General Anesthesia

Factors affecting recovery and discharge following ambulatory surgery

[Les facteurs influençant la récupération et la sortie après une opération en chirurgie ambulatoire]

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Purpose: Recovery and discharge following ambulatory surgery are important components of the ambulatory surgery experience. This review provides contemporary perspectives on the issues of discharge criteria, fast-tracking, patient escort requirements, and driving after ambulatory anesthesia.

Source: A search was performed in the Cochrane Central Register for Controlled Trials, MEDLINE®, EMBASE®, CINAHL, and PsycINFO, to review factors delaying discharge following ambulatory surgery. The following subject headings were used: "*ambulatory surgery, discharge, recovery, car driving, escort, transport, fast tracking, patient discharge, recovery, transportation of patients, hospital discharge, recovery room, patient transport, hospital discharge, recovery room, anesthetic recovery, patient transport, ambulatory surgical procedures, patient discharge, recovery of function, automobile driving, patient escort service, recovery room*". Using the same search engines, the following keywords were used: "*fast tracking, recovery, and discharge*".

Principal findings: The current literature supports that discharge scoring systems may be useful to guide discharge following ambulatory surgery. While fast-tracking has become common in some centres, further studies are required to justify more routine implementation of this practice in the management of patients undergoing ambulatory surgery. Patients at low risk for urinary retention can be discharged home without voiding. Patients should not drive until at least 24 hr postoperatively.

Conclusions: Ensuring rapid postoperative recovery and safe discharge following ambulatory surgery are important components of the ambulatory surgical program. A clearly defined process should be established for each ambulatory surgical unit to ensure the safe and timely discharge of patients after anesthesia, in accordance with current best evidence.

***Objectif** : La récupération et la sortie, suivant une opération en chirurgie ambulatoire, sont des composantes importantes de la chirurgie d'un jour. La présente revue fournit une nouvelle optique sur les critères de sortie, le mode opératoire rapide, les besoins d'accompagnement et la conduite automobile après une anesthésie ambulatoire.*

***Source** : Une recherche a été réalisée dans le Cochrane Central Register for Controlled Trials, MEDLINE®, EMBASE®, CINAHL et PsycINFO, pour revoir les facteurs qui retardent le départ du service de chirurgie ambulatoire. Les mots-sujets suivants ont été utilisés: «ambulatory surgery, discharge, recovery, car driving, escort, transport, fast tracking, patient discharge, recovery, transportation of patients, hospital discharge, recovery room, patient transport, hospital discharge, recovery room, anesthetic recovery, patient transport, ambulatory surgical procedures, patient discharge, recovery of function, automobile driving, patient escort service, recovery room». Avec les mêmes moteurs de recherches nous avons utilisé : «fast tracking, recovery, and discharge».*

***Constatations principales** : Les publications actuelles appuient le système de notation qui peut aider à décider du moment du départ d'un service de chirurgie ambulatoire. Le mode opératoire rapide est devenu courant dans certains centres, mais de nouvelles études doivent justifier l'application plus fréquente de cette pratique en chirurgie ambulatoire. Les patients à faible risque de rétention urinaire peuvent quitter le service avant une miction. Ils doivent attendre au moins 24 h après l'opération pour conduire une auto.*

***Conclusion** : Garantir une récupération postopératoire rapide et un départ hâtif et sûr après une opération ambulatoire sont des composantes importantes du programme de chirurgie ambulatoire. Un processus clairement défini doit être établi à cet effet.*

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AMBULATORY surgery has evolved considerably over the past two decades, with more complex procedures being performed, and more ASA class III patients being eligible. This progress, while driven partly by health care economics, has evolved through expanded scientific research in all areas of ambulatory anesthesia. Evolution of anesthetic pharmacology, including new drugs and better understanding of their complex interactions, as well as more targeted regional anesthetic techniques, have had an enormous impact. Another key area of development is facilitation of patient recovery and discharge from the postanesthesia care unit (PACU) and step-down unit, or ambulatory surgical unit (ASU). In this review, we address discharge criteria and the fast-track concept, and provide an overview and update of specific issues relating to delayed discharge, patient escort requirements, resumption of driving, and discharge following regional anesthesia.

Definition of recovery

Recovery is an ongoing process that begins from the end of intraoperative care until the patient returns to his/her preoperative physiological state.[1] This process is divided into three phases: *early recovery*, from the discontinuation of anesthetic agents until recovery of protective reflexes and motor function; *intermediate recovery*, when the patient achieves criteria for discharge; and *late recovery*, when the patient returns to his/her preoperative physiological state. The success of ambulatory surgery depends, in part, on the appropriate and timely discharge of patients who have been anesthetized. Premature discharge of patients, who later experience postoperative complications requiring unanticipated admission to the hospital or emergency care, should be an infrequent occurrence.

Fast-tracking

Fast-tracking is a clinical pathway that involves transferring the patient directly from the operating room to the ASU, bypassing the PACU.[2,3] Fast-tracking can be facilitated with the use of short- and ultra-short acting anesthetic drugs, together with their optimal titration using new monitoring technologies such as bispectral index monitoring, and auditory evoked potential monitoring.[4,5] Furthermore, proper patient selection, and prophylactic strategies to eliminate early postoperative complications (pain, nausea and vomiting), enables many patients to achieve an Aldrete score of either 9 or 10 in the operating room, allowing for PACU bypass. The limitations of the modified Aldrete scoring system include the fact that it does not address pain, nausea and vomiting, which are common side effects in the PACU.[6] White *et al.* devised a modified Aldrete scoring system, which incorporates assessment of pain and emetic symptoms (Table I).[7] Fourteen is the maximum possible score with the new fast-tracking scoring system; a score of 12 (with no score less than 1 in any category) is considered sufficient for bypassing PACU.

The fast-track concept has been devised to reduce nursing workload and hospital costs. Nursing and personnel costs account for the majority of PACU expenditures, as opposed to only 2% related to medication and supplies.[8] Despite theoretical benefits, cost savings attributable to fast-tracking are difficult to quantitate, and may be influenced by a number of factors, including the volume of procedures, case mix, and flexibility to reallocate staff during the day according to workload intensity. Numerous factors may offset savings.[9]

TABLE I Scoring system to determine whether outpatients can be transferred directly from the operating room to the step-down (phase II) unit

Discharge criteria	*Score*
Level of consciousness	
Awake and oriented	2
Arousable with minimal stimulation	1
Responsive only to tactile stimulation	0
Physical activity	
Able to move all extremities on command	2
Some weakness in movement of extremities	1
Unable to voluntarily move extremities	0
Hemodynamic stability	
Blood pressure < 15% of baseline MAP value	2
Blood pressure 15–30% of baseline MAP value	1
B1ood pressure > 30% below baseline MAP value	0
Respiratory stability	
Able to breathe deeply	2
Tachypnea with good cough	1
Dyspneic with weak cough	0
Oxygen saturation status	
Maintains value > 90% on room air	2
Requires supplemental oxygen (nasal prongs)	1
Saturation < 90% with supplemental oxygen	0
Postoperative pain assessment	
None, or mild discomfort	2
Moderate to severe pain controlled with *iv* analgesics	1
Persistent severe pain	0
Postoperative emetic symptoms	
None, or mild nausea with no active vomiting	2
Transient vomiting or retching	1
Persistent moderate to severe nausea and vomiting	0
Total possible score	14

A minimal score of 12 (with no score < 1 in any individual category) would be required for a patient to be fast-tracked (i.e., bypass the postanesthesia care unit) after general anesthesia. MAP = mean arterial pressure. Reproduced with permission from: *White P, et al.* Anesth Analg 1999; 88: 1069–72.

Adopting a fast-tracking pathway must not compromise patient safety, and it is important that randomized controlled trials and clinical auditing procedures address where the benefits outweigh the risks. In a large multicentre study involving 2,354 patients, the PACU bypass rate of patients having general anesthesia (GA) increased from a baseline of 15.9% to 58% after a one-month educational program.[10] Mean recovery time of patients who were fast-tracked was significantly shorter compared to that of patients who were not (84.6 ± 61.5 *vs* 175.1 ± 98.8 min, $P < 0.001$) with no change in patient outcome. In patients undergoing lower limb orthopedic surgery, 87% (756/869) of patients were able to bypass the PACU, with no significant differences between mild and invasive surgical procedure categories.[11] The fast-tracked patients were also discharged home earlier, and had a lower incidence of unplanned hospital admission. However, they needed more nursing interventions in the ASU compared to patients who did not bypass the PACU.[11] In another study of patients (aged 18–65 yr) undergoing knee arthroscopy and other simple ambulatory orthopedic procedures, 83% of 99 patients were successfully fast-tracked. The patients who achieved fast-track criteria did not increase operating room time, and were discharged home earlier.[12] However, patients in the fast-track group were not compared to conventional PACU admission, and the study was conducted in two institutions with different nursing and recovery settings.

