Paravertebral Blocks Provide Superior Same-Day Recovery over General Anesthesia for Patients Undergoing Inguinal Hernia Repair

Admir Hadzic, MD, PhD, Beklen Kerimoglu, MD, Dan Loreio, MD, Pelin Emine Karaca, MD, Richard E. Claudio, BS, Marina Yufa, MD, Ray Wedderburn, MD, Alan C. Santos, MD, MPH, and Daniel M. Thys, MD

The Department of Anesthesiology, St. Luke's-Roosevelt Hospital Center, College of Physicians and Surgeons of Columbia University, New York, New York

Inguinal herniorrhaphy is commonly performed on an outpatient basis under nerve blocks or local or general anesthesia (GA). Our hypothesis is that use of paravertebral blocks (PVB) as the sole anesthetic technique will result in shorter time to achieve home readiness and improved same-day recovery over a 'fast-track' GA. Fifty patients were randomly assigned to receive either PVB or GA under standardized protocols (PVB = 0.75% ropivacaine, followed by propofol sedation; GA = dolasetron 12.5 mg, propofol induction, rocuronium, endotracheal intubation; desflurane; bupivacaine 0.25% for field block). Eligibility for postanesthetic care unit (PACU) bypass and data on time-to-postoperative pain, ambulation, home readiness, and incidence of adverse events were collected. More patients in the PVB group (71%) met the criteria to bypass the postanesthetic care unit compared with patients in the GA group (8%; $P < 0.001$). Only 3 (13%) of patients in the PVB group requested treatment for pain while in the hospital, compared with 12 (50%) patients in the GA group, despite infiltration with local anesthetic ($P = 0.005$). Patients in the PVB group were able to ambulate earlier (102 ± 55 minutes) than those in the GA group (213 ± 108 minutes; $P < 0.001$). Time-to-home readiness and discharge times were shorter for patients in the PVB group (156 ± 60 and 253 ± 37 minutes) compared with those in the GA group (203 ± 91 and 218 ± 93 minutes) ($P < 0.001$). Adverse events (e.g., nausea, vomiting, sore throat) and pain requiring treatment in the first 24 hours occurred less frequently in patients who had received PVB than in those who had received GA. In outpatients undergoing inguinal herniorrhaphy, PVB resulted in faster time to home readiness and was associated with fewer adverse events and better analgesia before discharge than GA.

(Anesth Analg 2006;102:1076–81)

Inguinal hernia repair is a common surgical procedure and is typically performed on an outpatient basis. The choice of anesthetic technique depends on patient and surgeon preference, feasibility of the technique in a given patient, intra- and postoperative pain control, early recovery and monitoring requirements (e.g., ability to fast-track), skills of the anesthesiologist, and perioperative costs. Local anesthesia or field block with IV sedation (monitored anesthesia care), spinal anesthesia, and general anesthesia (GA) are all commonly used anesthetic techniques for outpatients undergoing inguinal herniorrhaphy procedures (1). Several surveys suggest that for this procedure most anesthesiologists choose GA (60%–70%) and far fewer choose centroneuraxial blocks (10%–20%) or field block anesthesia with sedation (5%–15%) as the primary anesthetic technique (2,3). More recently, the use of nerve blocks (ilioinguinal-hypogastric nerve block) and field block with local anesthetic have both been shown to decrease postoperative pain and to be cost-effective anesthetic techniques for outpatients undergoing unilateral inguinal herniorrhaphy (1,4). Specific peripheral nerve blocks, such as paravertebral block (PVB), have also been used with success, both as an anesthetic and analgesic technique, for inguinal herniorrhaphy (5–7). However, there are no prospective randomized studies comparing the use of PVB versus GA for outpatient inguinal hernia repair surgery. Our hypothesis is that use of

Supported by the Department of Anesthesiology, St. Luke's-Roosevelt Hospital Center, New York.

Accepted for publication October 19, 2005.

Address correspondence to Admir Hadzic, PhD, MD, Department of Anesthesiology, Travers 701, St. Luke's-Roosevelt Hospital Center, 1111 Amsterdam Avenue, New York, NY 10025. Address e-mail to admir@nysora.com.

DOI: 10.1213/01.ane.0000196532.56221.f2

0003-2999/06

PVB as a sole anesthetic technique will result in a shorter time to home readiness (primary outcome variable) and improved same-day recovery over GA.

