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PACU Bypass after Outpatient Knee Surgery Is Associated with Fewer Unplanned Hospital Admissions but More Phase II Nursing Interventions

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Background: **The authors recently proposed a recovery scoring system for outpatients receiving regional anesthesia (RA) or general anesthesia (GA). This scoring system was designed to allow qualifying patients to be directly routed to the phase II (step-down) recovery unit instead of the traditional postanesthesia care unit (PACU). We report PACU bypass rates using these criteria, and the extent to which PACU bypass was associated with (1) required nursing interventions in the step-down recovery unit, and (2) successful same-day discharge.**

Methods: **Day-of-surgery outcomes were studied for 894 outpatients undergoing outpatient sports medicine surgery on the lower extremity. We determined PACU-bypass rates, nursing interventions in the step-down recovery unit for common symptoms, and unplanned hospital admissions. Using logistic regression, we analyzed step-down nursing interventions based on PACU requirement *versus* PACU bypass, and anesthesia techniques used (GA *vs.* not, peripheral nerve blocks *vs.* not).**

Results: **Eighty-seven percent (778/894) of all patients bypassed PACU. Of PACU-bypass patients, 241/778 (31%) required step-down nursing interventions. Of patients requiring PACU, only 19/116 (16%) required additional interventions in step-down ($P < 0.001$). PACU-bypass patients were almost three times more likely (odds ratio 2.9, $P < 0.001$) to require at least one nursing intervention in the step-down unit, when compared with patients requiring PACU. Fewer unplanned admissions were required by patients who bypassed PACU (odds ratio = 0.3, $P = 0.007$).**

Conclusions: **For outpatient lower extremity surgery, applying our PACU-bypass criteria led to an 87% PACU bypass rate with no reportable adverse events.**

IN ambulatory surgery, recovery scoring systems are used to determine whether patients are transported from the operating room to the postanesthesia care unit (PACU, phase I) or the step-down recovery unit (SDRU, phase II). Ideally, recovery scoring systems should ensure that patients having symptoms are routed to the PACU, while alert symptom-free patients go to the step-down unit.

Generally, the most common symptoms requiring PACU admissions after general anesthesia (GA) are somnolence, pain, and postoperative nausea or vomiting (PONV).[1] Multimodal analgesia, using regional anesthesia (RA) with peripheral nerve blocks, and minimizing the use of systemic opioids tend to minimize pain, PONV, and somnolence. These factors should make patients less likely to require PACU care.

In a previous manuscript we introduced the Regional Anesthesia PACU Bypass Criteria (RAPBC, Appendix).[2] The RAPBC allows patients to bypass the PACU after regional anesthesia techniques, including neuraxial anesthesia. In the current manuscript, we will examine in greater detail the usefulness of the RAPBC for PACU bypass for patients undergoing outpatient knee surgery using GA or regional anesthesia.

The specific aim of this observational study is to demonstrate the usefulness of the RAPBC[2] for identifying which knee surgery patients can move directly to the step-down recovery unit.

Materials and Methods

Our Institutional Review Board for the Health Sciences exempted this study from obtaining additional informed consent for retrospective chart review.

Study Design

The study population is comprised of 894 consecutive outpatients undergoing lower extremity surgery by three sports medicine surgeons over a 3-yr period (July 1996 through June 1999), under the care of one of two anesthesiologists (BAW and MLK). Data were typically gathered within 4 weeks after the day of surgery, and were examined in the course of quality control for our outpatient lower extremity surgery clinical pathway. Patients for whom postoperative hospital admission was preapproved or based on unplanned extension of the planned surgical procedure were excluded from the current analysis.

