Ambulatory Anesthesia

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REVIEW

Advances in the use of intravenous techniques in ambulatory anesthesia

This article was published in the following Dove Press journal:
Ambulatory Anesthesia
29 July 2015
Number of times this article has been viewed

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Summary statement: Advances in the use of intravenous techniques in ambulatory anesthesia has become important for the anesthesiologist as the key perioperative physician in outpatient surgery. Key techniques and choices of anesthetics are important in accomplishing fast track goals of ambulatory surgery.

Purpose of review: The anesthesiologist in the outpatient environment must focus on improving perioperative efficiency and reducing recovery times while accounting for patients' well-being and safety. This review article focuses on recent intravenous anesthetic techniques to accomplish these goals.

Recent findings: This review is an overview of techniques in intravenous anesthesia for ambulatory anesthesia. Intravenous techniques may be tailored to accomplish outpatient surgery goals for the type of surgical procedure and individual patient needs. Careful anesthetic planning and the application of the plans are critical to an anesthesiologist's success with fast-track ambulatory surgery.

Conclusion: Careful planning and application of intravenous techniques are critical to an anesthesiologist's success with fast-track ambulatory surgery.

Keywords: intravenous anesthesia, outpatient anesthesia, fast-track surgery

Introduction

The growth and increasing popularity of fast-track surgery is not surprising, considering the advances in minimally invasive surgical techniques[1] and economic demands of today's health care state. Fast-track surgery was first introduced in the early 1990s to improve surgical throughput and operating room efficiency.[2] The principal goals of fast-track surgery are to improve operating room efficiency, facilitate early discharge from the hospital, and early resumption of activities of daily living.

In ambulatory anesthesia, anesthesiologists have evolved from physicians primarily focused on providing optimal intraoperative management and minimizing postoperative pain to perioperative physicians responsible for managing patients with co-existing medical conditions before, during, and after surgery.[3,4] Perioperative physicians play a key role in outpatient surgery through their choice of preoperative medications, intraoperative intravenous anesthetics and techniques, and prophylactic medications to minimize side effects (eg, nausea and vomiting, pain, dizziness), as well as the administration of adjunctive intravenous medications to maintain the function of major organ systems during and after surgery.

In addition to providing the best possible intraoperative anesthetic management, fast-track criteria require rapid emergence as well as the avoidance of postoperative side effects. The anesthesiologist should be well equipped with a practical understanding

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of intravenous techniques to optimally care for patients in ambulatory operations, as covered in this article.

Preoperative preparation

A smooth ambulatory operation is facilitated by optimal preoperative assessment and optimization of the patient's health. Proper preparation of the patient for surgery with appropriate education and health optimization results in reducing ambulatory surgery risks, improving patient outcomes, and a surgical experience that is reflected in an improved patient satisfaction score.

Preoperative medication

When indicated, intravenous medication is given preoperatively primarily to reduce anxiety, provide sedation, reduce sympathetic surges, and decrease postoperative side effects without delaying emergence from anesthesia.[5] Benzodiazepines are the most commonly used anxiolytics (eg, midazolam 10–20 μg/kg intravenously [IV]) and small doses can facilitate the perioperative fast-tracking process by minimizing anxiety and anxiety-related complications, while improving patient satisfaction.[6] Both beta blockers and alpha-2-agonists are increasingly popular adjuvants to outpatient anesthetic techniques as they provide anesthetic and analgesic sparing effects in addition to their hemodynamic uses.[7–10] Premedication with the alpha-2-agonists, dexmedetomidine (2.5 μg/kg IV), or clonidine (5 μg/kg PO), has been associated with a reduction in postoperative nausea and vomiting (PONV), intraoperative blood loss, and the use of perioperative opioid analgesics.[10–12] The inhibitory effect of these alpha-2-agonist agents on the hypothalamo-pituitary stress and sympathoadrenergic response[13] facilitates glycemic control in diabetic patients[14] and reduces acute coronary events postoperatively.[15]

Beta blockers suppress perioperative increases in circulating catecholamines and prevent adverse cardiovascular events in elderly patients undergoing non-cardiac surgery.[7] Beta blockers are effective in decreasing coronary demand and increasing supply to reduce cardiac events in surgical patients with coronary artery disease, and should be continued in all patients on chronic beta blocker therapy.[16,17] Perioperative beta blockade can improve hemodynamic stability during emergence and in the early postoperative period with little risk, provided there are no contraindications, including bradycardia, heart block, heart failure, hypotension, chronic obstructive pulmonary disease, and asthma.[16] Beta blockers in the ambulatory setting provide anesthetic and opioid-sparing effects, lead to a faster emergence and reduce postoperative side effects.

Fast-tracking intravenous anesthetic techniques

The ideal fast-track intravenous technique should provide optimal surgical conditions and intraoperative amnesia and analgesia, but notably a short recovery period with no adverse anesthetic effects.