A recent prospective study randomized 207 patients undergoing standardized GA into two groups: fast-track and PACU.[13] In the fast-track group, 81% of patients bypassed the PACU successfully. Ninety-seven percent of patients undergoing arthroscopy met fast-track criteria and were able to bypass the PACU. In patients undergoing gynecological laparoscopy, only 72% met fast-track criteria at the end of surgery. In this study, although the time to discharge was shorter in the fast-track group, the number of nursing interventions and nursing hours during recovery were not different between groups. This finding entails that the early phase of recovery represents only a small proportion of the overall nursing requirements. Other activities, such as *iv* therapy, administration of medication, hygiene, education, ambulation, charting, and provision of emotional support constitute the majority of the nursing workload following ambulatory surgery. It is perhaps not surprising that it may be difficult to realize cost savings using the fast-track approach. From the above studies we can conclude that fast-tracking is a concept that requires further clinical evaluation. It is apparent that many factors can influence costs of ambulatory surgery, and fast-tracking requires control of related factors to demonstrate true benefits and cost savings.[14]

TABLE II The modified Aldrete scoring system for determining when patients are ready for discharge from the postanesthesia care unit

Discharge criteria from postanesthesia care unit	*Score*
Activity: able to move voluntarily or on command	
Four extremities	2
Two extremities	1
Zero extremities	0
Respiration	
Able to deep breathe and cough freely	2
Dyspnea, shallow or limited breathing	1
Apneic	0
Circulation	
Blood pressure ± 20 mm of preanesthetic level	2
Blood pressure ± 20–50 mm preanesthesia level	1
Blood pressure ± 50 mm of preanesthesia level	0
Consciousness	
Fully awake	2
Arousable on calling	1
Not responding	0
O_2 saturation	
Able to maintain O_2 saturation > 92% on room air	2
Needs O_2 inhalation to maintain O_2 saturation > 90%	1
O_2 saturation < 90% even with O_2 supplementation	0

A score ≥ 9 was required for discharge. Reproduced with permission from: *Aldrete JA.* J Clin Anesth 1995; 7: 89–91.

Discharge scoring systems

The major accreditation bodies in the United States (Joint Commission of Accreditation of Hospitals, Accreditation Association for Ambulatory Health Care), and the Canadian Anesthesiologists' Society require that policies and procedures be implemented to ensure the safe recovery of patients after ambulatory surgery. Various scoring systems have been devised to guide the process of discharge and home-readiness, to ensure patient safety. A related issue is that of the liability risks of ambulatory anesthesia. To avoid inappropriate or premature discharge, the anesthesiologist must ensure that the patient is "street fit" prior to discharge, that there is appropriate documentation of recovery, and that specified discharge criteria are met. If a physician does not perform the discharge assessment, it must be undertaken according to a strict policy.

For any scoring system to be useful, it must be practical, simple, easy to remember, and applicable to most or all postanesthesia settings. Using commonly observed physical signs avoids additional burden to the

PACU personnel. Furthermore, by assigning numerical values to criteria indicating patient recovery, the assessment of progress becomes more objective.

Discharge from the PACU

To discharge patients safely from the PACU, various scores have been devised. The Aldrete scoring system utilizes numeric scores of 0, 1, or 2 assigned to motor function, respiration, circulation, consciousness and colour, with a maximum total score of 10.[15] More recently, oxygen saturation assessed by pulse oximetry replaced the colour parameter (Table II).[6] According to this scoring system, when patients achieve a score ≥ 9, they are considered fit for discharge from the PACU to a step-down unit or ASU, where phase II recovery occurs. Patients are considered to be in phase II recovery until they reach the criteria for discharge home. Phase III recovery lasts for several days, and continues until the patient has returned to his/her preoperative physiological status and is able to resume usual daily activities.

Discharge criteria from the ASU

Discharge of patients from the ASU requires strict adherence to validated criteria to ensure patient safety. This responsibility is generally delegated to nurses in the ASU unit who adhere to a written protocol for patient discharge that includes specific discharge criteria, or a discharge scoring system. Korttila *et al.*[16] developed criterion for safe discharge home following ambulatory surgery. These discharge criteria use outcome-based discharge observations which include the need to void and drink prior to discharge, the latter not being a prerequisite for discharge home. Chung *et al.*[17] devised the postanesthesia discharge scoring system (PADS). This scoring system is a simple method for providing a uniform assessment of all ambulatory surgical patients, which may facilitate assessment of home-readiness. It also establishes a routine of repeated evaluation, which may result in improved patient supervision. PADS was modified to eliminate requirements for oral fluid intake and documentation of urinary output prior to discharge.[18] The PADS scoring system is a cumulative index that measures the patient's home readiness based upon five major criteria: 1) vital signs; 2) ambulation; 3) pain; 4) postoperative nausea and vomiting (PONV); and 5) surgical bleeding. The pain criteria have been further refined to score pain with a visual analog scale ranging from 1–10 (Table III). Patients who achieve a score of 9 or greater are considered fit for discharge with an adult escort. The PADS scoring system is robust in that it permits evaluation of all patients who undergo anesthesia and surgery, irrespective of the type of operation. PADS also provides for an objective determination of the optimal length of patient stay following ambulatory surgery, and its use has been shown to facilitate timely patient discharge, within two hours following surgery.[19] At present, the PADS scoring system is used throughout the world in many ambulatory surgical centres. Alternatively, outcome-based discharge criteria may be used. All parameters of an outcome-based system need to be met before discharge, and typically include the following:

- Patient alert and orientated to time and place;
- Stable vital signs;
- Pain controlled by oral analgesics;
- Nausea or emesis controlled;
- Able to walk without dizziness;
- No unexpected bleeding from the operative site
- Discharge instructions and prescriptions received from surgeon and anaesthesiologist;
- Patient accepts readiness for discharge;
- Responsible adult present to accompany patient home.

Every ASU should adopt either the PADS scoring system or the outcome-based discharge criteria as part of the protocol for patient discharge after ambulatory surgery. Discharge score or criteria should be met and

TABLE III Revised postanesthetic discharge scoring system (PADS)

Vital signs	
Within 20% of preoperative baseline	2
20-40% of preoperative baseline	1
40% of preoperative baseline	0
Activity level	
steady gait, no dizziness, consistent with preop level	2
requires assistance	1
unable to ambulate / assess	0
Nausea and vomiting	
minimal: mild, no treatment needed	2
moderate: treatment effective	1
severe: treatment not effective	0
Pain	
VAS = 0-3 the patient has minimal or no pain prior to discharge	2
VAS = 4-6 the patient has moderate pain	1
VAS = 7-10 the patient has severe pain	0
Surgical bleeding	
minimal: does not require dressing change	2
moderate: required up to two dressing changes with no further bleeding	1
severe: required three or more dressing changes and continues bleed	0

VAS = visual analogue scale. Maximum score = 10; patients scoring ≥ 9 are fit for discharge. Fom the Ambulatory Surgical Unit, University Health Network, University of Toronto.

documented before patients can be safely discharged home.

Psychomotor tests of recovery

A number of psychomotor tests are available that can be divided into two categories: paper-and-pencil tests, and non-paper tests of recovery. These tests have been adapted from other areas for evaluating the postanesthesia period. The Trieger dot test is an example of a paper-and-pencil test.[20] The Maddox Wing[21] (a device to test extraocular muscle balance), driving simulators,[22] reaction time tests, and pegboard tests[23] have all been used to evaluate recovery from anesthesia. The flicker fusion threshold,[24] which measures the frequency at which the patient perceives a flashing light to be continuous, perceptual speed tests[25] and the digit symbol substitution test[26] have also been evaluated in the postoperative period. More recently, the multiple sleep latency test (as a measure of sleepiness), and a balance test have been suggested.[27,28] Unfortunately, many of these tests are too complex and impractical for routine use in the perioperative setting, and none has been validated as a guide to discharge following ambulatory surgery.