The steps patients went through on the day of surgery at our institution were described previously.[2] After surgery, patients were transported to either PACU ("phase

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Table 1. Categories of Outpatient Knee Surgery at the University of Pittsburgh Medical Center

	Categories of Surgical Invasiveness		
	"Mild"	"Invasive"	
	(Postoperative Nerve Block, Analgesia Optional)	Femoral Nerve Analgesia Routinely Recommended for Knee Surgery	Femoral and Sciatic Nerve Analgesia Routinely Recommended for Knee Surgery
Examples of cases in each category	Knee arthroscopy with: Debridement Lateral release Meniscal surgery Meniscal repair Removal of superficial hardware Drop-out cast application Evaluation under anesthesia—manipulation	Open arthrotomy Removal of deeply imbedded hardware Knee arthroscopy with: Mosaicplasty ACL reconstruction Proximal patellar realignment Osteotomy of femur	Tibial osteotomy Distal patellar realignment Knee arthroscopy with: ACL and/or other ligament reconstruction (LCL, PCL, MCL) Posterior oblique ligament or posterolateral corner reconstruction Meniscal reconstruction Extensive posterior meniscal repair requiring extracapsular suturing
Anesthesia techniques used	MAC: 24 Femoral nerve block: 2 GA: 84 GA-NB: 14 Spinal: 116 Spinal with femoral ± sciatic: 22 Lumbar–sciatic: 42 Total: 304	GA: 15 GA-NB: 122 Epidural: 49 Spinal: 8 Epidural with femoral: 2 Spinal with femoral ± sciatic: 176 Lumbar–sciatic: 89 Sciatic (for ankle surgery): 18 Total: 479	GA: 4 GA with femoral only: 4 GA with femoral and sciatic: 15 Spinal: 3 Spinal with femoral only: 6 Spinal with femoral and sciatic: 63 Lumbar–sciatic: 21 Total: 111

ACL = anterior cruciate ligament; LCL = lateral collateral ligament; PCL = posterior cruciate ligament; MCL = medial collateral ligament; MAC = monitored anesthesia care; GA = general anesthesia; GA-NB = general anesthesia with nerve block(s); Lumbar–sciatic = lumbar plexus and sciatic nerve blocks.

I recovery," with a traditional 1:2 nurse-to-patient staffing ratio), or readied for immediate transport to "phase 2 recovery," which was the SDRU. We used the RAPBC (Appendix) to determine whether our patients would be transported to the PACU or the SDRU; these two patient units were on separate hospital floors.

Throughout the study period, blood pressure was checked in neuraxial anesthesia patients in the sitting position before operating room exit, and patients were also asked if they had any symptoms consistent with orthostasis. This procedure was repeated and findings confirmed after transport from the operating room to the PACU, but before transport to the SDRU. If either evaluation showed hypotension or orthostatic symptoms, patients were immediately disqualified from consideration for PACU bypass.

Anesthesia Process Inputs

Anesthesia and Analgesia Technique Categories. Table 1 summarizes the specific anesthetic techniques used during the care of these patients, based on planned surgical invasiveness. In our center's clinical practice, patients were allowed to choose the anesthetic plan from the options available (*e.g.*, GA *vs.* spinal), and nerve blocks were routinely recommended for invasive procedures. Regardless of anesthesia technique selected, the two anesthesiologists (BAW and MLK) aimed to render all patients eligible for PACU bypass after completion of surgery.

Nerve Blocks Used: Analgesic versus *Anesthetic Blocks*

Nerve block *analgesia* consisted of a lower-concentration long-acting local anesthetic ("analgesic block," combined with a neuraxial or general anesthetic). Nerve block *anesthesia* consisted of higher concentration local anesthetic designed to also provide surgical anesthesia ("anesthetic block," not requiring an intraoperative neuraxial or general anesthetic).

Categories of Surgical Invasiveness

We used two predefined categories of surgical invasiveness (table 1).[3] "Mild" knee surgery patients were not routinely administered long-acting nerve block analgesia, although short-duration nerve blocks may have been used to provide surgical anesthesia. "Invasive" knee surgery patients were routinely administered femoral or lumbar plexus nerve block analgesia, with or without sciatic nerve block analgesia. These categories were derived based on clinical observations of postoperative pain patterns as influenced by the extent of surgical trauma on the periosteum in and around the knee. For operations on the foot and ankle, the sciatic and saphenous nerves were blocked.