Monitored anesthesia care

Compared with general anesthesia, monitored anesthesia care (MAC) techniques are often accomplished utilizing local anesthesia infiltration or peripheral nerve blocks in combination with intravenous sedative medications and may facilitate fast-track recovery.[18] Many different local anesthetic techniques can be applied; however, the simplest local technique with operator familiarity should be utilized to minimize side effects and risk of complications (namely, local anesthetic systemic toxicity from overdose or intravascular injection).[19]

Utilization of a MAC technique for hernia repairs, colorectal, and hand surgery is associated with a decrease in postoperative pain, opioid-sparing benefits, reduced PONV, and other opioid-related side effects.[19,20] Under MAC, local anesthetic infiltrations and/or peripheral nerve blocks using bupivacaine or ropivacaine are performed with no other anesthetic, or under general anesthetic; sedation may be added with midazolam and a variable rate of propofol infusion.[21] Additionally, dexmedetomidine[22] and ketamine[23] may be utilized as alternatives to opioid analgesics, to reduce opioid side effects and ventilator depression.[24] The leading cause of serious patient injuries during general anesthesia sedation cases is ventilator depression, and is most likely caused by over sedation and lack of vigilance.[25]

Intravenous MAC techniques can facilitate a fast-track recovery following ambulatory surgery and the patient may routinely bypass the postanesthesia care unit (PACU) or be discharged home earlier because of the fast emergence and low incidence of postoperative side effects. Newer intravenous agents as well as utilization of local anesthetics provides for opioid-sparing techniques. Although risks are lessened, intraoperative vigilance should always be maintained to avoid respiratory complications in the outpatient setting.[26,27]

General anesthesia

In spite of the advantages of regional, local infiltration, and MAC anesthetic techniques, many operations require a general anesthetic, and many patients and surgeons may refuse anything other than a general anesthetic. Propofol is clearly the intravenous induction medication of choice for outpatient

anesthesia due to its low side effect profile and fast onset.[28] For maintenance, utilizing the most insoluble inhalational anesthetics available, desflurane (3%–6%) and sevoflurane (0.75%–1.8%), may be advantageous over propofol infusions because of rapid emergence.[29–32] However, a skillfully timed infusion of propofol may also provide rapid emergence. Remifentanil infusions (0.05–0.20 $\mu g \cdot kg^{-1} \cdot min^{-1}$) may also be considered, and have been demonstrated as superior to nitrous oxide when utilized as an adjuvant.[33,34]

Short-acting beta blockers (eg, esmolol, labetalol, metoprolol) may be utilized as alternatives to opioid analgesics for treating transient, acute sympathetic responses.[35–37] Utilizing a laryngeal mask airway instead of an endotracheal tube, when possible, is desirable in a fast-track anesthetic as endotracheal tubes were demonstrated to lead to a higher incidence of nausea/vomiting and sore throat.[38] If an endotracheal tube is required, neuromuscular drug selection should be tailored to the patient's co-existing disease with kidney and liver metabolism as important considerations.[39] Sugammadex, a novel cyclodextrin compound, is a promising new medication, which may be of great interest to fast-track anesthesia since it can rapidly reverse steroid-based, non-depolarizing neuromuscular blockade.[40]

Although inhalational agents for maintenance may facilitate a faster emergence (versus propofol), the incidence of PONV in the early postoperative period is increased.[41] Prophylactic antiemetic medications should be employed to mitigate this side effect. A combination of low-dose droperidol (0.625 mg IV) and dexamethasone 4–8 mg IV)[42,43] should be considered. A 5-HT_3 antagonist (ondansetron 4 mg IV) should also be considered for patients at high risk or in the event that one of the previously two agents is not available as part of a multimodal antiemetic regimen.[44] The neurokinin-1 antagonist class of drugs may play an important role in PONV management in the future. Efforts to reduce opioid use will minimize postoperative pain and side effects associated with opioids, inclusive of the following classes: non-steroidal anti-inflammatory drugs (NSAIDs), cycloxygenase-2 (COX-2) inhibitors, intravenous acetaminophen, glucocorticoids, alpha-2-agonists, local anesthetics, and ketamine.[45,46]

Short-acting intravenous medications and inhalational agents and prophylactic medications may facilitate fast emergence and minimize side effects, allowing fast tracking of outpatient surgery.[36,47–49] The use of cerebral monitoring devices may also be of benefit toward fast-track goals to help calibrate a more precise anesthetic dosage.[50–54] In spontaneously breathing and non-paralyzed patients, however, the use of cerebral monitoring devices has been questioned.[55]

Postoperative care

Poorly controlled nausea and vomiting and poorly controlled pain have been demonstrated to delay discharge following outpatient surgery.[56]

Optimizing pain management

Improving postoperative pain management accelerates rehabilitation of activities of daily living that can otherwise be delayed for weeks following an elective operation.[57–59] According to a review by Liu and Wu,[60] there is "insufficient evidence to conclude that analgesic techniques influence postoperative mortality or morbidity" due to the low incidences of anesthetic complications. On the contrary, excessive administration of opioids for perioperative analgesia may contribute to acute opioid tolerance and hyperalgesia,[61–63] and may also contribute to dose-related opioid side effects such as respiratory depression, sedation, urinary retention, nausea and vomiting, and ileus. These side effects and complications may delay discharge time, add to the overall cost of care, and decrease patient satisfaction.[62,64] Although opioid infusions are often utilized via intravenous and epidural, they do not always improve pain management due to the risk of ventilatory depression and rapid development of tolerance.[63] This very difficult task of balancing the utilization of opioid medications with non-opioid analgesics must be navigated by the anesthesiologist, as optimal pain management may one day be mandated by accreditation bodies as a basic human right.[65]

