes costs, decreases separation from their home and family environment, reduces surgery waiting times, decreases their likelihood of contracting hospital-acquired infections, and appears to reduce postoperative complications. Compared to traditional hospital admissions, there is less pre- and postoperative lab testing and also a reduced demand for postoperative pain medication following ambulatory surgery. Unlike inpatient surgery, ambulatory surgery does not depend upon the availability of a hospital bed and may permit the patient greater flexibility in selecting the time of their elective operation. Furthermore, there is greater efficiency in the utilization of the operating and recovery rooms in the ambulatory setting, contributing to a decrease in the overall patient charges compared to similar hospital-based care.

COMPARISON OF GENERAL, SPINAL AND LOCAL ANESTHESIA

The optimal anesthetic technique in the ambulatory setting would provide for excellent operating conditions, a rapid recovery, no postoperative side effects, and a high degree of patient satisfaction. In addition to increasing the quality and decreasing the costs of the anesthetic services, the ideal anesthetic technique would also improve operating room (OR) efficiency and provide for an early discharge home without side effects. Local anesthesia with intravenous (IV) sedation (so-called monitored anesthesia care [MAC]), spinal anesthesia, and general anesthesia are all commonly used anesthetic techniques for ambulatory surgery. However, opinions differ as to the "best" anesthetic technique for these surgical procedures[2-15]. Rather than simply generalizing as to the best anesthetic technique for ambulatory surgery, it is necessary to individually analyze each surgical procedure. For example, in an Editorial in Anesthesia & Analgesia[16], Kehlet and White discussed the optimal anesthetic technique for inguinal hernia repair.

In the current cost-conscious environment, it is important to also examine the impact of anesthetic techniques on OR turnover times, as well as the recovery process after ambulatory surgery because prolonged recovery times and reduced efficiency and productivity contribute to increased cost of surgical care (Tables I and II)[10]. In addition, patient satisfaction with their perioperative experience and quality of recovery is improved when the anesthetic technique chosen for the procedure is associated with a low incidence of postoperative side effects [e.g., pain, dizziness, headaches, postoperative nausea and vomiting (PONV)][10,11]. For example, routine use of prophylactic antiemetic drugs during general anesthesia has been found to increase patient satisfaction in "at risk" surgical populations[17]. Furthermore, the use of local anesthetic infiltration and peripheral nerve blocks decreases postoperative pain after ambulatory surgery procedures irrespective of the anesthetic technique[4,18,19].

The time required to achieve a state of home-readiness ("fitness" for discharge home) is influenced by a wide variety of surgical and anesthetic factors[20,21]. However the major contributors to delays in discharge after ambulatory surgery are nausea, vomiting, dizziness, pain and prolonged sympathetic and/or motor blockade. Although the incidence of PONV can be decreased by the use of prophylactic antiemetic drugs[17], it remains a common side effect after general anesthesia and prolongs discharge after ambulatory surgery[10,11]. The primary factors delaying discharge after spinal anesthesia are recovery from the residual motor blockade and sympatholytic effects of the subarachnoid block, contributing to delayed ambulation and inability to void. These side effects can be minimized by the use of so-called mini-dose lidocaine fentanyl spinal anesthetic techniques[13,15].

Table I. Patient demographic characteristics, surgical, anesthetic, and recovery times for the three anesthetic techniques used for anorectal in the ambulatory setting[10].