Summary of Anesthesia Technique Categories that Were Compared

Three independent dichotomous anesthesia categories were derived from the myriad possible anesthesia and analgesia techniques. The first anesthesia category was

GA *versus* not ("No GA"). No GA included spinal, epidural, and peripheral nerve block anesthesia. The second anesthesia category was "recommended blocks not used" *versus* "recommended blocks used." For mild surgery, long-duration nerve blocks were not recommended, so mild surgery patients were categorized under recommended blocks used. The most common cause of recommended blocks not used in the invasive surgery patients was patient refusal of recommended nerve blocks.

Sedation Techniques

Regional anesthesia included sedation with midazolam and fentanyl (administered before nerve block procedures or intraoperatively) and a continuous infusion of propofol.

General Anesthesia Techniques

General anesthesia consisted of induction with propofol, maintenance with nitrous oxide and a volatile agent (sevoflurane or desflurane). The airway was secured using a laryngeal mask airway or an endotracheal tube.

Recovery Outcome Data

Recovery data consisted of the following parameters: PACU bypass *versus* PACU admission, postoperative symptoms requiring postoperative nursing intervention(s) in the SDRU, discharge times, and unplanned hospital admissions (for pain, PONV, somnolence, or a combination of these).

Postanesthesia Care Unit Bypass

We determined whether patients actually bypassed PACU (as opposed to tracking RAPBC-eligibility followed by a PACU admission), and categorized this as a dichotomous (yes–no) variable. According to the guidelines established by the clinicians (BAW and MLK) throughout the observational study period, patients with RAPBC scores of 7 or less were deemed ineligible for PACU bypass.

Same-Day Recovery Unit Nursing Interventions Required for Patient Symptoms

We determined the number of nursing interventions in the SDRU that were documented for the following patient symptoms: pain, PONV, shivering, pruritis, and urinary retention. The number of total SDRU nursing interventions per patient was recorded as a continuous variable. Whether any SDRU nursing interventions were required was also categorized as a dichotomous (yes–no) variable.

Discharge Times

Discharge times were calculated from the following formula: time discharged from hospital minus time of exit from the operating room. Discharge time was not calculated for patients who were unexpectedly admitted to the hospital.

Unplanned Admission

Unplanned admission was considered a dichotomous variable. Patients who were unexpectedly admitted for nausea or vomiting were most commonly treated before admission based on an attending anesthesiologists' protocol (BAW, MLK) with rescue medications including perphenazine, droperidol, dexamethasone, and ondansetron. Patients who were unexpectedly admitted for pain were most commonly treated before admission based on the same anesthesiologists' protocol with parenteral rescue medicines including opioids and nonsteroidal anti-inflammatory agents such as ketorolac.

Statistical Analyses

Demographics, and Postanesthesia Care Unit Bypass Disposition. Demographic data (table 2) were divided into the "mild" and "invasive" surgical categories, and PACU bypass disposition data (table 3) were divided into "PACU" and "PACU bypass" categories. Data regarding the dichotomous variables "SDRU nursing interventions required" and "unplanned admission" was analyzed using the chi-square test. The continuous variable "discharge time" was analyzed using the independent-samples *t* test.

Logistic Regression Models for Step-down Recovery Unit Nursing Interventions

We used binomial logistic regression to determine which covariates (age, gender, GA *vs.* not, recommended blocks used *vs.* not, surgical invasiveness categories, and RAPBC eligibility) were associated with SDRU nursing interventions. Dummy variables were constructed for the anesthesia–analgesia technique categories and the surgical invasiveness categories. The variables "aged under 21," "male," "GA not used," and "recommended blocks not used" were used as the referent category. Sequential regression models were run using SDRU nursing interventions as the dependent variable. Univariate regressions were run first, using one covariate at a time. Next, covariates that were significant predictors at a $P < 0.2$ level were considered together in the multivariate regression model.