Multimodal analgesia is the utilization of multiple modalities of pain control to synergistically provide analgesia while minimizing drug-related side effects.[66] Utilizing multimodal techniques has been demonstrated to improve fast-track goals in early ambulatory surgery studies.[67,68] Fast-track plans utilize the multimodal strategy[1,69] because administration of a single non-opioid analgesic such as a NSAIDs may not be sufficient exclusively and utilization of only opioid-based analgesics may have severe side effects.[46] Partial opioid agonists such as tramadol have been associated with undesirable side effects and dissatisfaction compared to both non-opioid- and opioid-based analgesics.[70]

Increasingly, painful and complex operations (eg, laparoscopic hysterectomy, adrenalectomy, nephrectomy, prostatectomy, shoulder replacements, hip replacements knee reconstructions, laminectomies) are being performed with minimally invasive techniques in the outpatient setting.[2,34,71] Thus, the use of multimodal techniques involving both opioid and non-opioid analgesics has become increasingly important in facilitating an expedited recovery process and

improved patient satisfaction.[45] Pavlin et al[56] demonstrated that moderate-to-severe pain prolonged the postanesthesia care unit stay by 40–80 minutes. Adjunct analgesics such as NSAIDs and local anesthetics reduced pain scores, as well as help in an earlier discharge time. Further studies with regard to multimodal techniques are needed and should focus on clinically significant metrics relevant to resumption of daily activities.[44]

Among the multiple issues that must be accounted for in the recovery process, including PONV[72] and hydration status,[45,64,73,74] adequate pain control is of chief concern to the patient[75] as well as their health care providers.[76]

Opioid analgesic medications will continue to play a role in management of perioperative pain. However, the role of non-opioid-based analgesic medications in perioperative pain management will likely expand as the number of minimally invasive surgery operations continue to grow.[1,34] Non-opioid medications such as NSAIDs (PO and IV), intravenous acetaminophen, COX-2 inhibitors, local anesthetics, ketamine, alpha-2-agonists, pregabalin, gabapentin, dextromethorphan, and even magnesium, may be utilized as a part of a multimodal approach to perioperative pain management[45] rather than aggressive use of opioid analgesics.[66,77] Other intravenous medications, which do not confer analgesic benefits such as antiemetics (droperidol)[78] and glucocorticoids (dexamethasone,[79] betamethasone,[80] methylprednisolone)[81] are of great benefit in reducing side effects in the postoperative period. Novel therapies like capsaicin, derived from chili peppers, have been established to provide analgesic benefits secondary to the effect in altering the nociceptive input at peripheral nerve ending.[82] The practitioner should also consider other non-pharmacologic modalities for pain control such as acustimulation, which has been demonstrated to be as effective as an adjuvant.[83]

Bisgaard[84] cites that "opioids should only be used when these other non-opioid analgesic techniques fail" in their assessment of multimodal techniques for analgesia in laparoscopy. Preemptive analgesic techniques have been suggested to account for the establishment of central sensitization;[77] however, this remains theoretical as there is no established clinically significant advantage over providing a multimodal approach perioperatively.[85] Further development should be focused on safe and cost-efficient drug delivery systems in not only the postoperative but also postdischarge period.[1] The multimodal strategy for pain control should be well coordinated between anesthesiologists, surgeons, and nursing staff to improve the outcome of our patients.[2] Novel non-opioid analgesics as well as older non-opioid analgesics such as intravenous lidocaine and infusion drug delivery systems such as the ON–Q/i–flow pump will improve our ability to provide postoperative as well as postdischarge pain management.[77,86,87]

A multimodal approach to pain management could synergistically provide a comprehensive plan, and quite possibly without utilization of any opioids.[45,46] By the selection of key intravenous medications, the anesthesiologist can successfully accomplish the goals of fast-track surgery by minimizing postoperative pain, side effects from opioid medications, and fast recovery and emergence from anesthesia. Fast-track criterion is focused on speedy recovery as well as adequate pain control and minimal side effects such as PONV.[88]

Postoperative nausea and vomiting

In spite of the attention to PONV and a plethora of antiemetic medications, the incidence of PONV is relatively high, present in as high as 30% of all surgical operations.[89] The risk factors for PONV have been well established: female, non-smokers, history of PONV, history of motion sickness, intraoperative volatile anesthetics and high-dose opioids, and postoperative opioids.[90] Intravenous medications in antiemetic prophylaxis should also be approached utilizing a multimodal approach, with the options of utilizing droperidol, ondansetron, and dexamethasone.[91,92] Multiple drugs are recommended for patients who have at least two risk factors for PONV.[93] Some non-traditional therapies may also be useful, including transdermal nicotine and topical capsaicin, as additions to an antiemetic prophylaxis regimen.[94,95] The anesthetic technique, utilization of propofol, adequate hydration, and opioid-sparing techniques, are key strategies in minimizing PONV.[96] Interestingly, the use of beta blockers and alpha-2-agonists to control hemodynamic responses intraoperatively with non-opioid analgesics will also minimize emetic symptoms.[36,37,45] Ketorolac showed advantages over glucocorticoid steroids in preventing PONV,[97] likely due to its opioid-sparing effects. Further, non-pharmacologic techniques can be helpful in reducing emetic symptoms, such as acupuncture, transcutaneous electrical nerve stimulation, and acupressure.[98–100] A concerted effort must be made in selecting intravenous medications for prophylaxis, minimizing opioids, adequately hydrating the patient, and providing possible non-pharmacologic adjuvants in reducing the patient's risk of PONV.