Mandatory oral fluid intake prior to discharge

Oral intake of fluids is no longer a prerequisite prior to discharge home. The studies that changed practices in the ambulatory setting are: Schreiner and Kearney *et al.*[29,30] in the pediatric population and Jin *et al.*[31] in the adult population. Schreiner *et al.* assigned children undergoing ambulatory surgery into either "mandatory drinker" or "elective drinker" groups. Children in the mandatory drinker group experienced a higher incidence of vomiting and a prolonged hospital stay compared with the elective drinker group. In the Kearney *et al.* study, children were randomly allocated in the postoperative period to one of two groups; drinking oral fluids or having oral fluids withheld for four to six hours postoperatively.[30] The incidence of vomiting in the group with fluids withheld was significantly less than the group of patients who drank. The greatest effect of withholding oral fluids was observed in patients who received opioids, where vomiting was reduced from 73% to 36%. In Jin *et al.*'s study of adult patients, neither drinking nor non-drinking affected the incidence of PONV, nor did early postoperative drinking prolong hospital stay.[31] Therefore, drinking oral fluids is not a requirement before discharge from the ASU, and changes to this effect have been incorporated in the Practice Guidelines for Postanesthetic Care.[32] Mandating oral fluid intake prior to discharge should be done only for selected patients, on a case-by-case basis. We suggest that the ASU discharge criteria be modified accordingly.

TABLE IV Risk factors for postoperative urinary retention following ambulatory surgery

1.	Type of surgery (anorectal, hernia, and vaginal/pelvic gynecologic surgery)
2.	Old age
3.	Male sex
4.	Spinal/epidural anesthesia
5.	Duration of surgery > 60 min
6.	Intraoperative fluids > 750 mL

Mandatory voiding prior to discharge

Both general and spinal anesthesia affect detrussor muscle function. Prolonged distension of the bladder can lead to a significant morbidity. Distension beyond the volume associated with voluntary emptying causes bladder atony and impaired voiding after return of function, and subsequent urinary retention.[33,34] Identified risk factors for postoperative urinary retention are presented in Table IV.[35–38] In current practice, voiding is not a requirement before discharge from the ASU, as it could delay the discharge of 5%–11% of patients who have no risk factors for urinary retention after ambulatory surgery.[39] The incidence of urinary retention, as defined by the inability to void at a bladder volume of 600 mL, is less than 1% in low risk ambulatory surgical patients.[35] Patients tend to void within three hours of surgery. When discharging ambulatory surgery patients, they should be given written instructions to seek medical help if they are unable to void within six to eight hours from the time of discharge. For patients at high risk of urinary complications, ultrasound monitoring of bladder volume can be used to determine the need for catheterization, and may be superior to clinical judgment. There is good agreement between ultrasound scanner estimates of urinary bladder volume and urine volume measured after emptying the bladder.[36]

Spinal anesthesia using long-acting local anesthetics (LA) is associated with delayed return of bladder function and urinary retention. Intrathecal bupivacaine 10 mg was associated with prolonged return of detrussor function (462 ± 61 min) compared to intrathecal lidocaine 100 mg (235 ± 30 min).[37] The urine volume generated in the bupivacaine group in this study was 1.6 times the "cyctometric capacity" (the bladder volume required to develop an urge to void preoperatively). Short-acting spinal anesthetics for low risk

procedures are associated with minimal risk of urinary retention, and patients can be discharged home without the need to void prior to discharge.[33]

In summary, low risk patients can be discharged home without voiding. They should be instructed to return to hospital if they are unable to void within six to eight hours. Patients at high risk of urinary retention should be required to void prior to discharge, and display a residual volume < 300 mL as measured by ultrasound. If the bladder volume is > 500–600 mL, catheterization should be performed prior to discharge.[38]

Malignant hyperthermia considerations

Patients with documented or suspected malignant hyperthermia syndrome (MHS) present regularly for ambulatory surgery. Overnight hospitalization for these patients is not required. Malignant hyperthermia syndrome patients can undergo ambulatory surgery so long as a trigger-free anesthesic is provided, and body temperature is monitored and remains normal for a minimum of four hours postoperatively.[40] These recommendations are in keeping with the guidelines of the Malignant Hyperthermia Association of the United States and the Malignant Hyperthermia Association of Canada.[41,42] Prior to discharge, the MHS patient should be given written instructions as to how to monitor his/her temperature at home, and how to recognize signs of malignant hyperthermia, with contact details to seek medical advice if necessary.

Discharge following regional anesthesia

There has been a growing interest in the practice of regional anesthesia as an essential factor to ensure rapid recovery and to meet fast-track eligibility in the setting of ambulatory surgery. The main advantages of regional anesthesia in this setting include: improved postoperative pain control, lower risk of nausea and vomiting,[43] potentially faster discharge and a reduction in the incidence of chronic pain syndromes.[44] Hadzic *et al.* assigned patients undergoing ambulatory wrist surgery to have either GA or infraclavicular nerve block using a short-acting LA. Patients in the nerve block group achieved PACU bypass criteria more quickly, had less pain and nausea, and were discharged home faster than patients in the GA group.[45] Similar findings were observed in patients having knee arthroscopy, hand surgery and rotator cuff surgery.[46–48] Interscalene blocks can provide good analgesia after shoulder surgery, shorten recovery time, and are associated with less nausea and vomiting and a lower rate of unanticipated hospital admissions compared with GA.[49,50] A suprascapular block can improve recovery profiles and facilitate early discharge after arthroscopic shoulder surgery.[51] In patients undergoing inguinal hernia repair, the use of local infiltration or ilioinguinal-hypogastric nerve block was associated with less time spent by the patient in the operating room, shorter duration of hospital stay, less postoperative pain, and fewer micturition difficulties compared with GA or spinal anesthesia.[52,53] However, pain reduction and analgesic requirements were short-lived.[54,55] The question of whether regional anesthesia is superior to GA for ambulatory surgery has been addressed in a recent meta-analysis involving 22 randomized controlled trials (1,362 patients).[43] Regional anesthesia confers the benefits of better pain control, less nausea and vomiting, and shorter lengths of stay in the PACU, although regional techniques have not been shown to reduce the length of stay (LOS) in the ASU.

The benefits of avoiding GA may be apparent for up to three days postoperatively, as postoperative cognitive dysfunction (POCD) may occur more frequently in patients receiving GA compared to LA infiltration.[56] These findings have been confirmed in a larger study as well.[57] The benefit of neuraxial anesthesia in reducing postoperative cognitive dysfunction has been questioned. A recent systematic review suggests that intraoperative neuraxial anesthesia does not decrease the incidence of POCD when compared with GA. The authors also stressed that there are many methodological and study-design issues that may affect interpretation of the results of some of these studies.[58]

Spinal anesthesia is a simple and reliable technique that has been widely used for ambulatory anesthesia. Currently, the use of lidocaine has declined because of the neurotoxic effects of the 5% hyperbaric solution, with numerous reports of transient neurological symptoms after its use in spinal anesthesia.[59–61] Recently, the use of 2-choloroprocaine as an alternative to lidocaine in ambulatory anesthesia has been revisited.[62] In this study volunteers received either 40 mg of 2% lidocaine or 40 mg of 3% 2-chloroprocaine intrathecally. The quality of surgical anesthesia and motor block was similar in the two groups. No patient developed transient neurological symptoms in the 2-chloroprocaine group. Patients in this group also experienced faster resolution of sensory anesthesia, and they achieved discharge criteria earlier, including times to complete regression and voiding. In another study, 40 mg of 3% 2-chloroprocaine produced similar motor block compared to bupivacaine 7.5 mg.[63]

Ben-David *et al.*[64] demonstrated that small doses of dilute 0.25% bupivacaine (7.5 mg) provide reli-

able anesthesia for knee arthroscopies, with a mean discharge time of 202 ± 14 min. Similar findings were demonstrated with unilateral spinal anesthesia using 7.5 mg of 5% hyperbaric ropivacaine and 5 mg of 5% hyperbaric levobupivacaine.[65] Vaghadia *et al.* showed that a combination of lidocaine 25 mg and fentanyl 25 μg produces adequate anesthesia and faster recovery for brief laparoscopic procedures.[66]

One factor limiting the popularity of outpatient spinal anesthesia is postdural puncture headache (PDPH). The 25G pencil-point needles produce an incidence of PDPH < 1%. Headaches that do occur are mild and self-limited.[67] Fine needles (29G) must be used to achieve similarly low headache rates with Quincke point needles. In a prospective study involving 676 patients assigned to 27G Whitacre or 27G Quincke needles, the frequencies of PDPH were 0.4% and 1.5%, respectively.[68]

Before allowing patients to ambulate after spinal anesthesia, it is important to ensure that the motor, sensory, and sympathetic blocks have regressed. Suitable criteria to judge block regression include normal perianal (S4–5) sensation, plantar flexion of the foot, and proprioception in the big toe.[69] For peripheral nerve blocks, it is safe to discharge patients home before full regression of motor and sensory block. Although the risk of accidental injury is very low,[70] patients should be given written instructions advising them; (i) to avoid driving while the leg is insensate, (ii) to avoid placing hot pads on the numb limb, (iii) to keep the limb elevated as much as possible in the first 24 hr to avoid swelling, (iv) to use walker, crutches when the leg is numb, or (v) to take analgesic medications as soon as the numbness starts to subside and is replaced by a tingling sensation.[71]

In summary, the role of regional anesthesia in ambulatory surgery is very promising and has demonstrated benefits of better pain control, less PONV, improved patient satisfaction and faster recovery. It is safe to discharge patients with insensate limbs provided the patients are educated appropriately, and that they have been provided with written instructions on the proper care and protection of their limb.

