
Postanesthesia Care Unit Challenges

Patricia A. Kapur, MD

The purpose of this discussion is to elucidate medical and institutional systems issues that affect patient management in the postanesthesia care unit (PACU). Factors that are of current interest in this regard include how ambulatory recovery paradigms have affected general approaches to PACU care, "fast tracking" and criteria-based recovery, contemporary perioperative pain management issues, current thinking on the management of postoperative nausea and vomiting (PONV), discharge issues for those patients who are going home the same day as surgery (up to 65% or more of US surgeries today), and special contemporary PACU issues, such as off-pump cardiac surgical patients, 23-h stays, and the PACU as an intensive care unit (ICU) overflow unit.

The hallmarks of ambulatory anesthesia care are high volume, fast turnover, and overall cost savings compared with inpatient care. Such cost saving is achieved by continuous optimization of the utilization of space, personnel, consumable supplies, and available facility time. Optimization is usually interpreted as the shortest time, the fewest supplies, and the lowest level of personnel at each step compatible with safe perioperative care. All of these ambulatory issues are directly applicable to PACU care and have resulted in a great emphasis on efficient PACU throughput, with a recognition, as some have suggested, that although anesthesia drug costs may well be <10% of operating room (OR) costs, PACU expenses may be 35% or more of OR costs. Thus, anesthesia drug acquisition costs must be balanced with their benefits to improve patient flow through the recovery process. Choice of anesthetics or techniques can improve OR efficiency or utilization and clearly reduce the required PACU staffing ratios and need for supplies and postoperative medications to treat anesthesia sequelae. Patients who wake up promptly, have pain management plans underway from the OR, and have little PONV will be very efficient participants in the recovery process.

With regard to choice of general anesthetics, short-acting drugs may be selected or, alternatively, experienced clinicians can achieve good timing of longer-acting anesthetics to achieve the quicker wake-ups expected currently (1). New devices such as laryngeal mask airways may also contribute to these throughput goals. In addition to favorable factors associated with

their insertion, such as lack of rise of intraocular pressure, absence of the need for muscle relaxants or reversal drugs, or possibility of laryngoscopy damage, laryngeal mask airways are tolerated at lighter levels of anesthesia, which can contribute to quicker wake-up (2). In addition, the disruptive effects of tracheal extubation are avoided. Other airway devices, such as the cuffed oral pharyngeal airway, share some of these advantages.

Bispectral index monitoring may be another way that clinicians can adjust anesthetic administration to result in enough, but not an excess of, anesthetic to facilitate rapid and smooth anesthetic emergence. For example, Song et al. (3) compared desflurane-anesthetized with propofol-anesthetized gynecologic patients who had similar weights, ages, anesthesia times, and average bispectral index values at the end of surgery, and they found very close awakening times and fast-track-eligible times. However, when specific bispectral index values were further examined, those patients who had the higher bispectral index values (>75) at the end of surgery from either group met fast-track eligibility criteria sooner than those with lower bispectral index values (<45), indicating that the former patients may have been able to forego Phase 1 (ICU level) PACU care and proceed directly to Phase 2 (predischARGE) care, with resulting staff and supply savings.

The choice of a regional anesthetic may facilitate or decrease PACU stay in cases such as peripheral or limb blocks, in which the patient's pain management needs are less because of residual pain relief from the block, if the block does not result in interference with ambulation or urinary bladder function and if the choice of a regional anesthetic reduces the incidence of nausea and emesis. On the other hand, spinal or epidural block can prolong recovery times when the patient must await recovery of lower extremity motor block or resumption of spontaneous voiding.

A variety of recovery efficiencies have resulted from approaches developed in ambulatory anesthesia environments, which are now being applied to varying degrees in other recovery environments. These include monitoring by criteria, developing analgesia or antiemetic protocols or clinical pathways, reexamining what appropriate discharge criteria should be, and

developing a role for family participation in the recovery process. Monitoring by criteria at the University of California, Los Angeles, Surgery Center, for example, includes only pulse oximetry and noninvasive blood pressure as the initial routine, with electrocardiogram monitoring only if the patient has a history of a conduction abnormality before surgery or displays an abnormality during surgery. When the patient is awake, alert, and stable, monitoring may be discontinued while the patient awaits completion of discharge arrangements. The routine application of pulse oximetry for patients immediately on arrival from the OR has meant that supplemental oxygen is also applied by criteria, i.e., if SpO_2 is $<94\%$ or if indicated by the previous or current condition (4).