Postoperative ileus and constipation

Postoperative ileus and constipation can be the source of abdominal pain and bloating, and may delay a patient's recovery and possibly delay discharge time.[101] Opioid-sparing

intravenous techniques will help reduce the incidence of postoperative ileus, and utilization of a peripheral acting mu-opioid receptor antagonist (alvimopan, methylnaltrexone) may be helpful. Strategies for preventing ileus also include early oral feeding, ambulation, and minimally invasive surgical techniques.[102]

The duration of ileus can be decreased by combining multimodal analgesic techniques with early oral feeding and early ambulation.[103] Avoidance of excess fluid is also key to early recovery of bowel function as has been suggested in enhanced recovery pathways in colorectal surgery[104] as well as a decrease in hospital length of stay.[105] Peripheral mu-opioid receptor antagonists (ie, alvimopan, methylnaltrexone) may also facilitate early resumption of bowel function and may also decrease the hospital length of stay.[106,107] The patient should be encouraged to continue to utilize a non-opioid analgesic pain management plan after discharge to reduce the incidence of postdischarge constipation and postdischarge nausea and vomiting (PDNV).[108]

Conclusion

Anesthesiologists need to be proactive in the planning and execution of fast-track ambulatory surgery programs, and must be prepared to utilize intravenous techniques tailored for this environment. The patient's co-existing diseases, and specific surgical considerations must be accounted for when selecting preoperative intravenous medications and optimal anesthetic and analgesic techniques, and coordinating a team of health care providers efficiently.[109–113] Pain must be addressed in a multimodal fashion and the patient's pain must be adequately controlled since it can lead to either a delay in discharge or an unanticipated hospital admission.[114] PONV remains a very challenging problem with high incidence in spite of many new antiemetic medications and a lot of attention paid to this problem.[115,116]

Inter-disciplinary collaboration in establishing an efficient outpatient surgery program and workflow is essential between physicians and nurses.[117,118] Anesthesiologists must be the leaders in this effort, and are the sole providers responsible for the intravenous medications and anesthetics that greatly influence the patient's outcomes.

Anesthesiologists are responsible for the success of the fast-track goals of outpatient surgery through the effective utilization of appropriate intravenous anesthetic techniques for a vast number of outpatient surgical operations. By applying the concepts of multimodal analgesia, as well as considering novel techniques to improve analgesia and minimize postoperative and postdischarge side effects, the patient will be able to resume activities of daily living with minimal recovery time.[1,79,107] This is the time for anesthesiologists to assume the leadership role as the perioperative physician in directing and executing an efficient ambulatory surgery program.

Disclosure

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this article.

References

1. White PF. Ambulatory anesthesia advances into the new millennium. *Anesth Analg*. 2000;90:1234–1235.
2. Kehlet H, Wilmore DW. Multimodal strategies to improve surgical outcome. *Am J Surg*. 2002;183:630–641.
3. Halaszynski TM, Juda R, Silverman DG. Optimizing postoperative outcomes with efficient preoperative assessment and management. *Crit Care Med*. 2004;32:S76–S86.
4. Hensel M, Schwenk W, Bloch A, et al. The role of anesthesiology in fast track concepts in colonic surgery. *Anaesthesist*. 2006;55:80–92.
5. White PF. Pharmacologic and clinical aspects of preoperative medication. *Anesth Analg*. 1986;65:963–974.
6. van Vlymen JM, Sa Rego MM, White PF. Benzodiazepine premedication: can it improve outcome in patients undergoing breast biopsy procedures? *Anesthesiology*. 1999;90:740–747.
7. Zaugg M, Tagliente T, Lucchinetti E, et al. Beneficial effects from beta-adrenergic blockade in elderly patients undergoing noncardiac surgery. *Anesthesiology*. 1999;91:1674–1686.
8. Johansen JW, Flaishon R, Sebel PS. Esmolol reduces anesthetic requirement for skin incision during propofol/nitrous oxide/morphine anesthesia. *Anesthesiology*. 1997;86:364–371.
9. Chia YY, Chan MH, Ko NH, Liu K. Role of beta-blockade in anaesthesia and postoperative pain management after hysterectomy. *Br J Anaesth*. 2004;93:799–805.
10. Segal IS, Jarvis DJ, Duncan SR, White PF, Maze M. Clinical efficacy of oral-transdermal clonidine combinations during the perioperative period. *Anesthesiology*. 1991;74:220–225.
11. Aho MS, Erkola OA, Scheinin H. Effect of intravenously administered dexmedetomidine on pain after laparoscopic tubal ligation. *Anesth Analg*. 1991;73:112–118.
12. Okuyama K, Inomata S, Toyooka H. The effects of prostaglandin E_1 or oral clonidine premedication on blood loss during paranasal sinus surgery. *Can J Anaesth*. 2005;52:546–547.
13. Mertes N, Goetters C, Kuhlmann M, Zander JF. Postoperative alpha-2 adrenergic stimulation attenuates protein catabolism. *Anesth Analg*. 1996;82:258–263.
14. Belhoula M, Ciébiéra JP, De La Chapelle A, Boisseau N, Coeurveille D, Raucoules-Aimé M. Clonidine premedication improves metabolic control in type 2 diabetic patients during ophthalmic surgery. *Br J Anaesth*. 2003;90:434–439.
15. Wallace AW, Galindez D, Salahieh A, et al. Effect of clonidine on cardiovascular morbidity after noncardiac surgery. *Anesthesiology*. 2004;101:284–293.