Factors delaying discharge following ambulatory surgery

In context of the above considerations, modern ambulatory anesthesia is safe, and provides for timely discharge of patients following surgery and recovery from anesthesia. A major study of 38,958 patients undergoing ambulatory surgery found that the risk of death within 30 days of surgery was 1:11,273.[72] The frequencies of myocardial infarction, stroke, and pulmonary emboli were lower than would be expected among a similarly matched age group of individuals who had not undergone ambulatory surgery. This excellent safety record has prompted investigators to explore other outcome variables to evaluate improvements and document the continued evolution of ambulatory surgical services. Clinically relevant outcome variables include factors such as delay in discharge, unanticipated admission, return visits to hospital, and readmission after discharge. These outcome variables also serve as a quality index to provide comparisons between ASUs and institutions.

Discharge time or postoperative LOS is an important outcome variable in ambulatory surgery. Several studies have investigated and determined the factors that contribute to delayed discharge, but there is no universal definition of an appropriate LOS.[35,73–75] Ambulatory LOS may be defined by the total recovery time, time to hospital discharge, or time to PACU discharge.[75] Increasing age, otorhinolaryngology (ENT), strabismus surgery, and congestive heart failure are important preoperative predictors of delayed discharge.[75,76] Intraoperative factors such as GA, long duration of surgery, and the presence of intraoperative cardiac events all contribute to a delay in discharge from the PACU. Postoperative pain and PONV are the two factors that commonly prolong stay after ambulatory surgery.[76,77]

Pain remains a common reason for delay in discharge[78,79] and is responsible for delay in discharge from the PACU and ASU in 30% and 13% of patients, respectively.[80] Pain is one of the top three postoperative symptoms which patients prefer to avoid during their perioperative experience.[81,82] Gagging on the endotracheal tube and PONV are two other key patient concerns. Chung *et al.* studied 10,008 ambulatory patients prospectively to identify risk factors for severe postoperative pain.[77] The incidence of severe pain was 5.3% in the PACU, and 1.7% in the ASU. Orthopedic procedures had the highest incidence of postoperative pain, particularly amongst patients undergoing shoulder surgery and removal of hardware. The length of surgery was also implicated in the development of postoperative pain. When surgery exceeded 90 min, 10% of patients had severe pain. If the surgery lasted more than 120 min, 20% suffered severe pain. Given these facts, anesthesiologists should tailor analgesia requirements to prevent pain in these patients. Patients with a high body-mass index had a higher incidence of severe pain in the PACU because of failure to titrate opioid dosage to body mass.

Postoperative nausea and vomiting is a common and troublesome problem after ambulatory surgery.

The incidence of PONV varies between 30–50%.[83,84] Postoperative nausea and vomiting is regarded as such an unpleasant symptom that willingness-to-pay models have shown patients would spend up to $100 for an effective antiemetic in this setting.[85] In a study of 16,411 ambulatory surgical patients, PONV was shown to be one of the most important factors contributing to a prolonged postoperative stay in ambulatory surgery.[75] In patients who experienced PONV, durations of stay were increased in association with GA and monitored anesthesia care by 25% and 79%, respectively. Apfel *et al.* identified four risk factors for the development of PONV: female sex, history of PONV or motion sickness, nonsmoking status, and use of postoperative opioids.[86] In the presence of either no risk factors, or one or two risk factors, the associated frequencies of PONV were 10%, 20% and 40% respectively. If three or four risk factors were present, the frequencies of PONV were 61%, and 79%, respectively. Additional important predictors include surgery duration > 60 min, major and laparoscopic gynecological surgery, laparoscopic cholecystectomy, intra-abdominal surgery, and middle-ear surgery.[87,88]

Other factors delaying discharge, including sore throat, headache, dizziness, and drowsiness, have been reported after ambulatory surgery, but less has been published about these problems. The overall incidence of sore throat is 12.1%,[89] with the incidence being higher in association with endotracheal anesthesia compared with anesthesia provided by a laryngeal mask airway (45.4% *vs* 17.5% respectively). Other risk factors for sore throat include: female sex, younger patients, use of succinylcholine, and gynecological surgery.

Perioperative hydration with 20 $mL \cdot kg^{-1}$ of *iv* isotonic fluid reduces postoperative symptoms such as thirst, nausea, dizziness, and drowsiness for up to 24 hr postoperatively.[90] Using a rapid infusion of 30 $mL \cdot kg^{-1}$ of *iv* isotonic solution, the severity of nausea and the incidence of vomiting were reduced, in comparison to 10 $mL \cdot kg^{-1}$ volume loading in ambulatory laparoscopic gynecology.[91] However, dizziness, thirst, and opioid consumption were not different between groups in that trial. Knowledge of these factors warrants specific fluid management strategies in ambulatory surgery to minimize the likelihood of delayed discharge and to maximize patient satisfaction. Wu *et al.* showed that the overall frequencies of postdischarge symptoms in patients undergoing ambulatory surgery are approximately 45% for pain, 17% for nausea, and 8% for vomiting.[92] The other major symptoms identified in their systematic review were drowsiness, dizziness, and fatigue. The development of newer anesthetic techniques and drugs, which help to facilitate earlier discharge from hospital, may represent cost shifting to patients and their caregivers. Future studies should explore the extent to which perioperative interventions can minimize postdischarge complications and facilitate early return to daily activities. The potential to modify indirect costs, such as time lost from work for both the patient and caregiver, may not provide an incentive for hospitals, but there are important implications for patient and society as a whole.

TABLE V Factors delaying discharge from ambulatory surgical unit

Preoperative	Female gender
	Increasing age
	CHF
Intraoperative	Long duration of surgery
	GA
	Spinal anesthesia
Postoperative	PONV
	Pain
	Drowsiness
	No escort

CHF = congestive heart failure; GA = general anesthesia; PONV = postoperative nausea and vomiting.

Another factor that influences discharge is the surgeon's skill and the number of outpatient procedures he/she performs in a given year. Patients having operations by "low-volume" surgeons tend to have an extended LOS when compared with outcomes of "high-volume" surgeons.[93] Logistical factors also play a role. Pavlin *et al.* found that system factors account for 41% of all delays in ASU; over half of these resulted from a lack of escort to take the patient home.[35] For patients receiving GA, the nurse attending the patient in the ASU was deemed the single most important factor determining discharge time, which suggests that nurses need to be adequately trained for ambulatory procedures, and their practices audited.[39]

In summary; it is difficult to eliminate completely all factors associated with delayed discharge (Table V); however, knowledge of the key factors, and adoption of a team approach to optimize perioperative management will lead to system improvements. An example of a multidisciplinary approach would incorporate proper patient selection in the preadmission clinics and surgical offices, adoption of current fasting guidelines, regional anesthesia with multimodal analgesia to reduce the incidence of postoperative pain and PONV, multimodal antiemetic prophylaxis in patients at high

TABLE VI Risk factors for unanticipated hospital admission

Surgical	Pain Bleeding Extensive surgery Surgical complications Abdominal surgery ENT and urology surgery
Anesthesia	Nausea and vomiting Somnolence Aspiration
Social	No escort
Medical	Medical complications related to DM, IHD, and sleep apnea

ENT = otorhinolaryngology; DM = diabetes mellitus; IHD = ischemic heart disease.

risk of PONV, and finally, use of minimally invasive surgical techniques.