Criteria-based recovery is a concept that means no minimum recovery time requirement. With patients rapidly emerging from anesthesia and variable stabilization times even for the more ill inpatients, there is little justification anymore for requiring fixed length of stays in recovery facilities. If PACU recovery Phase 1 discharge criteria are met in the OR, patients may proceed to a lower level of care (so-called fast tracking or PACU bypass) (5). When predischarge unit Phase 2 discharge criteria are met, patients are released to a responsible adult to go home. Issues to consider when establishing PACU bypass include whether or not the Phase 1 and Phase 2 areas are close together. If not, there may be staff reluctance to transfer otherwise eligible patients directly from the OR suite to the Phase 2 area. Are the Phase 2 nurses familiar with cardiopulmonary care if needed for a patient who may slip back to Phase 1 needs? If not, are Phase 1 staff readily available to help? Also, PACU bypass may not be institutionally acceptable if the Phase 2 would be an inpatient's room. However, if there are no distinct Phase 1 or Phase 2 areas, criteria can allow decreased staff resources as soon as patients meet Phase 2 criteria without having to move the patients whatsoever. In pediatric patients, Patel et al. (6) showed that there were shorter recovery times and less utilization of pain medication when children who met PACU bypass criteria were allowed to move directly to Phase 2, which resulted in earlier reunion of the children with their family members.

The development of pain management protocols or clinical pathways is merely another application of the Continuous Quality Improvement mantra of reducing variability to improve outcome and lower costs. If the entire team of caregivers, including physicians, nurses, and so on, all agree on a common approach to treating postoperative pain within the institution, the postoperative process will flow more smoothly than if the nursing staff has to determine the physicians' wishes for individual approaches for each patient. Even the preoperative caregivers can become part of the solution by understanding the institutional clinical

pathways for pain management and helping to address the pain management plans prospectively with patients. The recovery room staff can buy in to carrying out clear protocols, and the entire staff can commit to the early and thorough treatment of postoperative pain.

One of the hallmarks of current multimodal approaches to postoperative pain management is to reduce reliance on opioids for the sole approach to postoperative pain treatment. By avoiding somnolence from excessive opioids, as well as avoiding opioid-induced exacerbation of PONV, recovery can be considerably expedited and patient well-being improved. When opioids are used, a three-phase approach can be taken, including a rapidly acting IV opioid for quick titration of pain relief, followed by a moderate duration IV opioid for more severe pain and initiation of oral opioid-containing tablets for transition to home medication regimens as IV medication plasma levels wane. It is important to titrate relief of acute pain aggressively, not only for patient satisfaction, but to maintain the recovery momentum for each patient. Another important component of a multimodal pain management regimen is incision site infiltration with local anesthetics, either before incision to reduce neuronal wind-up at the spinal cord level or after incision, which, albeit to a lesser extent, can still result in a reduction of postoperative opioid requirements. Additional multimodal components are the use of a regional anesthetic with residual analgesic duration, where applicable, or the use of nonsteroidal antiinflammatory drugs (NSAIDs), once again to reduce opioid requirements.

Similarly, a commonly adhered-to local institutional approach to the treatment of PONV can lead to the same benefits of smooth cooperation of all members of the perioperative team to minimize the impact of this problem for patients. PONV is still a common cause of postoperative distress, consuming additional postoperative resources of time, staff, and supplies, persisting as a risk for at least 24 h after surgery and even, uncommonly, resulting in unanticipated postoperative inpatient admission for ambulatory patients. Unlike chemotherapy-induced emesis, which has a well delineated cause, PONV is multifactorial, including as risk factors age, sex, obesity, time of the menstrual cycle, history of previous PONV or motion sickness, increased gastric volume, pain, opioids, inhaled anesthetics, and increased incidence with particular procedures, such as laparoscopy, strabismus, and the like (7). Prevention strategies have included the use of propofol for its antiemetic properties, as previously mentioned; inclusion of local anesthetic infiltration, regional anesthesia, NSAIDs, or a combination of these to reduce total opioid use; prophylactic antiemetic medications; and nonpharmacologic approaches to antiemesis prevention.