	Local anesthesia	Spinal anesthesia	General anesthesia
Number (n)	31	31	31
Age (yr)	40 ± 9	43 ± 10	41 ± 9
Weight (kg)	83 ± 18	82 ± 16	82 ± 22
Height (cm)	171 ± 11	169 ± 8	172 ± 10
Sex (M / F) (n)	22/9	21/10	24/7
ASA physical status (I /II/III) (n)	10/18/3	10/16/ 5	11/15/5
Duration of surgery (min)	26 ± 14	26 ± 13	26 ± 15
Duration of anesthesia (min)	40 ± 15	72 ± 17*	75 ± 19*
Phase 1 PACU stay (min)	0	52 ± 18*	44 ± 27*
Phase 2 DSU stay (min)	71 ± 17	135 ± 113*	120 ± 52*
Time to oral intake (min)	12 ± 5	59 ± 18*	60 ± 29*
Initial Aldrete score in recovery (n)	10 ± 0	9.1 ± 0.4*	8.3 ± 0.7*†
Time to Aldrete score of 10 (min)	0	19 ± 7*	30 ± 19*†
Time to home-readiness (min)	76 ± 17	193 ± 112*	171 ± 58*
Duration of hospital stay (min)	116 ± 21	266 ± 112*	247 ± 65*

Values are mean ± SD
* $p < 0.05$ *vs* Local anesthesia with sedation
† $p < 0.05$ *vs* Spinal anesthesia
PACU = Postanesthesia Care Unit
DSU = Day-Surgery Unit

Table II. Incremental costs associated with the three anesthetic techniques for outpatient anorectal surgery[10].

	Local anesthesia with sedation	Spinal anesthesia	General anesthesia
Intraoperative costs (USD)			
Drugs	23.16 ± 9.29	3.92 ± 1.35*	48.22 ± 7.72*†
Supplies	4.23 ± 0.27	13.29 ± 0.35*	9.1 ± 0.24*†
Total OR drugs + supplies	27.39 ± 9.39	17.21 ± 1.55*	57.32 ± 7.89*†
OR labor costs	36.34 ± 14.04	66.30 ± 15.17*	68.45 ± 14.04*
Total intraoperative costs	63.73 ± 20.69	83.50 ± 15.17*	125.78 ± 20.69*†
Recovery costs (USD)			
Drugs	0.10 ± 0.20	0.63 ± 2.92	1.80 ± 4.94
Supplies	0	0.15 ± 0.47*	0.80 ± 0.82*†
Nursing labor costs: Phase 1	0	9.46 ± 3.22*	8.04 ± 4.94*
Phase 2	5.20 ± 1.23	9.94 ± 3.22*	8.79 ± 3.78*
Total	5.20 ± 1.23	19.40 ± 8.87*	16.83 ± 6.14*
Total recovery costs	5.29 ± 1.39	20.37 ± 9.15*	18.63 ± 9.96*
Perioperative costs (USD)			
Total drug costs	23.26 ± 9.25	4.55 ± 3.68*	50.03 ± 8.50*†
Total supplies	4.23 ± 0.27	9.72 ± 0.46*	13.44 ± 0.47*†
Total labor costs	41.54 ± 13.88	85.67 ± 17.83 *	85.29 ± 18.79*
Total perioperative costs	69.02 ± 20.39	103.68 ± 18.13 *	145.02 ± 25.31*†

‡ Values are mean ± SD in United States dollars (USD)
* $p < 0.05$ *vs* Local anesthesia with sedation
† $p < 0.05$ *vs* Spinal anesthesia

Other common concerns with spinal anesthesia include back pain, post-dural puncture headache and transient radicular irritation with lidocaine[22,23]. Although MAC is associated with the lowest incidence of postoperative side effects[10,11], the possibility of transient nerve palsy is a concern when peripheral nerve block techniques are used[25,26].

The cost savings with the use of newer general anesthetic techniques are lost if institutional practices mandate minimum lengths of stay in the Phase 1 unit [Postanesthesia care unit (PACU)] and do not permit fast-tracking of patients who emerge rapidly from anesthetic directly to the Phase 2 [Day-surgery ("step-down")] unit. Claims of reduced total costs with earlier discharge are commonly based on the assumption that there is a linear relationship between the costs of a service and the time spent providing it. However, since personnel costs are semi-fixed rather than variable, an additional 15-30 minute stay in the PACU may not be associated with increased costs to the institution unless the facility is working at or near its capacity[27]. In that situation, a longer stay is potentially associated with a "bottleneck" in the flow of patients through the OR suites and recovery areas, requiring overtime payments to the nurses and/or the hiring of additional perioperative personnel. There appears to be a much closer relationship between lower costs and bypassing of the PACU ("fast-tracking"), as the major factor in recovery care costs relates to the peak number of patients admitted to the PACU unit at any time[27]. Fast-tracking can lead to the use of fewer nurses and a mix of less highly trained, lower wage nursing aides and fully-qualified recovery room nurses, and reduces "overtime" personnel costs for busy ambulatory surgery units. Shorter anesthesia times, the ability to bypass the PACU (Phase 1), and a decreased length of stay in the day-surgery (Phase 2) unit will reduce total institutional costs[28]. Studies have demonstrated that "fast-tracking" ambulatory surgery patients decrease the times to actual discharge (Tables I and III)[29,30].