Methods

The study was approved by the IRB of St. Luke's-Roosevelt Hospital Center (New York, New York). Patients were eligible for participation if they were 18–70 years of age, had an ASA physical status I–IV, and were scheduled for outpatient open repair of the inguinal hernia. The hernias were direct or indirect inguinal, primary or recurrent, and fully reducible according to the Nyhus classification (8). Patients were recruited on the day of surgery by a coinvestigator and a research assistant. After obtaining written informed consent, patients were randomized using the method of sealed envelopes to receive either PVB or fast-track GA (specifically designed for rapid wake-up and same-day discharge), using standard protocols.

Data were recorded with respect to anesthesia drugs given and several physiologic parameters during anesthesia (heart rate, arterial blood pressure, and oxygen saturation). Patients were monitored during surgery and recovery according to standard guidelines published by the American Society of Anesthesiologists (9).

Patients assigned to receive PVB were given midazolam (2–4 mg IV) and alfentanil (500–1000 μg) in the operating room (OR) before block placement. These premedicants were used to decrease anxiety and discomfort during block injection while maintaining meaningful patient contact. A senior trainee or regional anesthesia fellow under the direction of an attending anesthesiologist performed the blocks.

Supplemental oxygen (5 L/min) was administered by facemask throughout. The PVB was performed using a 22-gauge, 8.89-cm Quincke-type point spinal needle (BD Medical Systems, Franklin Lakes, NJ). The block was performed unilaterally using a standard technique with the patient sitting (10). After walking off the transverse processes of T9–L1 vertebrae and inserting the needle 1 cm deeper to the superior or inferior ridge of the processes, 5 mL of ropivacaine (0.75%) was injected at each level.

After injection, surgeons proceeded with surgical preparation without waiting for complete onset of surgical anesthesia. During surgery, PVB patients received an IV infusion of propofol (Diprivan®; AstraZeneca Pharmaceuticals LP, Wilmington, DE), titrated to light sleep with easy arousability. No other intraoperative sedatives or opioids were allowed. After surgery, propofol was stopped, and the patient was taken to the Phase 1 postanesthesia care unit (PACU). PVB patients with inadequate surgical anesthesia, or those requiring intraoperative IV opioids, were given GA. The research team predetermined that all patients with failed blocks would be analyzed in the PVB treatment group to follow principles of intent-to-treat.

GA patients were given preoperative dolasetron (12.5 mg IV) for prophylaxis against postoperative nausea and vomiting (PONV), midazolam (1–2 mg), and fentanyl (50–100 μg). GA was induced with propofol (1.5–2.0 mg/kg); one dose of rocuronium (1 mg/kg) was given to facilitate endotracheal intubation. Anesthesia was maintained with desflurane in a 1:1 mixture of nitrous oxide and oxygen. The end-tidal concentration of desflurane was maintained at 3%–6%, based on mass spectrometry (Capnomac Ultima ULT1; Datex-Ohmeda, Helsinki, Finland). Fentanyl boluses (25–50 μg IV) were administered as deemed necessary by the attending anesthesiologist.

Surgeons prepared the skin for surgery after the correct placement of the endotracheal tube was confirmed. At the end of surgery, the surgeons infiltrated the wound using bupivacaine 0.25%. Patients were awakened after a wound dressing had been applied.

After surgery, patients were taken to the Phase 1 PACU. Phase 1 PACU nurses were blinded to the anesthetic technique used and had no access to the (automated) anesthesia record. Patients were evaluated using a modified Aldrete score (11) by the PACU nurse who made a decision regarding the patient's eligibility to bypass Phase 1 PACU going directly to the Phase 2 PACU. Patients could bypass Phase 1 PACU only with the following criteria: modified Aldrete score of 9 or more, visual analog scale (VAS) score <3, and no PONV. If admitted to Phase 1 PACU, vital signs were determined according to PACU policy, and presence of symptoms (e.g., PONV) was recorded.

Once in Phase 2 PACU, patients were assessed at 15-min intervals by the nurses. They determined when patients met discharge-to-home criteria (a score of ≥ 9 on the postanesthesia discharge scoring system) (12). There was no minimum time required for patients to remain in Phase 2 PACU. Voiding was not required for discharge (13).