Domino et al. (8) carried out a metaanalysis of the available literature comparing droperidol (D) to metoclopramide (M) or ondansetron (O), as well as M to O. In 1584 patients in 22 studies, D was found superior to M for postoperative emesis as well as nausea. No difference was found if propofol was used. The central nervous system side effects of D were only greater than M if D was used in doses ≥ 2.5 mg. In the 19 studies that included 2502 patients comparing O with M, O was superior to M for postoperative emesis, but they were equal in the treatment of nausea with equal occurrence of side effects. In 3863 patients in 23 studies in which O was compared with D, D was equal to O for both nausea and emesis in adults. Only for pediatric emesis was O superior to D. O was associated with headache more frequently than D, and only large doses of D, ≥ 1 to 2.5 mg, were associated with any greater incidence of central nervous system side effects. Pueyo et al. (9) also found D equal in efficacy to O for female abdominal surgery patients but found the combination of D + O to be superior to either drug alone for dramatically increasing the percentage of patients who had no PONV whatsoever. Tang et al. (10) found that patients who received 4 mg O at the end of surgery, compared with the beginning of surgery, had decreased PONV, increased time to any required rescue medications, earlier food intake, higher patient satisfaction, and best cost-effectiveness ratio. Tramer et al. (11) reported for O that 8 mg was required for effective prophylaxis compared with only 1 mg to treat established PONV. This may be true because prophylactic doses would be given some time earlier and peak plasma levels would have waned to perhaps those produced by a much lower dose given at the time that treatment would be needed. Scuderi et al. (12) hypothesized that prompt treatment of emesis in progress in the subgroup of patients who experienced emesis would result in patient satisfaction equivalent to the costly prophylaxis of all patients. In that study, half of the patients received placebo and half received 4 mg O for prophylaxis. If emesis occurred, half of those patients experiencing emesis promptly received 1 mg O and half placebo. No difference was found in discharge times, rate of unanticipated admission, return to normal activities, satisfaction with PONV control, or overall satisfaction when comparing the prophylaxis groups with the prompt-treatment groups. A subgroup of women who underwent emetogenic surgical procedures had slightly less satisfaction with treatment versus prophylaxis, however.

Gan et al. (13) used computer-controlled propofol infusions after surgery for patients who experienced PONV after general anesthesia and adjusted the infusion rates until there was a 50% decrease in the patients' symptoms. The researchers found that a median plasma concentration of propofol to achieve this 50% decrease in PONV symptoms was 343 ng/mL, a

level that was achievable with a 10-mg bolus of propofol followed by a $10 \mu\text{g}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ infusion. These levels are much lower than propofol plasma levels needed for anesthesia, which are an order of magnitude higher. A subsequent study by Gan et al. (14) compared patient-controlled IV propofol boluses of 20 or 40 mg with placebo for treatment of PONV after general anesthesia. The incidence of nausea and vomiting was less in the two propofol groups (e.g., 12% and 23% vs 56% for placebo, for vomiting), the need for rescue medications was less (17% and 23% vs 70% for placebo), and the finding of no PONV and no rescue needed was much greater with the 20 and 40 mg propofol bolus groups than with placebo (79% and 73% compared with 22%). PACU discharge times were shorter in the treated groups. Although the 24-h complete response for vomiting was not different, the 24-h satisfaction rate was better for the propofol groups. Because two patients were oversedated with the 40-mg propofol boluses in this study, the authors recommend 20 mg propofol as the appropriate bolus dose for patient-controlled antiemesis.

Song et al. (15) have looked at whether an IV bolus of 0.5 mg/kg propofol at skin closure after laparoscopic cholecystectomy in women would reduce the incidence of emesis and the need for rescue medications compared with placebo after sevoflurane or desflurane maintenance anesthesia. Only the sevoflurane plus propofol bolus at closure group had a significant (50%) reduction in emesis rate and need for rescue medications. The desflurane + propofol bolus group was no different from the two placebo groups.