The combination of low costs and high patient satisfaction suggests that the highest quality (cost/outcome) anesthetic may be achievable with a MAC technique assuming that the surgical procedure is amendable to this anesthetic approach (e.g., superficial surgical and endoscopic procedures). Cost estimates of different anesthetic regimens for ambulatory surgery are available (Table II)[10]. Unfortunately, many pharmacoeconomic studies have limited cost considerations to only the acquisition costs of the drugs and supplies rather than the total (direct + indirect) expenses associated with a given anesthetic technique. The total cost should include both the acquisition costs of drugs and the labor required for managing side effects (e.g., PONV, pain, drowsiness, bladder dysfunction). Since personnel costs constitute a major proportion of expenses in the OR and recovery areas, anesthetic techniques which require more time in the various phases of the perioperative process will not surprisingly be more expensive (Table II)[10,11].

The availability of improved sedation and analgesia techniques to complement local anesthetic infiltration has increased the popularity of performing surgery utilizing MAC techniques[31]. The high patient satisfaction with local anesthesia/sedation is also related to effective control of postoperative pain and the absence of side effects associated with the other commonly used general and spinal anesthetic techniques. The success of MAC techniques is dependent not only on the anesthesiologist, but also upon the skills of the surgeon in providing effective infiltration analgesia and gentle handling of the tissues during the intraoperative period. Local anesthesia without any monitoring or intravenous adjuvants (so-called "unmonitored" local anesthesia), has been successfully used in situations where local anesthesia is able to provide excellent analgesia and patients do not object to being awake and aware of events in the operating room[32]. The importance of good surgical skills is critically important because inadequate intraoperative control of pain can lead to prolonged surgery times and patient dissatisfaction with their surgical experience. In a prospective, randomized comparison of local infiltra-

Table III. Effect of fast-tracking on time to discharge and patient satisfaction after outpatient gynecologic laparoscopic surgery[29,30].

	Conventional recovery	Fast-track recovery
Age (yr)	30 ± 6	28 ± 5
Weight (kg)	69 ± 22	74 ± 14
Surgery time (min)	36 ± 11	37 ± 12
Home ready (min)	151 ± 50	112 ± 46*
Discharged home (min)	206 ± 46	159 ± 63*
Patient satisfaction (0-100)	93 ± 5	94 ± 4

* Significantly different from "conventional" pathway, p<0.05

tion with spinal and general anesthesia[33], surgeons in Sweden suggested the technical difficulties and patient pain were "more intense" during surgery under local anesthesia. This finding is consistent with an earlier report by Fairclough, et al[34]. However, with these surgical provisions, it is widely accepted that superficial surgical procedures can be performed as safely and effectively under local anesthesia as under any other form of anesthesia. In fact, the researchers in Sweden concluded that "for most patients, local anesthesia can be recommended as the standard procedure for outpatient knee arthroscopy"[33].