Unanticipated hospital admission

Unanticipated hospital admission is defined as the admission of patients scheduled for ambulatory surgery due to unforeseen problems such as surgical and anesthetic complications.[94] The rate of unanticipated hospital admission from the ASU is considered an index of quality of care. In most centres, the rate averages 1–2%. The commonest causes are: surgical factors (pain, extensive surgery, bleeding), anesthetic factors (PONV and anesthesia-related complications), social, and medical factors (Table VI).[95–97] Fortier *et al.* reported an unanticipated hospital admission rate of 1.4% in 15,172 consecutive ambulatory surgical patients.[97] Surgical, medical, social and medical reasons accounted for 38.1%, 25.1%, 19.5% and 17.2% of the reasons for admission, respectively. Otorhinolaryngology (18.2%), urology (4.8%) and chronic pain patients (3.9%) accounted for the top three types of surgery admitted to hospital. The predictive factors were: male patients, ASA status II or III, long duration of surgery, surgery finishing after 1500 hr, postoperative bleeding, excessive pain, nausea and vomiting, and excessive drowsiness or dizziness. In 10,772 children undergoing ambulatory surgery, 242 (2.2%) experienced unanticipated hospital admission.[98] The reasons for admission were surgical (54%), anesthetic (16%), social (14%), medical (11%) and unclassified (4%). Orthopedic surgery accounted for the largest absolute number of unanticipated admissions, followed by urology and general surgery. However, measured as a percentage of caseload, urology experienced the highest proportion of unanticipated hospital admissions. In more complex procedures such as laparoscopic cholecystectomy, the rate is higher and varies between 3.4% to 39%.[99,100] This variability is attributable to case selection, and surgical expertise. The main risk factors are surgical time greater than 60 min (fourfold increased risk of admission), age > 50 yr, ASA physical status class III, and surgery undertaken after 1300 hr.[99,101] Other complex procedures are ENT surgery. A recent study showed that septoplasty is associated with a high risk for admission (13.4%).[102] Three factors are significantly associated with unanticipated admissions in ENT surgery: the type of surgery (tympanomastoidectomy with ossicular reconstruction), the duration of GA (more than two hours), and asthma as a co-existing condition.[103]

In summary, unanticipated hospital admission following ambulatory surgery is a measure of quality of care. With continual pressure for cost containment, more surgical procedures will be performed on an ambulatory basis. Long duration of surgery, postoperative bleeding, pain, nausea and vomiting are the most common factors associated with unanticipated admission.. Proper selection of patients, minimally invasive surgical techniques,[104] and implementation of multiple clinical pathways to deal with postoperative complications in the PACU and ASU can reduce the likelihood of unanticipated hospital admission.

Readmission after ambulatory surgery

A *return hospital visit* is defined as a visit to the emergency room or ASU within 30 days of surgery. In association with ambulatory surgery, *hospital readmission* is defined as an ambulatory surgical patient requiring inpatient admission following discharge from an ASU due to complications.[94] The readmission rate after ambulatory surgery is between 1–3%.[105,106] It is expected that more admissions will be associated with return hospital visits occurring within 24 hr of discharge than after 24 hr. This fact prompted the International Association for Ambulatory Surgery to divide the timing of this outcome into two epochs: i) hospital admission within the first 24 hr; and ii) hospital admission from 25 hr until 28 days after surgery.[107] Mezei *el al.* studied prospectively 17,638 ambulatory surgical patients over three years. The number of patients who returned to hospital within 30 days was 193 (1.1%), in whom 26 (0.15%) of admissions were complication-related, (25 surgical complications and one medical complication). The majority of patients were readmitted for additional elective surgery. In a

study by Twersky *et al.*, the return hospital visit rate was 3%, with a complications-related admission rate of 1.3%. There were no anesthesia- related admissions in either study. Patients undergoing urologic procedures such as transurethral resection of bladder tumour, varicocelectomy and hydrocelectomy, are more likely to return to hospital.[105,106] The leading causes of readmission to hospital related to these procedures are bleeding and surgical complications. Other causes are pain, urinary retention and infection.[107]

In a study of 564,267 outpatient surgical procedures, Fleisher *et al.* identified that age > 85 yr, previous inpatient hospital admission within six months, surgical performance at a physician's office or outpatient hospital, and invasiveness of surgery identified those elderly patients who were at increased risk of inpatient hospital admission or death within seven days of surgery.[108] Coley *et al.* evaluated retrospectively the return and readmission rate in 20,817 patients following ambulatory surgery.[109] The percentage of return visits to the hospital within 30 days was 5.7%. Of these return visits, 1.5% were related directly to the original ambulatory surgery procedure. Pain was the most commonly reported reason for return, occurring in 38% of patients. General surgery, ENT and urology were the specialties associated with the highest rates of readmission accounting for 3.2%, 3.1% and 2.9%, respectively.

Vaghadia *et al.* examined bleeding as a factor responsible for readmission in a study of 172,710 outpatient procedures.[110] The readmission rate due to bleeding was 0.4%, and urological and gynecological procedures were found to be associated with the highest readmission rates. The majority of patients with clinically significant bleeding could be identified within 30–45 min of their arrival in a PACU. Current evidence suggests that extending the postoperative observation period beyond one hour to prevent return to hospital due to bleeding is not justified, if the patient is otherwise ready for discharge.

Return hospital admission is an outcome related mainly to surgical complications such as extensive surgery, pain and urinary retention. Quality assurance audits are important to identify factors leading to hospital readmission, and should be conducted periodically with an evalution of patient selection criteria, especially for the specialties of ENT and urology.

Postoperative patient instructions

The success and safety of an ambulatory surgery program is dependent, in part, on the patient's understanding, and his/her compliance with instructions. Considerable responsibility is placed on patients to adhere to the information and instruction they receive prior to surgery. It has been shown that patients often forget verbal instructions, or ignore them altogether.[111,112] In most institutions, written instructions are provided. Given the availability of sophisticated information systems, it was perhaps inevitable that such technologies would find their way into patient education. Instructional video presentations are now shown to patients preoperatively in many preoperative care units. Documenting the benefits of such an initiative may be difficult. One study found that patients who saw a preoperative information video claimed that they found it helpful, although their knowledge regarding the perioperative period was not demonstrably better than patients who had not seen the same video.[113] Another recent study suggests that failure to adhere to written instructions could be related to low health literacy and age.[114] In this study, low heath literacy was more prevalent in patients aged > 65 yr.

Follow-up of patients is an important part of ambulatory surgery. This process can increase patient satisfaction, provide additional advice and reassurance to patients, facilitate audits to improve clinical practice, and facilitate research in ambulatory anesthesia. Table VII (available as Additional Material at www:cja-jca.org) presents an example of a postoperative telephone questionnaire that can be used by nurses for patient follow-up.

Patient escort

The Canadian Anesthesiologists' Society, the American Society of Anesthesiologists, and other regulatory bodies recommend having a responsible adult escort to accompany patients home after ambulatory surgical procedures.[32,115] Various studies have shown that there exists significant psychomotor and cognitive impairment after GA, as well as regional anesthesia and monitored anesthesia care. Accordingly, a responsible adult escort is required to accompany patients home following ambulatory surgery.[116,117] In a prospective case controlled study conducted over a period of 38 months, the incidence of patients with no escort was found to be 0.2% (60/28,391 patients).[118] In this study, two groups of patients without an escort were identified: patients known preoperatively not to have an escort (no known escort, $n = 24$) and patients whose escort did not show (no-show escort, $n = 36$). It is a common practice for personnel in ASUs to ensure that patients have an escort to accompany patients home. Hospitals should implement policies to prevent patient discharge without an escort. This should be a fundamental issue of patient safety in relation to ambulatory anesthesia.