Interest has grown in the application of nonpharmacologic means to blunt the occurrence of PONV. Lee and Done (16) conducted a metaanalysis of the available literature that compared P6 acupuncture point stimulation by various means to prevent PONV. Compared with placebo patients, who experienced a mean occurrence of early nausea of 35% (range 9%–63% among the studies included in the metaanalysis), P6 stimulation reduced the risk of early nausea to 0.40, with a number needed to treat (NNT) of 5. This means that five patients had to be treated to eliminate early nausea in one patient, which is comparable with other prophylactic methods. For early emesis, again with a mean placebo incidence of 35% (range 6%–53%), P6 stimulation reduced the risk to 0.47, also with an NNT of 5. There was no consistent difference in late PONV compared with placebo. In addition, some of the available studies compared P6 stimulation with various antiemetics. Although antiemetics reduced the occurrence of early emesis to 14%, the P6 stimulation patients had a relative risk of only 0.89, which is close to 1. In other words, P6 stimulation had a similar outcome and perhaps even a little lower incidence of early emesis compared with antiemetic prophylaxis. The NNT for the comparison with antiemetics was 63.

In other words, it took many patients to show any difference between antiemetics and P6 stimulation, suggesting similar effectiveness.

These current findings relevant to the treatment of PONV to increase patient satisfaction and smooth recovery room utilization indicate that for low-risk patients, prompt treatment of PONV when it occurs can be as effective and cost-effective as prophylactic medication; thus, antiemetic prophylaxis for these patients is not indicated. For medium-risk patients, lower-cost antiemetic prophylaxis, such as small-dose D, may be as effective as O or other 5-hydroxytryptamine receptor 3 (5-HT₃) blocking drugs. For high-risk patients, the literature would suggest a variety of approaches: use of a P6 acupressure band; use of propofol as a component of the anesthetic; local anesthetic infiltration of incision sites, regional anesthesia, or NSAIDs to reduce opioid use; avoidance of inhaled anesthetics; and choice and most appropriate timing of antiemetic prophylaxis, i.e., D, 5-HT₃ inhibitor, propofol at the end of the case, with or without dexamethasone (which has been shown to have antiemetic properties and to enhance the total antiemetic effect of other classes of antiemetic drugs). Also of importance is hydration of patients (17), because many patients develop PONV when they stand to dress or go to the restroom, and mild degrees of orthostasis may contribute to medullary hypotension and initiation of emetic reflex arcs. Finally, oral fluids should be given only when the patient wishes to drink, because premature forcing of oral intake can also bring on or exacerbate PONV (18).

Thus, some of the ways that full-service medical centers have adapted to the developments spurred by the widespread dissemination of lessons learned from ambulatory PACU patient flow patterns have been to change PACU systems and procedures, to change PACU staffing patterns (registered nurses supplemented by licensed practical or vocational nurse, nursing aids, etc., for non-license-requiring activities), to reexamine and eliminate mandatory times required at the different recovery levels, and to modify PACU discharge requirements. Current home discharge criteria include patients being awake and alert, having stable vital signs, being able to ambulate consistent with their preoperative condition and surgical effects, having no active bleeding, having pain and nausea adequately controlled, having oral intake, being required to void before discharge only if the surgery or anesthetic technique indicated, and having a responsible adult available. As mentioned above, postoperative oral intake should be optional and can take place if not surgically contraindicated and if the patient is awake and alert, is not nauseated, and desires oral intake.

Pavlin et al. (19) looked at whether voiding was necessary before discharge after ambulatory surgery

by using an ultrasound device to determine bladder volume, catheterizing when indicated, and following outcomes. They found that low-risk groups could be safely discharged, but care should be taken with high-risk groups, such as those having spinal or epidural anesthesia, pelvic (gynecologic or urologic) or hernia surgery, or those with a history of urinary retention. Pediatric caudal analgesia, however, has not been associated with delayed return to micturition (20).

New trends in PACU management include the early recovery of cardiac surgical patients who formerly would have required cardiopulmonary bypass, but who now are being operated on "off-pump," with early tracheal extubation planned and only step-down unit care anticipated after their PACU stay. In effect, the PACU is being asked to provide 4–6 h or more of ICU-level care for these patients, who may be more unstable cardiovascularly than other PACU patients and may be receiving several hemodynamically active IV infusions, etc. Unlike all of the other issues discussed earlier, these patients increase the total staffing demands, the average time per patient for low-ratio care (1:1 nursing care may be required for some hours), and utilization of PACU supplies. Institutions justify this increased allocation of resources from the PACU with the idea of gaining overall improvement in patient care and decrease of other ICU allocations.