16. Lindenauer PK, Pekow P, Wang K, Mamidi DK, Gutierrez B, Benjamin EM. Perioperative beta-blocker therapy and mortality after major noncardiac surgery. *N Engl J Med*. 2005;353:349–361.
17. Devereaux P, Beattie W, Choi P, et al. How strong is the evidence for the use of perioperative beta-blockers in patients undergoing noncardiac surgery? A systematic review and metaanalysis. *Br Med J*. 2005;331:313–321.
18. Sa Régo M, Watcha MF, White PF. The changing role of monitored anesthesia care in the ambulatory setting. *Anesth Analg*. 1997;85: 1020–1036.
19. White PF. Choice of peripheral nerve block for inguinal herniorrhaphy: is better the enemy of good? *Anesth Analg*. 2006;102:1073–1075.
20. Li S, Coloma M, White PF, et al. Comparison of the costs and recovery profiles of three anesthetic techniques for ambulatory anorectal surgery. *Anesthesiology*. 2000;93:1225–1230.
21. Taylor E, Ghouri AF, White PF. Midazolam in combination with propofol for sedation during local anesthesia. *J Clin Anesth*. 1992;4: 213–216.
22. Arain SR, Ebert TJ. The efficacy, side effects, and recovery characteristics of dexmedetomidine versus propofol when used for intraoperative sedation. *Anesth Analg*. 2002;95:461–466.
23. Badrinath S, Avramov MN, Shadrick M, Witt TR, Ivankovich AD. The use of a ketamine-propofol combination during monitored anesthesia care. *Anesth Analg*. 2000;90:858–862.
24. Sa Rego MM, Inagaki Y, White PF. Remifentanil administration during monitored anesthesia care: are intermittent boluses an effective alternative to a continuous infusion? *Anesth Analg*. 1999;88:518–522.
25. Bhananker SM, Posner KL, Cheney FW, Caplan RA, Lee LA, Domino KB. Injury and liability associated with monitored anesthesia care: a closed claims analysis. *Anesthesiology*. 2006;104:228–234.
26. White PF, Rohrich RJ. Safety of outpatient surgery: is mandatory accreditation of outpatient surgery centers enough? *Plast Reconstr Surg*. 2001;107:189–192.
27. Cinnella G, Meola S, Portincasa A, et al. Sedation analgesia during office-based plastic surgery procedures: comparison of two opioid regimens. *Plast Reconstr Surg*. 2007;119:2263–2270.
28. Pavlin DJ, Rapp SE, Polissar NL, Malmgren JA, Koerschgen M, Keyes H. Factors affecting discharge time in adult outpatients. *Anesth Analg*. 1998;87:816–826.
29. Tang J, Chen L, White PF, et al. Recovery profile, costs, and patient satisfaction with propofol and sevoflurane for fast-track office-based anesthesia. *Anesthesiology*. 1999;91:253–261.
30. Song D, Joshi GP, White PF. Fast-track eligibility after ambulatory anesthesia: a comparison of desflurane, sevoflurane, and propofol. *Anesth Analg*. 1998;86:267–273.
31. Fredman B, Sheffer O, Zohar E, et al. Fast-track eligibility of geriatric patients undergoing short urologic surgery procedures. *Anesth Analg*. 2002;94:560–564.
32. Tang J, White PF, Wender RH, et al. Fast-track office-based anesthesia: a comparison of propofol versus desflurane with antiemetic prophylaxis in spontaneously breathing patients. *Anesth Analg*. 2001;92: 95–99.
33. Song D, White PF. Remifentanil as an adjuvant during desflurane anesthesia facilitates early recovery after ambulatory surgery. *J Clin Anesth*. 1999;11:364–367.
34. Song D, Whitten CW, White PF. Remifentanil infusion facilitates early recovery for obese outpatients undergoing laparoscopic cholecystectomy. *Anesth Analg*. 2000;90:1111–1113.
35. Smith I, Van Hemelrijck J, White PF. Efficacy of esmolol versus alfentanil as a supplement to propofol-nitrous oxide anesthesia. *Anesth Analg*. 1991;73:540–546.
36. Coloma M, Chiu JW, White PF, Armbruster SC. The use of esmolol as an alternative to remifentanil during desflurane anesthesia for fast-track outpatient gynecologic laparoscopic surgery. *Anesth Analg*. 2001;92: 352–357.
37. White PF, Wang B, Tang J, Wender RH, Naruse R, Sloninsky A. The effect of intraoperative use of esmolol and nicardipine on recovery after ambulatory surgery. *Anesth Analg*. 2003;97:1633–1638.