Driving issues

General anesthetic agents can impair psychomotor function and skills related to driving for up to eight hours postoperatively.[119] These studies were, however, conducted prior to the introduction of short-acting *iv* and volatile anesthetics, which provide faster recovery and earlier return to normal daily activities. General anesthetic agents have been shown to permit prompt return of driving skills at two, three, and four hours postanesthesia, when compared to corresponding control sessions.[117] When interpreting such studies, it is important to note that healthy volunteers, unlike patients, do not experience perioperative anxiety, sleep deprivation, and postoperative pain. Furthermore, patients may receive preoperative sedatives, and postoperative analgesics or antiemetics. In a prospective study of 20 patients undergoing knee arthroscopy under GA, patients demonstrated lower alertness levels and impaired driving skills preoperatively and two hours postoperatively.[120] These parameters returned to normal within 24 hr, providing objective evidence that it is reasonable for patients to resume driving 24 hr after surgery. One reservation with interpreting studies addressing post-operative cognitive dysfunction is that most studies do not address the component of cognitive function most likely being altered by sedative or general anesthetic drugs.[58] Cognitive function constitutes: verbal comprehension, perceptual organization, executive function (e.g., abstraction, problem solving, and cognitive flexibility), learning and memory, attention and concentration, and processing or psychomotor speed. Most studies in this area of investigation base their conclusions on a change in only one or two domains.[121,122]

Conclusions

Ambulatory surgery will continue to grow and expand. Continued advances in surgical techniques (e.g., minimally invasive surgery), anesthetic pharmacology, regional anesthesia, and postoperative analgesia, will allow ever more complex procedures to be conducted on an ambulatory basis. Discharge scoring systems will help to facilitate discharge. Improved understanding of potential complications, updating patient information and clinical pathways based upon current best evidence, and addressing patient escort and driving issues, will help to ensure the safe recovery and discharge of patients following their outpatient procedures.

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References

1 *Marshall SI, Chung F.* Discharge criteria and complications after ambulatory surgery. Anesth Analg 1999; 88: 508–17.

2 *White PF.* Bypassing (fast-tracking) of the recovery room after ambulatory surgery. Acta Anaesthesiol Scand 1998; 42: 189–91.

3 *Lubarsky DA.* Fast-track in the postanesthesia unit: unlimited possibilities? J Clin Anesth 1996; 8(Suppl): S70–S2.

4 *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: 811–7.

5 *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: 1245–8.

6 *Aldrete JA.* The post-anesthesia recovery score revisited (Letter). J Clin Anesth 1995; 7: 89–91.

7 *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: 1069–72.

8 *Dexter F, Tinker J.* Analysis of strategies to decrease postanesthesia care unit costs. Anesthesiology 1995; 82: 94–101.

9 *Dexter F, Macario A, Manberg PJ, Lubarsky DA.* Computer simulation to determine how rapid anesthetic recovery protocols to decrease the time for emergence or increase the phase I postanesthesia care unit bypass rate affect staffing of an ambulatory surgery center. Anesth Analg 1999; 88: 1053–63.

10 *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.

11 *Williams BA, Kentor ML, Williams JP, et al.* PACU bypass after outpatient knee surgery is associated with fewer unplanned hospital admissions but more phase II nursing interventions. Anesthesiology 2002; 97: 981–8.

12 *Duncan PG, Shandro J, Bachand R, Ainsworth L.* Pilot study of recovery room bypass ("fast-track protocol") in a community hospital. Can J Anesth 2001; 48: 630–6.

13 *Song D, Chung F, Ronayne M, Ward B, Yogendran S, Sibbick C.* Fast-tracking (bypassing the PACU) does

not reduce nursing workload after ambulatory surgery. Br J Anaesth 2004; 93: 768–74.
14 *Millar J.* Fast-tracking in day surgery. Is your journey to the recovery room really necessary? (Editorial) Br J Anaesth 2004; 93: 756–8.
15 *Aldrete JA, Kroulik D.* A postanesthetic recovery score. Anesth Analg 1970; 49: 924–34.
16 *Korttila KT.* Post-anaesthesia psychomotor and cognitive function. Eur J Anaesthesiol Suppl 1995; 10: 43–6.
17 *Chung F, Chan VW, Ong D.* A post-anesthetic discharge scoring system for home readiness after ambulatory surgery. J Clin Anesth 1995; 7: 500–6.
18 *Chung F.* Recovery pattern and home-readiness after ambulatory surgery. Anesth Analg 1995; 80: 896–902.
19 *Marshall S, Chung F.* Assessment of 'home-readiness' -- discharge criteria and postdischarge complications. Curr Opin Anesthesiol 1997; 10: 445–50.
20 *Newman MG, Trieger N, Miller JC.* Measuring recovery from anesthesia: a simple test. Anesth Analg 1969; 48: 136–40.
21 *Hannington-Kiff JG.* Measurement of recovery from outpatient general anaesthesia with a simple ocular test. Br Med J 1970; 3: 132–5.
22 *Korttila K, Tammisto T, Ertama P, Pfaffli P, Blomgren E, Hakkinen S.* Recovery, psychomotor skills, and simulated driving after brief inhalational anesthesia with halothane or enflurane combined with nitrous oxide and oxygen. Anesthesiology 1977; 46: 20–7.
23 *Craig J, Cooper GM, Sear JW.* Recovery from day case anaesthesia. Comparison between methohexitone, althesin and etomidate. Br J Anaesth 1982; 54: 447–51.
24 *Vickers MD.* The measurement of recovery from anaesthesia. Br J Anaesth 1965; 37: 296–302.
25 *Reitan JA, Porter W, Braunstein M.* Comparison of psychomotor skills and amnesia after induction of anesthesia with midazolam or thiopental. Anesth Analg 1986; 65: 933–7.
26 *Arain SR, Ebert TJ.* The efficacy, side effects, and recovery characteristics of dexmedetomidine versus propofol when used for intraoperative sedation. Anesth Analg 2002; 95: 461–6.
27 *Lichtor JL, Alessi R, Lane BS.* Sleep tendency as a measure of recovery after drugs used for ambulatory surgery. Anesthesiology 2002; 96: 878–83.
28 *Ledin T, Gupta A, Tytor M.* Postural control after propofol anaesthesia in minor surgery. Acta Otolaryngol Suppl 1995; 520(Pt 2): 313–6.
29 *Schreiner MS, Nicolson SC, Martin T, Whitney L.* Should children drink before discharge from day surgery? Anesthesiology 1992; 76: 528–33.
30 *Kearney R, Mack C, Entwistle L.* Withholding oral fluids from children undergoing day surgery reduces vomiting. Paediatr Anaesth 1998; 8: 331–6.
31 *Jin FL, Norris A, Chung F, Ganeshram T.* Should adult patients drink fluids before discharge from ambulatory surgery? Anesth Analg 1998; 87: 306–11.
32 *American Society of Anesthesiologists Task Force on Postanesthetic Care.* Practice guidelines for postanesthetic care: a report by the American Society of Anesthesiologists Task Force on Postanesthetic Care. Anesthesiology 2002; 96: 742–52.
33 *Mulroy MF, Salinas FV, Larkin KL, Polissar NL.* Ambulatory surgery patients may be discharged before voiding after short-acting spinal and epidural anesthesia. Anesthesiology 2002; 97: 315–9.
34 *Axelsson K, Mollefors K, Olsson JO, Lingardh G, Widman B.* Bladder function in spinal anaesthesia. Acta Anaesthesiol Scand 1985; 29: 315–21.
35 *Pavlin DJ, Pavlin EG, Gunn HC, Taraday JK, Koerschgen ME.* Voiding in patients managed with or without ultrasound monitoring of bladder volume after outpatient surgery. Anesth Analg 1999; 89: 90–7.
36 *Rosseland LA, Stubhaug A, Breivik H.* Detecting postoperative urinary retention with an ultrasound scanner. Acta Anaesthesiol Scand 2002; 46: 279–82.
37 *Kamphuis ET, Ionescu TI, Kuipers PW, de Gier J, van Venrooij GE, Boon TA.* Recovery of storage and emptying functions of the urinary bladder after spinal anesthesia with lidocaine and with bupivacaine in men. Anesthesiology 1998; 88: 310–6.
38 *Joshi GP.* The Society for Ambulatory Anesthesia: 19th Annual Meeting Report. Anesth Analg 2005; 100: 982–6.
39 *Pavlin DJ, Rapp SE, Polissar NL, Malmgren JA, Koerschgen M, Keyes H.* Factors affecting discharge time in adult outpatients. Anesth Analg 1998; 87: 816–26.
40 *Bryson GL, Chung F, Cox RG, et al.; Canadian Ambulatory Anesthesia Research Education Group.* Patient selection in ambulatory anesthesia - an evidence-based review: part II. Can J Anesth 2004; 51: 782–94.
41 *Malignant Hyperthermia Association of the United States.* Medical Professionals' FAQs. 2003; available from URL; http://www.mhaus.org/index.cfm/fuseaction/Content.Display/PagePK/MedicalFAQs.cfm.
42 *Malignant Hyperthermia Association of Canada.* Elective management of malignant hyperthermia susceptible patients. 2003; available from URL; http://www.mhacanada.org/MHA%20Poster%20txt.pdf.
43 *Liu SS, Strodtbeck WM, Richman JM, Wu CL.* A

comparison of regional versus general anesthesia for ambulatory anesthesia: a meta-analysis of randomized controlled trials. Anesth Analg 2005; 101: 1634–42.