Daily pain scores and overall satisfaction with anesthesia were assessed as single VAS scores (1–10); these scores were then arbitrarily trichotomized as 0–2 (unacceptable), 3–7 (marginal), and 8–10 (acceptable).

The severity of postoperative pain was repeatedly assessed using the VAS at 15-min intervals. If patients complained of pain in Phase 1 PACU, morphine (1–2 mg IV) was administered every 5–10 min until the patient was comfortable (VAS score ≤ 3). The pain management protocol in Phase 2 PACU and at home consisted of acetaminophen (325 mg) with codeine (30 mg) every 4 hours as needed.

Hospital time intervals (e.g., induction time, OR time, and PACU time) were recorded using data from

the automated record-keeping system. Data on discharge time were collected from the nursing documentation and verified by research assistants.

The research assistant, who was blinded to the type of anesthetic used, collected patient data by phone at 24, 48, and 72 hours and 2 weeks after surgery. During the first 3 postoperative days, data included highest VAS pain score and daily pill counts. Data on additional variables of anesthesia recovery (e.g., appetite, self-care, ambulation, interest in daily activities, and anxiety) were also collected during the phone interview. At 2 weeks after surgery, patients were asked about the occurrence of potential complications (e.g., prolonged numbness, radiating pain in the distribution of the lumbar plexus, and/or motor weakness).

Discrete categoric data are presented as n (%); continuous data are given as mean ± SD. Confidence intervals (95% CI) are reported for the specific aims (PACU bypass and discharge times), and number-needed-to-treat analysis is reported for PACU bypass ineligibility and unplanned hospital admission. Differences in demographic, surgical, anesthetic, and postoperative data were tested by independent Student's t-test (continuous data) or by χ^2 (categoric data) and Fisher's exact test (where appropriate). For descriptive purposes, P value differences <0.05 are noted in the tables. All analyses were conducted using SPSS for Windows, (version 11.0.1; SPSS Inc., Chicago, IL).

Results

Recruitment began in April 2002, and study follow-ups were completed by March 2003. Fifty patients were enrolled and randomly assigned to the anesthesia groups; no refusals to participate occurred after randomization. One patient in the PVB group was excluded because of a protocol violation (lidocaine was used for PVB instead of ropivacaine) and one patient in the GA group was excluded because the patient was directly admitted from the OR as a result of surgical considerations. No patient in the PVB group required intraoperative opioids or GA. The patients in the GA group received 280 ± 100 μg of fentanyl and patients in the PVB group received 420 ± 210 μg of alfentanil before the block placement and 53 ± 12 μg/kg/min (range, 35–71 μg/kg/min) propofol infusion. The remaining patients, 24 in each group, were evenly distributed by gender, and had similar height, weight, and surgical procedures. However, patients in the PVB group were older than patients in the GA group (Table 1). Although the majority of patients had ASA physical status I or II, all four patients (8%) with ASA physical status III or IV were in the PVB group (Table 1).

Surgical, anesthetic, and postoperative times did not differ between the groups. The mean induction time was slightly longer in the PVB group (Table 2). With respect to pain scores assessed as part of criteria to bypass PACU, fewer patients in the PVB group reported moderate/severe pain (more than 3 on a 10-point scale) than patients in the GA group ($P = 0.05$) (Table 3). More patients who received PVB were able to bypass the PACU (Table 3).

Table 1. Demographic Characteristics of the Study Sample

	Paravertebral block ($n = 24$)	General anesthesia ($n = 24$)
Men (%)	22 (92)	19 (79)
Age (yr)	62 ± 17	44 ± 13
Height (cm)	174 ± 10	171 ± 10
Weight (kg)	75 ± 14	73 ± 11
ASA physical status		
I	5 (21)	16 (67)
II	15 (63)	8 (33)
III	4 (17)	

n (%) for discrete variables, mean ± SD for continuous variables. There were no significant differences between the groups.

Overall, approximately half of all patients had nausea postoperatively; nausea was significantly more common among GA patients (Table 3). However, only one patient had an episode of vomiting (Table 3). As expected, more patients who had GA than PVB had sore throat either in the PACU or in Phase 2 (Table 3).

Fewer patients who received regional anesthesia required medication for pain relief before discharge home, compared with half of the patients who received GA (3 vs 12, respectively, $P = 0.005$).