Also becoming prevalent is the increased occurrence of "extended recovery," "short stay," or "23-hour" units associated with PACU activities. The concept is for extended (after anesthesia) recovery so that patients who could benefit from additional observation for parenteral analgesics, reduced activity to prevent hematoma formation (e.g., after flaps or grafts), or for observation for minor surgical or anesthetic sequelae, etc., need not undergo full hospital admission with its attendant costs and bureaucracy. Such areas may be the recovery suite after hours or an adjacent area that also can offer reduced nursing care levels, comfortable surroundings, television, and visiting hours. Patients with medical instability, such as those staying for cardiac observation or airway or pulmonary conditions such as exacerbation of bronchospastic disease, should be transferred to full-service care. Physicians are not usually present but are on call at such facilities.

A third growing development in PACU is the increased use of part of the PACU as an ICU overflow area. Full-service medical centers are becoming more and more "complex procedure" dependent. Nonhospital surgery centers and office-based surgery have spun off more of the healthy patients and straightforward procedures, and home health services are available for out-of-hospital medical management of stable patients. Furthermore, non-operating-room invasive procedures now are also complex and require higher levels of postprocedure care. Thus the needed ratio of

ICU/ward beds is higher than originally planned for many medical centers. It is often problematic to flex ICU beds beyond the building's fixed capacity. There are physical constraints, licensing issues, the availability of additional trained staff, and the general preparedness of the institution to flex on a moment's notice. The logical reason to look to the PACU to meet these needs is that the PACU is an ICU. It has expert nursing skills, high-quality monitors in place, ventilatory and respiratory therapy support, and laboratory support, and it may already be the first stop for many ICU patients.

The requirements to make ICU overflow possible in a PACU include the presence of an excess PACU bed capacity. Extra beds may be available on evenings or nights only, or there may be 24-h bed capacity. There must be extra nursing and support staff available and close coordination between PACU leadership and the bed allocation staff, and admitting physicians must have reasonable expectations and cooperate with the flexible, nonpermanent status of the overflow unit and its personnel. Medical care responsibilities on the physician side may be delegated to a PACU specialist, an interventionalist, the patients' primary physicians, or a hospitalist or consultant. Nursing responsibilities can fall to an extended PACU staff, the medical center nursing team, a float pool, or a combination. State code and licensing requirements need to be adhered to or an exception applied for and obtained.

It is important for the PACU leadership team to plan for ICU overflow versus overrun. The former can be accomplished by defining the suitable location in the PACU, developing a staffing paradigm for the evanescent presence of the ICU overflow patients, and developing cost accounting and supply flow adaptations so that this expense can be costed out appropriately and expenses detailed separately from those of the PACU. Medical center interface issues have to be sorted out, such as whose patients are moved out of the overflow unit first, whether "crashing" patients on the wards go to the overflow unit versus standard ICU beds when they become available, who assumes leadership and makes decisions, and whether the ICU overflow unit is available for training opportunities, e.g., for anesthesiology residents, if the institution is a training location. A well managed ICU overflow capability in the PACU can provide a value-added benefit to the medical center and the physician medical group. It can help to optimize the surgical or interventional procedure throughput by providing extra ICU and observation beds when the ICUs are full, it can help the institution adapt to unpredictability in the Medical Center census, and it can demonstrate leadership and problem-solving ability by the anesthesiology department.

In summary, the PACU is a dynamic location in a medical center or surgery center that has a key role in

optimizing patient satisfaction with the perioperative and periprocedure experience in the center. It has the capacity to contribute significantly to cost-containment initiatives by optimizing the utilization of personnel, space, time, and consumables while providing excellent postoperative care. The ability of the PACU to do these things is intricately interwoven with advances in and choices of anesthesia techniques and drugs that provide minimal adverse anesthetic sequelae, as well as with the ability of the recovery team to reduce variability in patient care paradigms to minimize the occurrence of unanticipated events (21,22). Current prompt multimodal approaches to perioperative pain management, as well as the prevention or prompt control of PONV, are particularly critical for achieving the ideal PACU throughput.