44 *Reuben SS, Pristas R, Dixon D, Faruqi S, Madabhushi L, Wenner S.* The incidence of complex regional pain syndrome after fasciectomy for Dupuytren's contracture: a prospective observational study of four anesthetic techniques. Anesth Analg 2006; 102: 499–503.

45 *Hadzic A, Arliss J, Kerimoglu B, et al.* A comparison of infraclavicular nerve block versus general anesthesia for hand and wrist day-case surgeries. Anesthesiology 2004; 101: 127–32.

46 *Hadzic A, Karaca PE, Hobeika P, et al.* Peripheral nerve blocks result in superior recovery profile compared with general anesthesia in outpatient knee arthroscopy. Anesth Analg 2005; 100: 976–81.

47 *McCartney CJ, Brull R, Chan VW, et al.* Early but no long-term benefit of regional compared with general anesthesia for ambulatory hand surgery. Anesthesiology 2004; 101: 461–7.

48 *Hadzic A, Williams BA, Karaca PE, et al.* For outpatient rotator cuff surgery, nerve block anesthesia provides superior same-day recovery over general anesthesia. Anesthesiology 2005; 102: 1001–7.

49 *Brown AR, Weiss R, Greenberg C, Flatow EL, Bigliani LU.* Interscalene block for shoulder arthroscopy: comparison with general anaesthesia. Arthroscopy 1993; 9: 295–300.

50 *Wu CL, Rouse LM, Chen JM, Miller RJ.* Comparison of postoperative pain in patients receiving interscalene block or general anesthesia for shoulder surgery. Orthopedics 2002; 25: 45–8.

51 *Ritchie ED, Tong D, Chung F, Norris AM, Miniaci A, Vairavanathan SD.* Suprascapular nerve block for pain relief after arthroscopic shoulder surgery: a new modality? Anesth Analg 1997; 84: 1306–12.

52 *Song D, Greilich NB, White PF, Watcha MF, Tongier WK.* Recovery profiles and costs of anesthesia for outpatient unilateral inguinal herniorrhaphy. Anesth Analg 2000; 91: 876–81.

53 *Nordin P, Zetterstrom H, Gunnarsson U, Nilsson E.* Local, regional, or general anaesthesia in groin hernia repair: multicentre randomised trial. Lancet 2003; 362: 853–8.

54 *Toivonen J, Permi J, Rosenberg PH.* Effect of preincisional ilioinguinal and iliohypogastric nerve block on postoperative analgesic requirement in day-surgery patients undergoing herniorrhaphy under spinal anaesthesia. Acta Anaesthesiol Scand 2001; 45: 603–7.

55 *Andersen FH, Nielsen K, Kehlet H.* Combined ilioinguinal blockade and local infiltration anaesthesia for groin hernia repair--a double-blind randomized study. Br J Anaesth 2005; 94: 520–3.

56 *Tzabar Y, Asbury AJ, Millar K.* Cognitive failures after general anaesthesia for day-case surgery. Br J Anaesth 1996; 76: 194–7.

57 *Ward B, Imarengiaye C, Peirovy J, Chung F.* Cognitive function is minimally impaired after ambulatory surgery. Can J Anesth 2005; 52: 1017–21.

58 *Wu CL, Hsu W, Richman JM, Raja SN.* Postoperative cognitive function as an outcome of regional anesthesia and analgesia. Reg Anesth Pain Med 2004; 29: 257–68.

59 *Tarkilla P, Huhtala J, Tuominen M.* Transient radicular irritation after spinal anaesthesia with hyperbaric 5% lignocaine. Br J Anaesth 1995; 74: 328–9.

60 *Schneider M, Ettlin T, Kaufmann M, et al.* Transient neurologic toxicity after hyperbaric subarachnoid anesthesia with 5% lidocaine. Anesth Analg 1993; 76: 1154–7.

61 *Rodriguez-Chinchilla R, Rodriguez-Pont A, Pintanel T, Vidal-Lopez F.* Bilateral severe pain at L3-4 after spinal anaesthesia with hyperbaric 5% lignocaine. Br J Anaesth 1996; 76: 328–9.

62 *Kouri ME, Kopacz DJ.* Spinal 2-chloroprocaine: a comparison with lidocaine in volunteers. Anesth Analg 2004; 98: 75–80.

63 *Yoos JR, Kopacz DJ.* Spinal 2-chloroprocaine: a comparison with small-dose bupivacaine in volunteers. Anesth Analg 2005; 100: 566–72.

64 *Ben-David B, Levin H, Solomon E, Admoni H, Vaida S.* Spinal bupivacaine in ambulatory surgery: the effect of saline dilution. Anesth Analg 1996; 83: 716–20.

65 *Cappelleri G, Aldegheri G, Danelli G, et al.* Spinal anesthesia with hyperbaric levobupivacaine and ropivacaine for outpatient knee arthroscopy: a prospective, randomized, double-blind study. Anesth Analg 2005; 101: 77–82.

66 *Vaghadia H, McLeod DH, Mitchell GW, Merrick PM, Chilvers CR.* Small-dose hypobaric lidocaine-fentanyl spinal anesthesia for short duration outpatient laparoscopy. I. A randomized comparison with conventional dose hypobaric lidocaine. Anesth Analg 1997; 84: 59–64.

67 *Pittoni G, Toffoletto F, Calcarella G, Zanette G, Giron GP.* Spinal anesthesia in outpatient knee surgery: 22-gauge versus 25-gauge Sprotte needle. Anesth Analg 1995; 81: 73–9.

68 *Santanen U, Rautoma P, Luurila H, Erkola O, Pere P.* Comparison of 27-gauge (0.41-mm) Whitacre and Quincke spinal needles with respect to post-dural puncture headache and non-dural puncture headache. Acta Anaesthesiol Scand 2004; 48: 474–9.