Patients who received regional anesthesia ambulated sooner than patients who received general anesthesia (Table 3). Patients who received regional anesthesia voided sooner than patients who received GA. PVB patients also took food approximately 1 hour sooner than patients who received GA (Table 3). Moreover, twice as many patients in the GA group took longer than 3 hours to void than in the PVB group (12 vs 6, $P = 0.07$). Patients who received regional anesthesia were ready for discharge and were discharged home approximately 1.5–2 hours sooner than patients who received GA (Table 3).

Data obtained from the telephone interviews at the 24th, 48th, and 72nd postoperative hours are missing on one patient in the regional anesthesia group and three patients in the GA group because these four patients could not be reached by phone despite repeated efforts by the research staff. In addition, among patients who were interviewed, a few patients had difficulty quantifying pain scores and number of pain pills taken (Table 4).

The incidence of backache was more frequent in the GA group in the 2 weeks after surgery (8 vs 2, $P = 0.02$); in addition, more patients in the GA group had headache (7 vs 3), although this difference did not

Table 2. Surgical, Anesthetic, and Postoperative Intervals

	Paravertebral block ($n = 24$)	General anesthesia ($n = 24$)	P-value
OR [a]	97 ± 32	103 ± 47	NS
Induction [b]	13 ± 8	8 ± 5	0.03
Preparation [c]	11 ± 18	7 ± 5	NS
Surgery [d]	61 ± 27	68 ± 30	NS
Postoperative [e]	7 ± 3	6 ± 3	NS

Data are presented as mean number of minutes ± SD.
NS = not significant.
[a] Time from patient entry into operating room (OR) to patient exit from OR.
[b] Time from patient entry into OR to completion of anesthesia induction.
[c] Duration of surgical procedure (from incision to closure).
[d] Time from completion of anesthesia induction to positioning of patient for surgery.
[e] Time from patient exit from OR to anesthesia care assumed by nursing.

reach statistical significance ($P = 0.1$). Level of pain was dichotomized to compare no or minimal pain (0–3 on a 10-point scale) with moderate or severe pain (4–10 on a 10-point scale) (Table 4). The groups did not differ in these variables as reported in the 24-, 48-, or 72-hour interviews. No trends within the groups were revealed when level of pain (trichotomized as 0–2, 3–7, and 8–10) and number of pain pills (categorized as 0, 1–3, 4–7, and 8–10) were analyzed. However, the median time to first pain (VAS >3) was 2 h (range 0–8) in the GA group and 14 h (range 1–23) in the PVB group ($P < 0.05$).

Scores below 8 (on a 10-point scale) reflect difficulty as reported by the patient in the telephone interviews. Few patients in either group reported difficulties in sleeping, appetite, self-care, and ambulation within the first 72 hours after surgery.

Discussion

Rapid recovery, adequate analgesia, prevention of PONV, and timely discharge are essential to a successful ambulatory anesthesia practice (14–16). Our data suggest that, from both the hospital's and the patient's perspective, there are advantages to using PVB versus GA for outpatient inguinal hernia surgery. Regional anesthesia (PVB) was associated with shorter time to home readiness, more patients being able to bypass Phase 1 PACU, less postoperative pain, faster ambulation, and quicker discharge home.

Our findings of shorter time to home readiness could be due, in part, to the fact that patients who had received PVB were more alert upon arrival to the PACU and had significantly less pain before discharge home than did patients in the GA group. Indeed, postoperative pain is a common reason for unexpected hospital admission or delay in discharge (17–20). Overall, very few patients had significant pain upon arrival to the PACU in either group. However, in the Phase 2 in the PVB group, only one patient had moderate-to-severe pain (VAS ≥3) as opposed to six (25%) patients in the GA group despite infiltration of the wound with bupivacaine after surgery. This is because the duration of field block anesthesia with bupivacaine is significantly shorter (2–3 h) than PVB with long-acting local anesthetic (8–18 h). Therefore, almost half of the patients in the GA group required pain medication before discharge home, as opposed to only three in the PVB group. It is possible that a multimodal approach to postoperative pain management (including the addition of antiinflammatory drugs) and/or addition of ilioinguinal-iliohypogastric

Table 3. Short-Term Postoperative Course in the Postanesthesia Care Unit (PACU) and Phase 2