Linear Regression Models for Predicting Discharge Times

For each category of surgical invasiveness (*i.e.*, mild and invasive), we created linear regression models to determine associations between the following dichotomous covariates and discharge times: (1) GA (*versus* not), (2) PACU bypass (*versus* not), (3) SDRU nursing interventions required, (4) aged over 20 (*versus* not), and (5) gender. For the invasive surgery linear regression model, we also included the covariate recommended

Table 2. Demographic Data

Variable	Total	"Mild" Surgery*	"Invasive" Surgery*
N	894	304	590
Age (mean ± SEM)	30.7 ± 0.9	36.7 ± 1.8	27.6 ± 1.0
ASA/PS I	638	188	450
ASA/PS II	236	104	132
ASA/PS > II	20	12	8
Male	540	185 (61%)	355 (60%)
Female	354	119 (39%)	235 (40%)
GA (*vs.* no GA)	—	97 (32%)	159 (27%)
Received indicated blocks (*vs.* not receiving indicated blocks)*	—	Blocks not indicated	590 (83%)
PACU bypass	—	269 (89%)	509 (86%)
SDRU interventions required	—	56 (18%)	199 (34%)
Discharge times [min (95% CI)]†	—	217 (207–227)	235 (227–242)
Unplanned admissions‡	24	1 (0.3%)	23 (3.9%)

* Refer to table 1 for definitions of "mild" *versus* "invasive" knee surgery. According to the authors designing the criteria, "mild" surgery did not require nerve blocks, whereas "invasive" surgery required femoral and/or sciatic nerve blocks based on anticipated surgical trespass. † $P = 0.004$ by independent samples *t* test. ‡ $P < 0.001$ by chi-square test.

ASA/PS = American Society of Anesthesiologists' Physical Status classification; GA = general anesthesia; block = having received femoral/lumbar plexus and/or sciatic block(s) relevant to surgical site and anticipated surgical invasiveness; PACU = postanesthesia care unit (phase I recovery); SDRU = step-down recovery unit (phase II recovery).

blocks used (*versus* not). For all tests, $P < 0.05$ was considered significant.

Results

Using RAPBC, 756/869 (87%) patients bypassed PACU, with no significant differences between mild and invasive surgical categories (table 2).

Demographics

Included in the demographics data (table 2) is the distribution of patients among surgical invasiveness categories (categories 1 to 2). Patients undergoing mild surgery (a prototype of which was diagnostic knee arthroscopy) were significantly older than those undergoing invasive knee surgery (a prototype of which is arthroscopic reconstruction of the anterior cruciate ligament). There were no significant differences in the use of GA for mild *versus* invasive surgery.

Table 3. Postanesthesia Care Unit Bypass Disposition and Associations with Nursing Interventions and Unplanned Admissions

	PACU (n = 116)	PACU Bypass (n = 778)	*P* Value
Patients in whom SDRU nursing interventions were required	18 (16%)	237 (31%)	< 0.001* OR = 2.4 (1.4–4.0)
SDRU interventions required per symptomatic patient	1.7 (1.1–2.3)	1.9 (1.7–2.0)	NS
Discharge times [mean (95% CI)]	258 (242–274)	224 (218–230)	< 0.001*
Unplanned admission (%)	9 (8.0%)	15 (1.9%)	< 0.001* OR = 0.23 (0.10–0.55)

* By independent samples *t* test.

PACU = postanesthesia care unit (phase I recovery); SDRU = step-down recovery unit (phase II recovery); OR = odds ratio (95% confidence interval of odds ratio).

Comparisons of Postanesthesia Care Unit versus *Postanesthesia Care Unit Bypass*

PACU Bypass, and SDRU Nursing Interventions. When compared with patients taken to PACU, patients bypassing PACU were more likely to require at least one nursing intervention in the SDRU for common symptoms (pain, PONV, table 3).

Seventy-three of 97 (75%) patients having mild surgery with GA bypassed PACU; these patients were discharged significantly sooner (184 ± 19 min after OR exit) than were spinal anesthesia patients who bypassed PACU (225 ± 12 min, $P < 0.001$). There were no significant differences in discharge times and SDRU nursing interventions in GA patients requiring PACU *versus* spinal patients bypassing PACU.

Discharge Times

Postanesthesia care unit bypass patients were discharged home significantly sooner after operating room exit, when compared with patients requiring PACU (table 3).