38. Joshi GP, Inagaki Y, White PF, et al. Use of the laryngeal mask airway as an alternative to the tracheal tube during anesthesia. *Anesth Analg*. 1997;85:573–577.
39. Murphy GS, Szokol JW, Marymont JH, Avram MJ, Vender JS, Rosengart TK. Impact of shorter-acting neuromuscular blocking agents on fast-track recovery of the cardiac surgery patient. *Anesthesiology*. 2002;96:600–606.
40. Sacan O, White PF, Tufanogullari B, Klein K. Sugammadex reversal of rocuronium-induced neuromuscular blockade: a comparison with neostigmine-glycopyrrolate and edrophonium-atrophine. *Anesth Analg*. 2007;104:569–574.
41. Apfel CC, Kranke P, Katz MH, et al. Volatile anaesthetics may be the main cause of early but not delayed postoperative vomiting: a randomized controlled trial of factorial design. *Br J Anaesth*. 2002;88: 659–668.
42. Tang J, Chen X, White PF, et al. Antiemetic prophylaxis for office-based surgery: are the 5-HT3 receptor antagonists beneficial? *Anesthesiology*. 2003;98:293–298.
43. Apfel CC, Korttila K, Abdalla M, et al; IMPACT Investigators. A factorial trial of six interventions for the prevention of postoperative nausea and vomiting. *N Engl J Med*. 2004;350:2441–2451.
44. White PF. Prevention of postoperative nausea and vomiting – a multimodal solution to a persistent problem. *N Engl J Med*. 2004;350: 2441–2451.
45. White PF. The changing role of non-opioid analgesic techniques in the management of postoperative pain. *Anesth Analg*. 2005;01:S5–S22.
46. Kehlet H. Postoperative opioid sparing to hasten recovery. What are the issues? *Anesthesiology*. 2005;102:1983–1985.
47. Coloma M, Zhou T, White PF, Markowitz SD, Forestner JE. Fast-tracking after outpatient laparoscopy: reasons for failure after propofol, sevoflurane and desflurane anesthesia. *Anesth Analg*. 2001;93: 112–115.
48. Apfelbaum JL, Walawander CA, Grasela TH, et al. Eliminating intensive postoperative care in same-day surgery patients using short-acting anesthetics. *Anesthesiology*. 2002;97:66–74.
49. Patel RI, Verghese ST, Hannallah RS, Aregawi A, Patel KM. Fast-tracking children after ambulatory surgery. *Anesth Analg*. 2001;92: 918–922.
50. Gan TJ, Glass PS, Windsor A, et al. Bispectral index monitoring allows faster emergence and improved recovery from propofol, alfentanil, and nitrous oxide anesthesia. BIS Utility Group. *Anesthesiology*. 1997;87: 808–817.
51. Song D, Joshi GP, White PF. Titration of volatile anesthetics using bispectral index facilitates recovery after ambulatory anesthesia. *Anesthesiology*. 1997;87:842–848.
52. Song D, van Vlymen J, White PF. Is the bispectral index useful in predicting fast-track eligibility after ambulatory anesthesia with propofol and desflurane? *Anesth Analg*. 1998;87:1245–1248.
53. White PF, Ma H, Tang J, Wender RH, Sloninsky A, Kariger R. Does the use of electroencephalographic bispectral index or auditory evoked potential index monitoring facilitate recovery after desflurane anesthesia in the ambulatory setting? *Anesthesiology*. 2004;100:811–817.
54. Avidan MS, Zhang L, Burnside BA, et al. Anesthesia awareness and the bispectral index. *N Engl J Med*. 2008;358:1097–1108.
55. Zohar E, Luban I, White PF, Ramati E, Shabat S, Fredman B. Bispectral index monitoring does not improve early recovery of geriatric outpatients undergoing brief surgical procedures. *Can J Anaesth*. 2006;53: 20–25.
56. Pavlin DJ, Chen C, Penaloza DA, Polissar NL, Buckley FP. Pain as a factor complicating recovery and discharge after ambulatory surgery. *Anesth Analg*. 2003;97:1627–1632.
57. Strassels SA, McNicol E, Wagner AK, et al. Persistent postoperative pain, health-related quality of life, and functioning 1 month after hospital discharge. *Acute Pain*. 2004;6:95–104.
58. Mattila K, Toivonen J, Janhunen L, Rosenberg PH, Hynynen M. Postdischarge symptoms after ambulatory surgery: first-week incidence, intensity, and risk factors. *Anesth Analg*. 2005;101:1643–1650.