	Paravertebral block ($n = 24$)	General anesthesia ($n = 24$)	P-value
Moderate/severe pain (4+)			
PACU	1 (4)	3 (13)	NS
Phase 2	1 (4)	6 (25)	0.05
Bypass PACU	17 (71)	2 (8)	0.001
Nausea			
Any episode	4 (17)	10 (37)	0.05
Vomiting			
PACU	0	1 (4)	NS
Sore throat			
Any episode	2 (8)	12 (50)	0.001
Treatment for pain	3 (13)	12 (50)	
Ambulation (min)	102 ± 55	213 ± 108	0.001
Food intake (min)	64 ± 37	128 ± 50	0.001
Voiding (min)	128 ± 64	213 ± 82	0.001
Home readiness (min) [a]	156 ± 60	253 ± 139	0.004
Discharge (min) [a]	179 ± 63	296 ± 141	0.001

Data are presented as n (%) for discrete variables and mean ± SD for continuous variables.
NS = not significant.
[a] From end of surgery

Table 4. Long-Term Postoperative Course Through the 2-wk Follow-Up

	Paravertebral block (n = 23)	General anesthesia (n = 21)
Pain score 24 h		
Low (0–2)	7 (29)	6 (25)
Moderate (3–7)	11 (45)	15 (62)
High (8–10)	3 (13)	2 (8)
Pain medication 24 h[a]		
None	2 (9)	3 (15)
1–3 pills	7 (32)	7 (35)
4–7 pills	10 (46)	8 (40)
8–10 pills	3 (14)	2 (10)
Pain score 48 h[b]		
Low (0–2)	9 (43)	9 (43)
Moderate (3–7)	11 (48)	12 (57)
High (8–10)	0	0
Pain medication 48 h[c]		
None	4 (19)	6 (29)
1–3 pills	8 (38)	9 (43)
4–7 pills	7 (33)	5 (24)
8–10 pills	2 (10)	1 (5)
Pain score 72 h		
Low (0–2)	15 (65)	13 (62)
Moderate (3–7)	8 (35)	8 (38)
High (8–10)	0	0
Pain medication 72 h[a]		
None	8 (36)	13 (65)
1–3 pills	8 (36)	6 (30)
4–7 pills	5 (23)	0
8–10 pills	1 (5)	1 (5)
Sleep[d]		
24 h	8 (35)	9 (43)
72 h	3 (13)	2 (10)
Appetite[d]		
24 h	4 (17)	7 (33)
72 h	2 (9)	2 (10)
Self-care[d]		
24 h	7 (30)	8 (38)
72 h	5 (22)	2 (10)
Ambulation[d]		
24 h	9 (39)	12 (57)
72 h	8 (35)	7 (33)

Data are presented as n(%) for discrete variables and as mean ± SD for continuous variables. There were no significant differences between the groups.

[a] One patient in each group could not quantify response.

[b] Three patients in the regional anesthesia group could not quantify response.

[c] Two patients in the regional anesthesia group could not quantify response.

[d] Self-reported by the patient as having difficulty with sleep, appetite, self-care and ambulation.

blocks could have improved analgesia for patients in the GA group (1,21). However, using PVB, we were able to accomplish both anesthesia and effective postoperative analgesia and avoid the use of GA altogether. In addition, multimodal analgesia using newer nonopioid analgesics (specifically, cyclooxygenase-2 inhibitors) is not a universal practice.

Some perceived disadvantages of PVB versus GA include the lack of training, risk of pneumothorax (proportional to the number of levels blocked), the additional time required to perform the block, the possibility of block failure, and the potential that patients having blocks ultimately may have more pain when the blocks wear off. These disadvantages were not apparent in our study, although our sample size was underpowered to determine these specific outcomes. Although the induction time was statistically significantly shorter in the GA group, the actual difference of 5 min has little clinical relevance, and the total OR time was not affected. However, it is possible that OR times could have been even shorter for the PVB group if blocks had been placed preoperatively (22). Anesthesia-controlled time for emergence (time from end of the application of surgical dressing until OR exit) is typically shorter after regional anesthesia than after GA (22,23). Applying these findings would help offset any additional time needed to place the block in the OR before the procedure begins.