While most studies have suggested that local anesthesia (e.g., local infiltration and/or peripheral nerve blocks) are not only well-accepted by patients and surgeons for superficial outpatient procedures (e.g., breast surgery, knee arthroscopy, anorectal surgery, and inguinal herniorrhaphy) but is also more cost-effective than either spinal or general anesthesia[10,11,35], some studies have suggested that spinal anesthesia is more cost-effective than general anesthesia[5,7]. These and other studies[13,15] have suggested that the use of smaller dosages of lidocaine (15-30 mg) or bupivacaine (3-6 mg) combined with a potent opioid (e.g., fentanyl, 12.5-25 µg, or sufentanil, 5-10 µg) contributes to a faster recovery of both motor and bladder function than conventional doses of the local anesthetic alone. Earlier discharge after spinal anesthesia using the so-called mini-dose techniques will clearly improve its cost-effectiveness in the ambulatory setting. Unfortunately, side effects such as pruritis and nausea are increased even when small doses of fentanyl (or sufentanil) are administered into the subarachnoid space[15].

Even though central neuroaxial blocks can be made more cost-effective by using smaller doses of short-acting local anesthetics combined with potent opioid analgesics, use of MAC techniques for superficial (non-cavitary) ambulatory surgery procedures will result in the shortest times to home readiness, lowest pain scores at discharge, and smallest incremental costs when compared to both spinal and general anesthesia[10,11]. Therefore, in situations where fast-tracking is permitted, the use of MAC techniques would appear to offer significant advantages over both central neuroaxis blocks (i.e., spinal/epidural) and general anesthetic techniques.

The availability of more rapid and shorter-acting intravenous and inhaled anesthetics, analgesics and adjunctive drugs, as well as improved cerebral monitoring capabilities, has facilitated the recovery process after general anesthesia. For example, studies involving the use of "light" general anesthetic techniques with a laryngeal mask airway device and local analgesia have demonstrated that outpatients undergoing superficial surgical procedures (e.g., hernia repair, breast surgery) are able to ambulate within 30 min and can be discharged home in less than 60 min after completion of their operation[36-38]. When tracheal intubation is required [e.g., laparoscopic procedures, risk factors for aspiration (e.g., diabetics, morbidly obese, esophageal dysfunction)], use of minimal, effective doses of newer short-acting opioid analgesics (e.g., remifentanil) and sympatholytic (e.g., esmolol) drugs can facilitate the early recovery process and allow patients to achieve earlier discharge times after ambulatory surgery[39-42]. The use of the more costly drugs can be economically justified if improvements in recovery and work patterns can be demonstrated[43]. However, anesthetic practices have advanced to the point where cost savings from variations in drug use are only apparent when system-wide improvements are made in the efficacy of resource utilization (including personnel, space, time, consumables and capital investments)[44].

FAST-TRACKING CONCEPTS

Ambulatory anesthesia is administered with the dual goals of rapidly and safely establishing satisfactory conditions for the performance of therapeutic or diagnostic procedures while ensuring a rapid, predictable recovery with minimal postoperative sequelae. If the careful titration of short-acting drugs permits a safe transfer of patients directly from the operating room suite to the less labor-intensive recovery area where the patient can be discharged home within one hour after surgery, significant cost savings to the institution can be achieved[44]. Bypassing the Phase I recovery (i.e., PACU) has been termed "fast-tracking" after ambulatory surgery[45]. In addition, fast-tracking can also be accomplished directly from the PACU by creating a specialized area where recovery procedures are organized along the lines of a step-down unit[46]. The criteria used to determine fast-track eligibility (Table IV)[47] has been made even more stringent than the standard PACU discharge criteria in order to reduce the need for interventions in areas with less nursing personnel. The use of anesthetic techniques associated with a more rapid recovery will result in fewer patients remaining deeply sedated in the early postoperative period[30,48], decrease the risk for airway obstruction and cardiorespiratory instability, and reduce the number of nursing interventions[49]. By reducing the need for "intensive" nursing care in the early postoperative period using anesthetic techniques associated with a faster emergence from anesthesia, a well-organized fast tracking program can permit an institution to use fewer nurses in the recovery areas and leads to significant cost savings[50]. The fast-track concept is gaining wider acceptance throughout the world[51]. Even elderly outpatients can be fast-tracked after general anesthesia if short-acting drugs are utilized[49].