59. Wu CL, Rowlingson AJ, Partin AW, et al. Correlation of postoperative pain to quality of recovery in the immediate postoperative period. *Reg Anesth Pain Med*. 2005;30:516–522.
60. Liu SS, Wu CL. Effect of postoperative analgesia on postoperative complications. A systematic update of the evidence. *Anesth Analg*. 2007;104(3):689–702.
61. Guignard B, Bossard AE, Coste C, et al. Acute opioid tolerance: intraoperative remifentanil increases postoperative pain and morphine requirement. *Anesthesiology*. 2000;93:409–417.
62. Oderda GM, Evans RS, Lloyd J, et al. Cost of opioid-related adverse drug events in surgical patients. *J Pain Symptom Manage*. 2003;25: 276–283.
63. Parker RK, Holtmann B, White PF. Patient-controlled analgesia. Does a concurrent opioid infusion improve pain management after surgery? *JAMA*. 1991;266:1947–1952.
64. Liu SS, Richman JM, Thirlby R, Wu CL. Efficacy of continuous wound catheters delivering local anesthetic for postoperative analgesia: a quantitative and qualitative systematic review of randomized controlled trials. *J Am Coll Surg*. 2006;203:914–932.
65. White PF, Kehlet H. Improving pain management: are we jumping from the frying pan into the fire? *Anesth Analg*. 2007;105:10–12.
66. Kehlet H, Dahl JB. The value of "multimodal" or "balanced analgesia" in postoperative pain treatment. *Anesth Analg*. 1993;77:1048–1056.
67. Michaloliakou C, Chung F, Sharma S. Preoperative multimodal analgesia facilitates recovery after ambulatory laparoscopic cholecystectomy. *Anesth Analg*. 1996;83:44–51.
68. Eriksson H, Tenhunen A, Korttila K. Balanced analgesia improves recovery and outcome after outpatient tubal ligation. *Acta Anaesthesiol Scand*. 1996;40:151–155.
69. Kehlet H, Dahl JB. Anesthesia, surgery and challenges in postoperative recovery. *Lancet*. 2003;362:1921–1928.
70. Rawal N, Allvin R, Amilon A, Ohlsson T, Hallén J. Postoperative analgesia at home after ambulatory hand surgery: a controlled comparison of tramadol, metamizol, and paracetamol. *Anesth Analg*. 2001;92: 347–351.
71. White PF, Kehlet H, Neal JM, et al; Fast-Track Surgery Study Group. Role of the anesthesiologist in fast-track surgery: from multimodal analgesia to perioperative medical care. *Anesth Analg*. 2007;104: 1380–1396.
72. White PF, Kehlet H. Postoperative pain management and patient outcome: time to return to work! *Anesth Analg*. 2007;104: 487–490.
73. Kehlet H, Jensen TS, Woolf CJ. Persistent postsurgical pain: risk factors and prevention. *Lancet*. 2006;367:1618–1625.
74. White PF, Rawal S, Latham P, et al. Use of a continuous local anesthetic infusion for pain management after median sternotomy. *Anesthesiology*. 2003;99:918–923.
75. Macario A, Weinger M, Carney S, Kim A. Which clinical anesthesia outcomes are important to avoid? The perspective of patients. *Anesth Analg*. 1999;89:652–658.
76. Brennan F, Carr DB, Cousins M. Pain management: a fundamental human right. *Anesth Analg*. 2007;105:205–221.
77. Woolf CJ, Chong M-S. Preemptive analgesia – treating post-operative pain by preventing the establishment of central sensitization. *Anesth Analg*. 1993;77:362–379.
78. Yamamoto S, Yamaguchi H, Sakaguchi M, Yamashita S, Satsumae T. Preoperative droperidol improved postoperative pain relief in patients undergoing rotator-cuff repair during general anesthesia using intravenous morphine. *J Clin Anesth*. 2003;15:525–529.
79. Bisgaard T, Klarskov B, Kehlet H, Rosenberg J. Preoperative dexamethasone improves surgical outcome after laparoscopic cholecystectomy. *Ann Surg*. 2003;238:651–660.
80. Aasboe V, Raeder JC, Groegaard B. Betamethasone reduces postoperative pain and nausea after ambulatory surgery. *Anesth Analg*. 1998;87: 319–323.
81. Romundstad L, Breivik H, Niemi G, Helle A, Stubhaug A. Methylprednisolone intravenously 1 day after surgery has sustained analgesic and opioid-sparing effects. *Acta Anaesthesiol Scand*. 2004;48: 1223–1231.
82. Kim KS, Nam YM. The analgesic effects of capsicum plaster at the Zusanli point after abdominal hysterectomy. *Anesth Analg*. 2006;103: 709–713.
83. White PF. Use of alternative medical therapies in the perioperative period: is it time to get 'on board'. *Anesth Analg*. 2007;104:251–254.
84. Bisgaard T. Analgesic treatment after laparoscopic cholecystectomy: a critical assessment of the evidence. *Anesthesiology*. 2006;104: 835–846.
85. Moiniche S, Kehlet H, Dahl JB. A qualitative and quantitative systematic review of preemptive analgesia for postoperative pain relief. *Anesthesiology*. 2002;96:725–741.
86. Kaba A, Laurent SR, Detroz BJ, et al. Intravenous lidocaine infusion facilitates acute rehabilitation after laparoscopic colectomy. *Anesthesiology*. 2007;106:11–18.
87. Cottam DR, Fisher B, Atkinson J, et al. A randomized trial of bupivicaine pain pumps to eliminate the need for patient controlled analgesia pumps in primary laparoscopic Roux-en-Y gastric bypass. *Obes Surg*. 2007;17:595–600.
88. White PF, Song D. New criteria for fast-tracking after outpatient anesthesia: a comparison with the modified Aldrete's scoring system. *Anesth Analg*. 1999;88:1069–1072.
89. Watcha M, White PF. Postoperative nausea and vomiting. Its etiology, treatment, and prevention. *Anesthesiology*. 1992;77:162–184.
90. Apfel CC, Roewer N. Risk assessment of postoperative nausea and vomiting. *Int Anesthesiol Clin*. 2003;41:13–32.
91. Feo CV, Sortini D, Ragazzi R, De Palma M, Liboni A. Randomized clinical trial of the effect of preoperative dexamethasone on nausea and vomiting after laparoscopic cholecystectomy. *Br J Surg*. 2006;93: 295–299.
92. Bianchin A, De Luca A, Caminiti A. Postoperative vomiting reduction after laparoscopic cholecystectomy with single dose of dexamethasone. *Minerva Anestesiol*. 2007;73:343–346.
93. White PF, Watcha M. Postoperative nausea and vomiting: prophylaxis versus treatment. *Anesth Analg*. 1999;89:1337–1339.
94. Kim KS, Koo MS, Jeon JW. Capsicum plaster at the Korean hand acupuncture point reduces postoperative nausea and vomiting after abdominal hysterectomy. *Anesth Analg*. 2002;95:1103–1107.
95. Ionescu D, Badescu C, Acalovschi I. Nicotine patch for the prevention of postoperative nausea and vomiting: a prospective randomised trial. *Clin Drug Investig*. 2007;27:559–564.
96. Scuderi PE, James RL, Harris L, Mims GR. Multimodal antiemetic management prevents early postoperative vomiting after outpatient laparoscopy. *Anesth Analg*. 2000;91:1408–1414.
97. Thagaard KS, Jensen HH, Raeder J. Analgesic and antiemetic effect of ketorolac vs betamethasone or dexamethasone after ambulatory surgery. *Acta Anaesthesiol Scand*. 2007;51:271–277.
98. Lee A, Done M. The use of nonpharmacologic techniques to prevent postoperative nausea and vomiting: a meta-analysis. *Anesth Analg*. 1999;88:1362–1369.
99. White PF, Issioui T, Hu J, et al. Comparative efficacy of acustimulation (ReliefBand) versus ondansetron (Zofran) in combination with droperidol for preventing nausea and vomiting. *Anesthesiology*. 2002;97:1075–1081.
100. Gan TJ, Jiao KR, Zenn M, Georgiade G. A randomized controlled comparision of electro-acupoint stimulation or ondansetron versus placebo for the prevention of postoperative nausea and vomiting. *Anesth Analg*. 2004;99:1070–1075.
101. Holte K, Kehlet H. Postoperative ileus: a preventable event. *Br J Surg*. 2000;87:1480–1493.
102. Baig MK, Wexner SD. Postoperative ileus: a review. *Dis Colon Rectum*. 2004;47:516–526.
103. Basse L, Torbol JE, Lossel K, Kehlet H. Colonic surgery with accelerated rehabilitation or conventional care. *Dis Colon Rectum*. 2004;47:271–278.
104. Joshi GP. Intraoperative fluid restriction improves outcome after major elective gastrointestinal surgery. *Anesth Analg*. 2005;101: 601–605.