69 *Pflug AE, Aasheim GM, Foster C.* Sequence of return

of neurological function and criteria for safe ambulation following subarachnoid block (spinal anaesthetic). Can Anaesth Soc J 1978; 25: 133–9.
70 *Klein SM, Nielsen KC, Greengrass RA, Warner DS, Martin A, Steele SM.* Ambulatory discharge after long-acting peripheral nerve blockade: 2382 blocks with ropivacaine. Anesth Analg 2002; 94: 65–70.
71 *Enneking FK, Chan V, Greger J, Hadzic A, Lang SA, Horlocker TT.* Lower-extremity peripheral nerve blockade: essentials of our current understanding. Reg Anesth Pain Med 2005; 30: 4–35.
72 *Warner MA, Sheilds SE, Chute CG.* Major morbidity and mortality within 1 month of ambulatory surgery and anaesthesia. JAMA 1993; 270: 1437–41.
73 *Claxton AR, McGuire G, Chung F, Cruise C.* Evaluation of morphine versus fentanyl for postoperative analgesia after ambulatory surgical procedures. Anesth Analg 1997; 84: 509–14.
74 *Nielsen KC, Tucker MS, Steele SM.* Outcomes after regional anesthesia. Int Anesthesiol Clin 2005; 43: 91–110.
75 *Chung F, Mezei G.* Factors contributing to a prolonged stay after ambulatory surgery. Anesth Analg 1999; 89: 1352–9.
76 *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.
77 *Chung F, Ritchie E, Su J.* Postoperative pain in ambulatory surgery. Anesth Analg 1997; 85: 808–16.
78 *Shaikh S, Chung F, Imarengiaye C, Yung D, Bernstein M.* Pain, nausea, vomiting and ocular complications delay discharge following ambulatory microdiscectomy. Can J Anesth 2003; 50: 514–8.
79 *Wilson AT, Nicholson E, Burton L, Wild C.* Analgesia for day-case shoulder surgery. Br J Anaesth 2004; 92: 414–5.
80 *Pavlin DJ, Chen C, Penaloza DA, Polissar NL, Buckley FP.* Pain as a factor complicating recovery and discharge after ambulatory surgery. Anesth Analg 2002; 95: 627–34.
81 *Jenkins K, Grady D, Wong J, Correa R, Armanious S, Chung F.* Post-operative recovery: day surgery patients' preferences. Br J Anaesth 2001; 86: 272–4.
82 *Macario A, Weinger M, Carney S, Kim A.* Which clinical anesthesia outcomes are important to avoid? The perspective of patients. Anesth Analg 1999; 89: 652–8
83 *Gan TJ.* Postoperative nausea and vomiting: can it be eliminated? JAMA 2002; 287: 1233–6.
84 *Golembiewski J, Chernin E, Chopra T.* Prevention and treatment of postoperative nausea and vomiting. Am J Health Syst Pharm 2005; 62: 1247–60.
85 *Gan T, Sloan F, Dear Gde L, El-Moalem HE, Lubarsky DA.* How much are patients willing to pay to avoid postoperative nausea and vomiting? Anesth Analg 2001; 92: 393–400.
86 *Apfel CC, Laara E, Koivuranta M, Greim CA, Roewer N.* A simplified risk score for predicting postoperative nausea and vomiting: conclusions from cross-validations between two centers. Anesthesiology 1999; 91: 693–700.
87 *Apfel CC, Kranke P, Eberhart LH, Roos A, Roewer N.* Comparison of predictive models for postoperative nausea and vomiting. Br J Anaesth 2002; 88: 234–40.
88 *Koivuranta M, Laara E, Snare L, Alahuhta S.* A survey of postoperative nausea and vomiting. Anaesthesia 1997; 52: 443–9.
89 *Higgins PP, Chung F, Mezei G.* Postoperative sore throat after ambulatory surgery. Br J Anaesth 2002; 88: 582–4.
90 *Yogendran S, Asokumar B, Cheng DC, Chung F.* A prospective randomized double-blinded study of the effect of intravenous fluid therapy on adverse outcomes on outpatient surgery. Anesth Analg 1995; 80: 682–6.
91 *Magner JJ, McCaul C, Carton E, Gardiner J, Buggy D.* Effect of intraoperative intravenous crystalloid infusion on postoperative nausea and vomiting after gynaecological laparoscopy: comparison of 30 and 10 ml kg^{-1}. Br J Anaesth 2004; 93: 381–5.
92 *Wu CL, Berenholtz SM, Pronovost PJ, Fleisher LA.* Systematic review and analysis of postdischarge symptoms after outpatient surgery. Anesthesiology 2002; 96: 994–1003.
93 *Jain NB, Pietrobon R, Guller U, Ahluwalia AS, Higgins LD.* Influence of provider volume on length of stay, operating room time, and discharge status for rotator cuff repair. J Shoulder Elbow Surg 2005; 14: 407–13.
94 *Imasogie N, Chung F.* Effect of return hospital visits on economics of ambulatory surgery. Curr Opin Anaesthesiol 2001; 14: 573–8.
95 *Gold BS, Kitz DS, Lecky JH, Neuhaus JM.* Unanticipated admission to the hospital following ambulatory surgery. JAMA 1989; 262: 3008–10.
96 *Osborne GA, Rudkin GE.* Outcome after day-care surgery in a major teaching hospital. Anaesth Intensive Care 1993; 21: 822–7.
97 *Fortier J, Chung F, Su J.* Unanticipated admission after ambulatory surgery- a prospective study. Can J Anaesth 1998; 45: 612–9.
98 *Awad IT, Moore M, Rushe C, Elburki A, O'Brien K, Warde D.* Unplanned hospital admission in children undergoing day-case surgery. Eur J Anaesthesiol 2004; 21: 379–83.

99 *Lau H, Brooks DC.* Predictive factors for unanticipated admissions after ambulatory laparoscopic cholecystectomy. Arch Surg 2001; 136: 1150–3.

100 *Leeder PC, Matthews T, Krzeminska K, Dehn TC.* Routine day-case laparoscopic cholecystectomy. Br J Surg 2004; 91: 312–6.

101 *Robinson TN, Biffl WL, Moore EE, Heimbach JK, Calkins CM, Burch JM.* Predicting failure of outpatient laparoscopic cholecystectomy. Am J Surg 2002; 184: 515–9.

102 *Ganesan S, Prior AJ, Rubin JS.* Unexpected overnight admissions following day-case surgery: an analysis of a dedicated ENT day care unit. Ann R Coll Surg Engl 2000; 82: 327–30.

103 *Dornhoffer J, Manning L.* Unplanned admissions following outpatient otologic surgery: the University of Arkansas experience. Ear Nose Throat J 2000; 79: 710, 713–7.

104 *Cohen MS, Finkelstein SE, Brunt LM, et al.* Outpatient minimally invasive parathyroidectomy using local/regional anesthesia: a safe and effective operative approach for selected patients. Surgery 2005; 138: 681–7.

105 *Mezei G, Chung F.* Return hospital visits and hospital readmissions after ambulatory surgery. Ann Surg 1999; 230: 721–7.

106 *Twersky R, Fishman D, Homel P.* What happens after discharge? Return hospital visits after ambulatory surgery. Anesth Analg 1997; 84: 319–24.

107 *Lemo P.* Development of clinical indicators for ambulatory surgery. Euroanaesthesia refresher course 2005 Vienna, Austria 28-31 May 2005; available from URL; http://www.euroanesthesia.org/education/rc2005vienna/2RC2.pdf.

108 *Fleisher LA, Pasternak LR, Herbert R, Anderson GF.* Inpatient hospital admission and death after outpatient surgery in elderly patients: importance of patient and system characteristics and location of care. Arch Surg 2004; 139: 67–72.

109 *Coley KC, Williams BA, DaPos SV, Chen C, Smith RB.* Retrospective evaluation of unanticipated admissions and readmissions after same day surgery and associated costs. J Clin Anesth 2002; 14: 349–53.

110 *Vaghadia H, Scheepers L, Merrick PM.* Readmission for bleeding after outpatient surgery. Can J Anaesth 1998; 45: 1079–83.

111 *Chung F, Lane R, Spraggs C, et al.* Ondansetron is more effective than metoclopramide for the treatment of opioid-induced emesis in post-surgical adult patients. Ondansetron OIE Post-Surgical Study Group. Eur J Anaesthesiol 1999; 16: 669–77.

112 *Laffey JG, Carroll M, Donnelly N, Boylan JF.* Instructions for ambulatory surgery-patient comprehension and compliance. Ir J Med Sci 1998; 167: 160–3.

113 *Zvara DA, Mathes DD, Brooker RF, McKinley CA.* Video as a patient teaching tool: does it add to the preoperative anesthetic visit? Anesth Analg 1996; 82: 1065–8.

114 *Chew LD, Bradley KA, Flum DR, Cornia PB, Koepsell TD.* The impact of low health literacy on surgical practice. Am J Surg 2004; 188: 250–3.

115 Day Surgery - revised edition 2005. Association of Anaesthetists of Great Britain and Ireland. Available from URL; http://www.aagbi.org/pdf/DaySurgery2.pdf.

116 *Apfelbaum JL, Lichtor JL, Lane BS, Coalson DW, Korttila KT.* Awakening, clinical recovery, and psychomotor effects after desflurane and propofol anesthesia. Anesth Analg 1996; 83: 721–5.

117 *Sinclair DR, Chung F, Smiley A.* General anesthesia does not impair simulator driving skills in volunteers in the immediate recovery period - a pilot study. Can J Anesth 2003; 50: 238–45.

118 *Chung F, Imasogie N, Ho J, Ning X, Prabhu A, Curti B.* Frequency and implications of ambulatory surgery without a patient escort. Can J Anesth 2005; 52: 1022–6.

119 *Korttila K, Linnoila M, Ertama P, Hakkinen S.* Recovery and simulated driving after intravenous anesthesia with thiopental, methohexital, propanidid, or alphadione. Anesthesiology 1975; 43: 291–9.

120 *Chung F, Kayumov L, Sinclair DR, Edward R, Moller HJ, Shapiro CM.* What Is the Driving Performance of Ambulatory Surgical Patients after General Anesthesia? Anesthesiology 2005; 103: 951–6.

121 *Rasmussen LS, Larsen K, Houx P, Skovgaard LT, Hanning CD, Moller JT; The International Study of Postoperative Cognitive Dysfunction.* The assessment of postoperative cognitive function. Acta Anaesthesiol Scand 2001; 45: 275–89.

122 *Miller LS, Rohling ML.* A statistical interpretative method for neuropsychological test data. Neuropsychol Rev 2001; 11: 143–69.