Unplanned Admissions

Eight percent of patients taken to the PACU required unplanned hospital admission after transfer to the SDRU. This was significantly greater than in PACU-bypass patients, who required unplanned admission just below 2% of the time ($P < 0.001$, table 3). Results of logistic regression to determine predictors of SDRU nursing interventions

Table 4. Results of Logistic Regressions Testing Predictors of Nursing Interventions in the Step-down Recovery Unit

Logistic Regression	Any SDRU Nursing Interventions for Symptoms	*P* Value
Univariate		
Age ≤ 20 yr	1.0	
Age > 20 yr	0.5 (0.4–0.7)	**<0.001**
Male	1.0	
Female	1.8 (1.3–2.4)	**<0.001**
No GA	1.0	
GA	1.3 (1.0–1.8)	**0.072**
Did not receive indicated blocks	1.0	
Received blocks according to surgical invasiveness	0.6 (0.4–1.0)	**0.05**
PACU required	1.0	
PACU bypass	2.4 (1.4–4.0)	**0.001**
Multivariate		
Age ≤ 20 yr	1.0	
Age > 20 yr	0.6 (0.4–0.8)	0.001
Male	1.0	
Female	1.6 (1.2–2.2)	0.002
No GA	1.0	
GA	1.5 (1.1–2.1)	0.017
Did not receive indicated blocks	1.0	
Received blocks according to surgical invasiveness	0.6 (0.4–1.0)	0.034
PACU required	1.0	
PACU bypass	2.9 (1.6–4.9)	0.001

Items with **boldfaced *P* values** in the univariate logistic regression results were included in the multivariate logistic regression equation.

SDRU = step-down recovery unit (phase II recovery); GA = general anesthesia; PACU = postanesthesia care unit (phase I recovery).

Predictors of Step-down Recovery Unit Nursing Interventions

Multivariate regression (table 4) showed that when compared with the referent category, women (odds ratio = 1.6; $P = 0.002$), patients aged 20 years and younger (odds ratio = 1.67; $P = 0.001$), patients receiving GA (odds ratio = 1.3; $P = 0.017$), and PACU bypass patients (odds ratio = 2.9; $P < 0.001$) were more likely to require at least one nursing intervention for symptoms in the SDRU. Mild surgery patients and invasive surgery patients having received recommended nerve blocks (based on surgical invasiveness) were 60% as likely to have required an SDRU nursing intervention ($P = 0.034$), when compared with the referent category.

Results of Linear Regression to Determine Predictors of Discharge Times

Predictors of Discharge Times after Mild Surgery. Multivariate linear regression modeling showed that GA and PACU bypass were associated with 18% and 14% reductions in discharge times, respectively (table 5, left column). Women had a 12% greater time to discharge than men. Patients requiring any nursing interventions in the SDRU had an associated 45-min increase in discharge time. Age was not associated with discharge times.

Predictors of Discharge Times after Invasive Surgery. After invasive surgery, PACU bypass was associated with an 18% reduction in discharge time (table 5). Requiring at least one nursing intervention was associated with a 47 min increase in discharge time. GA, age, gender, and use of blocks were not associated with discharge time differences.

Discussion

When compared with patients requiring PACU, PACU-bypass patients had more postoperative nursing interventions in the SDRU, faster discharge times, and fewer unplanned hospital admissions. When PACU bypass occurred, women, patients 20 years of age or younger, and those who had GA were most likely to require one or more nursing intervention in the SDRU. Anesthesiologists cannot control patient age or gender, but our preliminary finding that patients who have had GA (with almost exclusively volatile agents during the observation period) require more nursing interventions suggests that judicious selection of anesthetic techniques has the po-

Table 5. Results of Linear Regressions Testing Associations between Discharge Times and Covariates