105. Lobo DN, Bostock KA, Neal KR, Perkins AC, Rowlands BJ, Allison SP. Effect of salt and water balance on recovery of gastrointestinal function after elective colonic resection: a randomized controlled trial. *Lancet*. 2002;359:1812–1818.
106. Delaney CP, Weese JL, Hyman NH, et al; Alvimopan Postoperative Ileus Study Group. Phase III trial of alvimopan, a novel, peripherally acting, mu opioid antagonist, for postoperative ileus after major abdominal surgery. *Dis Colon Rectum*. 2005;48:1114–1125.
107. Viscusi ER, Goldstein S, Witkowski T, et al. Alvimopan, a peripherally acting mu-opiod receptor antagonist, compared with placebo in postoperative ileus after major abdominal surgery. Results of a randomized, double-blind, controlled study. *Surg Endosc*. 2006;20:64–70.
108. Raeder JC, Steine S, Vatsgar TT. Oral ibuprofen versus paracetamol plus codeine for analgesia after ambulatory surgery. *Anesth Analg*. 2001;92:1470–1472.
109. Watkins AC, White PF. Fast-tracking after ambulatory surgery. *J Perianesth Nurs*. 2001;16:379–387.
110. White PF, Rawal S, Nguyen J, Watkins A. PACU fast-tracking: an alternative to "bypassing" the PACU for facilitating the recovery process after ambulatory surgery. *J Perianesth Nurs*. 2003;18:247–253.
111. Pasero C, Belden J. Evidence-based perianesthesia care; accelerated postoperative recovery programs. *J Perianesth Nurs*. 2006;21:168–176.
112. Papadakos PJ. Physician and nurse consideration for recovery fast-track patients in the ICU. *J Cardiothorac Vasc Anesth*. 1995;9:21–23.
113. Davenport DL, Henderson WG, Kuhri SF, Mentzer RM. Preoperative risk factors and surgical complexity are more predictive of costs than postoperative complications: a case Study Using the National Surgical Quality Improvement Program (NSQIP) Database. *Ann Surg*. 2005;242:463–471.
114. Awad IT, Chung F. Factors affecting recovery and discharge following ambulatory surgery. *Can J Anaesth*. 2006;53:858–872.
115. Gramke HF, de Rijke JM, van Kleef M, et al. The prevalence of postoperative pain in a cross-sectional group of patients after day-case surgery in a university hospital. *Clin J Pain*. 2007;23:543–548.
116. White PF, O'Hara JF, Roberson CR, Wender RH, Candiotti KA; POST-OP Study Group. Impact of current antiemetic practices on patient outcomes of postoperative emetic symptoms: prospective study in high-risk patients. *Anesth Analg*. 2008;107(2):452–458.
117. Kehlet H. Surgical stress and outcome – from here to where? *Reg Anesth Pain Med*. 2006;31:47–52.
118. Dahl JB, Kehlet H. Perioperative medicine – a new sub-specialty or a multidisciplinary strategy to improve perioperative management and outcome? *Acta Anaesthesiol Scand*. 2002;46:121–122.