Improved titration of anesthetic drugs using EEG-based cerebral monitors (e.g., bispectral index [BIS], physical state index [PSI], auditory-evoked potential [AEP], and entropy)

Table IV. Criteria for fast-tracking outpatients after ambulatory surgery. A minimum score of 12, with no score < 1 in any individual category, would be required for a patient to be fast-tracked after general anesthesia[47].

I.	Level of consciousness	*Score*
	• awake and oriented	2
	• arousable with minimal stimulation	1
	• responsive only to tactile stimulation	0
II.	Physical activity	
	• able to move all extremities on command	2
	• some weakness in movement of extremities	1
	• unable to voluntarily move extremities	0
III.	Hemodynamic stability	
	• blood pressure < 15% of baseline MAP value	2
	• blood pressure between 15-30% of baseline MAP value	1
	• blood pressure > 30% below baseline MAP value	0
IV.	Respiratory stability	
	• able to breathe deeply	2
	• tachypnea with good cough	1
	• dyspneic with weak cough	0
V.	Oxygen saturation status	
	• maintains value > 90% on room air	2
	• requires supplemental oxygen (nasal prongs)	1
	• saturation less than 90% with supplemental oxygen	0
VI.	Postoperative pain assessment	
	• none or mild discomfort	2
	• moderate-to-severe pain controlled with IV analgesics	1
	• persistent severe pain	0
VII.	Postoperative emetic symptoms	
	• none or mild nausea with no active vomiting	2
	• transient vomiting or retching	1
	• persistent moderate-severe nausea and vomiting	0
	Total score	14

can lead to a faster emergence from anesthesia[52,53] and can be useful in predicting fast-track eligibility[54]. Although the early studies involving propofol[52] and the newer volatile anesthetics sevoflurane and desflurane[53], suggested that the anesthetic-sparing effect could facilitate a faster emergence from anesthesia, these studies failed to demonstrate a decrease in the times to discharge home because standard recovery practices were used. However, if outpatients are allowed to recover via a fast-track pathway, use of cerebral monitoring can actually reduce discharge times[55].

While the availability of more rapid and shorter-acting anesthetic drugs (e.g., propofol, sevoflurane, desflurane, remifentanil) has clearly facilitated the early recovery process after general anesthesia, the preemptive use of non-opioid analgesics (e.g., local anesthetics, ketamine, nonsteroidal antiinflammatory drugs, COX-2 inhibitors, acetaminophen)[56] and antiemetics (e.g., droperidol, metoclopramide, 5-HT_3 antagonists, dexamethasone)[57], will reduce postoperative side effects and accelerate both the immediate and late recovery phases after ambulatory surgery.

MULTIMODAL APPROACHES TO PREVENTING POSTOPERATIVE COMPLICATIONS

As more complex procedures are performed utilizing minimally-invasive surgical approaches (e.g., laparoscopic adrenalectomy, arthroscopic knee and shoulder reconstructions), the ability to effectively control postoperative side effects may make the difference between performing a given procedure on an inpatient or ambulatory basis. For routine antiemetic prophylaxis, the most cost-effective combination consists of low-dose droperidol (0.5-1 mg) and dexamethasone (4-8 mg)[58]. Interestingly, dexamethasone appears to facilitate an earlier discharge independent of its effects on PONV[59,60]. Outpatients at high risk of PONV will benefit from the addition of a 5-HT_3 antagonist (e.g., ondansetron, dolasetron, granisetron)[61,62] or an acustimulation device (e.g., SeaBand®, ReliefBand®)[63,64]. Droperidol remains the most cost-efffective antiemetic assuming side effects can be avoided[65,66]. Although controversy exists regarding its potential for cardiac arrhythmias, droperidol has remained a safe and effective antiemetic for over 30 years[67]. An aggressive multimodal approach to minimize PONV can improve the recovery process and enhance patient satisfaction[68]. In addition to utilizing combination antiemetic therapy, simply insuring adequate hydration will minimize nausea and other side effects (e.g., dizziness, drowsiness, thirst) during the postoperative period[69].