Studies have demonstrated that the field block and/or ilioinguinal/iliohypogastric blocks are significantly more cost-effective anesthesia techniques than GA or spinal anesthesia (1). Surprisingly, according to several large reports, GA remains the most commonly used anesthesia technique for inguinal herniorrhaphy, whereas local anesthesia is used in only 15%–18% of hernia operations (2,24). The reports on the favorable effects of field block and/or ilioinguinal/genitofemoral blocks on the outcome after herniorrhaphy are compelling, and future studies should be designed to compare the PVB versus field block in this setting. This is of particular interest, given the simplicity of the field block compared with the more specialized training required for successful and safe application of PVBs. On the other hand, the adequacy of PVB as a sole anesthetic technique for inguinal hernia repair surgery has been reported (5). PVB results in unilateral, segmental anesthesia and analgesia of long duration in the territory of the blocked roots (25). This is in sharp contrast to more commonly practiced spinal anesthesia, which results not only in much shorter duration of analgesia but also in bilateral blockade, which precludes ambulation until its anesthetic effects completely wear off.

PONV remains a common problem after anesthesia; these symptoms commonly result in discharge delays after ambulatory surgery (14,20,25–28). In the current study, patients receiving PVB had a significantly less postoperative nausea, although they did not receive prophylactic dolasetron, an antiemetic, as did patients receiving GA. The odds ratio of experiencing PONV after GA with volatile anesthetics (e.g., desflurane, compared with propofol sedation/anesthesia) has been reported to be 2.7–10.6 (29). It is probable that the use of volatile anesthetics as the primary maintenance technique, when superimposed on the significant postoperative pain and opioid requirements after

shoulder surgery (17), may have predisposed patients to the postoperative nausea. Using antiemetics with different sites of action may have reduced the risk of PONV in the GA group (29–31).

The limitation of this study is that our data may not be reproducible in institutions without comparable expertise in performing peripheral nerve blocks. Indeed, the training and practice of peripheral nerve blocks varies significantly from institution to institution, and in-depth training is a prerequisite for the success and safety of peripheral nerve blocks (32,33). Regardless, other institutions with a tradition of using regional anesthesia have reported success rates and time-efficiency with multiple-level PVBs similar to ours (7). In addition, our study was powered for the main outcome variable (the time to home readiness), and a significant difference was found between the two groups for this primary outcome variable. Any difference between other assessed variables may be suggestive of a true difference; however, this requires further study for verification.

In summary, under the conditions of our clinical practice, PVB with long-acting local anesthetic in outpatients having inguinal hernia surgery provided efficient and reliable surgical conditions. Compared with GA with field block, nerve block anesthesia with a long-acting local anesthetic also resulted in increased eligibility for PACU bypass, faster same-day recovery, fewer adverse events on the day of surgery and longer duration of analgesia upon discharge home.