References

1. Ashworth J, Smith I. Comparison of desflurane with isoflurane or propofol in spontaneously breathing ambulatory patients. *Anesth Analg* 1996;82:338-41.
2. Wilkens CJ, Cramp PGW, Staples J, Stevens WC. Comparison of the anesthetic requirement for tolerance of laryngeal mask airway and endotracheal tube. *Anesth Analg* 1992;75:794-7.
3. Song D, van Vlymen J, White PF. Bispectral (BIS) index predicts fast-track eligibility after ambulatory anesthesia [abstract]. *Anesthesiology* 1998;89:A16.
4. Di Benedetto RJ, Graves SA, Gravenstein N, Konicek C. Pulse oximetry monitoring can change routine oxygen supplementation practices in the postanesthesia care unit. *Anesth Analg* 1994;78:365-8.
5. Patterson P. "Fast tracking" of patients through PACU: is it safe? *OR Manager* 1998;14:8-9.
6. Patel R, Hannallah R, Verghese S, et al. Fast tracking in children undergoing short surgical procedures [abstract]. *Anesthesiology* 1998;89:A53.
7. Watcha MF, White PF. Postoperative nausea and vomiting: its etiology, treatment, and prevention. *Anesthesiology* 1992;77:162-8.
8. Domino K, Anderson EA, Polissar NL, Posner KL. Comparative efficacy and safety of ondansetron, droperidol, and metoclopramide for preventing postoperative nausea and vomiting: a meta-analysis. *Anesth Analg* 1999;88:1370-9.
9. Pueyo FJ, Carrascosa F, Lopez L, et al. Combination of ondansetron and droperidol in the prophylaxis of postoperative nausea and vomiting. *Anesth Analg* 1996;83:117-22.
10. Tang J, Wang B, White PF, et al. The effect of timing of ondansetron administration on its efficacy, cost-effectiveness, and cost-benefit as a prophylactic antiemetic in the ambulatory setting. *Anesth Analg* 1998;86:274-82.
11. Tramer MR, Reynolds JM, Moore RA, McQuay HJ. Efficacy, dose-response, and safety of ondansetron in prevention of postoperative nausea and vomiting. *Anesthesiology* 1997;87:1277-89.
12. Scuderi PE, James RL, Harris L, Mims GR III. Antiemetic prophylaxis does not improve outcomes after outpatient surgery when compared to symptomatic treatment. *Anesthesiology* 1999;90:360-71.
13. Gan TJ, Glass PSA, Howell ST. Determination of plasma concentrations of propofol associated with 50% reduction in postoperative nausea. *Anesthesiology* 1997;87:779-84.
14. Gan TJ, El-Molem H, Ray J, Glass PSA. Patient-controlled antiemesis. *Anesthesiology* 1999;90:1564-70.

15. Song D, Whitten CW, White PF, et al. Antiemetic activity of propofol after sevoflurane and desflurane anesthesia for outpatient laparoscopic cholecystectomy. *Anesthesiology* 1998;89: 838–43.
16. Lee A, Done ML. The use of non-pharmacologic techniques to prevent postoperative nausea and vomiting: a meta-analysis. *Anesth Analg* 1999;88:1362–9.
17. Yogendran S, Asokumar B, Cheng DCH, 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.
18. Schreiner MS, Nicolson SC, Martin T, Whitney L. Should children drink before discharge from day surgery? *Anesthesiology* 1992;76:528–33.
19. Pavlin DJ, Pavlin EG, Fitzgibbon DR, et al. Should voiding be required before discharge after ambulatory surgery [abstract]? *Anesthesiology* 1998;89:A1.
20. Fisher QA, McComiskey CM, Hill JL, et al. Postoperative voiding interval and duration of analgesia following peripheral or caudal nerve blocks in children. *Anesth Analg* 1993;76:173–7.
21. Pavlin DJ, Rapp SE, Polissar NL, et al. Factors affecting discharge time in adult outpatients. *Anesth Analg* 1998;87:816–26.
22. Cohen MM, O'Brian-Pallas LL, Copplestone C, et al. Nursing workload associated with adverse events in the postanesthesia care unit. *Anesthesiology* 1999;91:1882–90.