A multimodal (or "balanced") approach to providing postoperative analgesia is also essential in the ambulatory setting[70-72]. Not surprisingly, pain has been found to be a major factor complicating recovery and delaying discharge after ambulatory surgery[73]. The addition of low-dose ketamine (75-150 μg/kg) to a multimodal analgesic regimen improved postoperative analgesia and functional outcome after painful orthopedic surgery procedures[74,75]. Following outpatient surgery, pain must be controllable with oral analgesics (e.g., acetaminophen, ibuprofen, acetaminophen with codeine) before patients are discharged from the facility. Although the potent rapid-acting opioid analgesics (e.g., fentanyl, sufentanil) are commonly used to treat moderate-to-severe pain in the early recovery period, these compounds increase the incidence of PONV and may contribute to a delayed discharge after ambulatory surgery[56,73]. As a result of the concerns regarding opioid-related side effects, there has been an increased interest in the use of potent non-steroidal anti-inflammatory agents (e.g., diclofenac, ketorolac), which can effectively reduce the requirements for opioid-containing oral analgesics after ambulatory surgery, and can lead to an earlier discharge home[76]. Other less expensive oral non-steroidal analgesics (e.g., ibuprofen, naproxen)[77,78] may be acceptable alternatives to fentanyl and the parenteral non-selective NSAIDs if administered in a pre-emptive fashion. Recently, premedication with the COX-2 inhibitors (e.g., celecoxib, rofecoxib, valdecoxib, parecoxib) has become more popular because they are devoid of potential adverse effects on platelet function[79]. For routine clinical use, oral premedication with rofecoxib (50 mg), celecoxib (400 mg) or valdecoxib (40 mg) is a simple and cost-effective approach to improving pain control and decreased discharge times after ambulatory surgery[80-84]. The injectable COX-2 inhibitor, parecoxib, may prove useful in the future[85,86]. Finally, acetaminophen is a very cost-effective alternative to the COX-2 inhibitors if it can be given in a high enough dose (40-60 mg/kg po or pr) prior to the end of surgery[87,88].

One of the keys to facilitating the recovery process is the routine use of local anesthetics as part of a multimodal regimen[56]. Use of local anesthetic techniques for intraoperative analgesia during MAC, as well as adjuncts to general (and spinal) anesthesia, can provide excellent analgesia during the early postoperative recovery and postdischarge periods[4,18,19]. Even simple wound infiltration and instillation techniques have been shown to improve postoperative analgesia following a variety of lower abdominal, peripheral extremity and even laparoscopic procedures. A wide variety of peripheral extremity blocks have also been utilized to minimize postoperative pain[89,90]. More recently, use of continuous local anesthetic delivery systems (e.g., I-Flow) have been found to improve pain control after major ambulatory orthopedic surgery by extending periopheral nerve blocks[91-93]. Patient-controlled local anesthetic delivery has also been described for improving pain relief after discharge home([94]. Following laparoscopic procedures, abdominal pain can also be minimized by the use of a local anesthesia at the portals and topically applied at the surgical site[95,96]. Shoulder pain is also common following laparoscopic surgery, and this has been reported to be reduced with subdiaphragmatic instillation of local anesthetic solutions[95]. Following arthroscopic knee surgery, instillation of 30 mL of bupivacaine 0.5% into the joint space reduces postoperative opiate requirements and permits earlier ambulation and discharge[96]. The addition of morphine (1-2 mg), ketorolac (15-30 mg), clonidine (0.1-0.2 mg) and/or triamcinolone (10-20 mg) to the intraarticular local anesthetic solution can further reduce pain after arthroscopic surgery[97-99]. Electroanalgesia can also be used as part of a multimodal treatment regimen[100]. Future growth in the complexity of surgical procedures being performed on an ambulatory basis will require further improvements in our ability to provide effective postoperative pain relief outside the surgical facility (e.g., subcutaneous opioid PCA, patient-controlled local anesthesia with a disposable infusion system, transcutaneous analgesic delivery systems).

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