References

1. Song D, Greilich N, White P, et al. Recovery profiles and costs of anesthesia for outpatient unilateral inguinal herniorrhaphy. Anesth Analg 2000;91:876–81.
2. Bey-Nielsen M, Kehlet H. Prospective nation-wide quality assessment of 26,304 herniorrhaphy in Denmark. Lancet 2001;358: 1124–8.
3. Kehlet H, White P. Optimizing anesthesia for inguinal herniorrhaphy: general, regional or local anesthesia? Anesth Analg 2001;93:1367–9.
4. Harrison C, Morris S, Harvey J. Effect of ilioinguinal and iliohypogastric nerve block and would infiltration 0.5% bupivacaine on postoperative pain after hernia repair. Br J Anaesth 1994;72:691–3.
5. Wassef M, Randazzo T, Ward W. The paravertebral nerve root block for inguinal herniorrhaphy—a comparison with the field block approach. Reg Anesth Pain Med 1998;23:451–6.
6. Weltz C, Klein S, Arbo J, Greengrass R. Paravertebral block anesthesia for inguinal hernia repair. World J Surg 2003;27: 425–9.
7. Klein S, Pietrobon R, Nielsen K, et al . Paravertebral somatic nerve block compared with peripheral nerve block for outpatient inguinal herniorrhaphy. Reg Anesth Pain Med 2002;27: 476–80.
8. Nyhus L, Klein M, Rogers F. Inguinal hernia. Curr Prob Surg 1991;28:401–50.
9. American Society of Anesthesiologists. Standards, guidelines and statements: standards for basic anesthetic monitoring, 2004. Available at: http://www.asahq.org/publicationsAndServices/standards/02.pdf. Accessed January 04, 2005.
10. Hadzic A, Vloka J. Interscalene brachial plexus block. In: Hadzic A, Vloka J, eds. Peripheral nerve blocks: principles and practice. New York: McGraw-Hill 2003:109–22.
11. Aldrete J. The post-anesthesia recovery score revisited. J Clin Anesth 1995;7:89–91.
12. Chung F. Recovery pattern and home-readiness after ambulatory surgery. Anesth Analg 1995;80:896–902.
13. Mulroy M, Salinas F, Larkin K, Polissar N. Ambulatory surgery patients may be discharged before voiding after short-acting spinal and epidural anesthesia. Anesthesiology 2002;97:315–9.
14. Junger A, Klasen J, Benson M, et al. Factors determining length of stay of surgical day-case patients. Eur J Anaesthesiol 2001;18: 314–21.
15. Pavlin D, Rapp S, Polissar N, et al. Factors affecting discharge time in adult outpatients. Anesth Analg 1998;87:816–26.
16. Chung F, Ritchie E, Su J. Postoperative pain in ambulatory surgery. Anesth Analg 1997;85:808–16.
17. Williams B, Kentor M, Vogt M, et al. The economics of nerve block pain management after anterior cruciate ligament reconstruction: Significant hospital cost savings via associated PACU bypass and same-day discharge. Anesthesiology 2004; 100:697–706.
18. White P, Song D. New criteria for fast-tracking after outpatient anesthesia: a comparison with the modified Aldrete's scoring system. Anesth Analg 1999;88:1069–72.
19. Williams B. For outpatients, does regional anesthesia truly shorten the hospital stay, and how should we define postanesthesia care unit bypass eligibility? Anesthesiology 2004;101:3–6.
20. Gold B, Kitz D, Lecky J, Neuhaus J. Unanticipated admission to the hospital following ambulatory surgery. JAMA 1989;262: 3008–10.
21. Ma H, Tang J, White P, et al. Perioperative rofecoxib improves early recovery after outpatient herniorrhaphy. Anesth Analg 2004;98:970–5.
22. Williams B, Kentor M, Williams J, et al. Process analysis in outpatient knee surgery: Effects of regional and general anesthesia on anesthesia-controlled time. Anesthesiology 2000;93: 529–38.
23. Williams B, DeRiso B, Figallo C, et al. Benchmarking the perioperative process: III. Effects of regional anesthesia clinical pathway techniques on process efficiency and recovery profiles in ambulatory orthopedic surgery. J Clin Anesth 1998;10:570–8.
24. Hair A, Duffy K, McLean J, et al. Groin hernia repair in Scotland. Br J Surg 2000;87:1722–26.
25. Karmakar M. Thoracic Paravertebral block. Anesthesiology 2001;95:771–80.
26. Coveney W, Weltz C, Greengrass R, et al. Use of paravertebral block anesthesia in the surgical management of breast cancer: experience in 156 cases. Ann Surg 1998;227:496–501.
27. Kapur P. The big 'little problem'. Anesth Analg 1991;73:243–5.
28. Fisher D. The 'big little problem' of postoperative nausea and vomiting: do we know the answer yet? Anesthesiology 1997;87: 1271–3.
29. Sinclair D, Chung F, Mezei G. Can postoperative nausea and vomiting be predicted? Anesthesiology 1999;91:109–18.
30. Apfel C, Korttila K, Abdalla M, et al. A factorial trial of six interventions for the prevention of postoperative nausea and vomiting. N Engl J Med 2004;350:2441–51.
31. Gupta A, Stierer T, Zuckerman R, et al. Comparison of recovery profile after ambulatory anesthesia with propofol, isoflurane, sevoflurane and desflurane: a systematic review. Anesth Analg 2004;98:632–41.
32. Hadzic A, Vloka J, Kuroda M, et al. The practice of peripheral nerve blocks in the United States: a national survey. Reg Anesth Pain Med 1998;23:241–6.
33. Kopacz D, Neal J. Regional anesthesia and pain medicine: residency training—the year 2000. Reg Anesth Pain Med 2002;27: 9–14.