Covariate	"Mild" Surgery			"Invasive" Surgery		
	Beta	*P* Value	Minutes (95% CI)	Beta	*P* Value	Minutes (95% CI)
Constant	—	—	244 (212–276)	—	—	257 (237–277)
GAVA used	−0.183	0.002	−34 −(13–55)	—	—	—
PACU bypassed	−0.142	0.015	−38 −(8–69)	−0.177	< 0.001	−47 −(26–68)
SDRU nursing interventions required	0.180	< 0.001	45 (21–70)	0.323	< 0.001	27 (20–34)
Age > 20 yr	—	—	—	—	—	—
Female	0.118	0.030	21 (1–41)	—	—	—
Recommended nerve blocks used	—	—	—	—	—	—

GAVA = general anesthesia with volatile agent; PACU = postanesthesia care unit (phase I recovery); SDRU = step-down recovery unit (phase II recovery).

tential to reduce nursing requirements. A randomized clinical trial is required to provide definitive proof.

Practical Comparisons of RAPBC to Existing Recovery Scoring Systems

Slower resolution of neuraxial anesthesia (*versus* volatile or total intravenous GA) introduces a semantic difference between RAPBC (PACU bypass) and another recovery scoring system, the White-Song Fast-Track Criteria (fast-tracking).[4] PACU bypass is more appropriately defined as a mechanism which leads to the rapid reuniting of patients and families, aiming to reduce the overall postoperative nursing labor intensity and monitoring. Fast-tracking may then be considered a rapid-discharge mechanism which includes PACU bypass. Staffing strategies for recovery room nurses should distinguish the differences in PACU bypass and fast-tracking in that PACU bypass should reduce PACU (phase I) nursing requirements and staffing costs, while not necessarily decreasing step-down (phase II) nursing requirements. Fast-tracking, however, should reduce both PACU and step-down nursing requirements. Patient preferences should also be considered: to be symptom-free is more important to patients that to be rapidly discharged home.[4]

The major practical difference between RAPBC and the White-Song Fast-Track Criteria is that the RAPBC does not have any stipulations about zero subscores disqualifying bypass eligibility. The White-Song criteria allow PACU bypass for patients with (1) transient vomiting or retching, or (2) moderate to severe pain controlled with intravenous analgesics,[4] but these criteria do not address shivering or pruritis. We feel these common clinical scenarios may potentially increase the workload for SDRU nursing staff. The RAPBC immediately excludes patients with hypotension or orthostasis before leaving the operating room, or in the PACU immediately after transfer from the OR; RAPBC also conveniently excludes patients from PACU bypass eligibility with any nausea, vomiting, pain, shivering, or pruritis without the burden of a scoring process.

Interdependence of RAPBC on Surgical Invasiveness Categories and Corresponding Anesthesia Plans

It is in the patient's best interest to carefully consider the planned invasiveness of the surgical procedure before considering anesthesia techniques designed to bypass PACU. Properly identifying surgical invasiveness and prescribing an appropriate plan corresponding with anticipated surgical pain is essential for implementing RAPBC, or any PACU-bypass criteria, in one's own institution. Similarly, antiemetic prophylaxis for patients at risk is a logical part of a PACU-bypass plan, and is logically administered by the anesthesia care team when there is a 1:1 to 1.5:1 staffing ratio of anesthesia health care provider to patient, *versus* a 1:2 or more nurse-to-patient ratios in the PACU and the SDRU. That said, because this observational study is not a prospective randomized clinical trial addressing different anesthesia techniques and same-day clinical outcomes, further prospective study is required to determine which available anesthesia techniques and antiemetic strategies, for invasive outpatient surgery, can produce similar or more favorable results with respect to PACU bypass success, minimized nursing interventions in the SDRU, and avoided hospital admissions.

Characteristics of Patients Requiring Unplanned Hospital Admissions

Twelve of the 24 patients who were admitted to the hospital had GA, the other 12 did not. Six of the 24 admitted patients did not receive the recommended nerve blocks based on planned surgical invasiveness. Ten patients were admitted for pain (three patients who did not receive the recommended nerve blocks), PONV (six patients who did receive the recommended nerve blocks, three of these had GA), or both pain and PONV (one patient), another 10 for somnolence (evenly divided between GA and not). Three patients were admitted after deviation from the clinical pathway standing orders for management of pain or PONV (surgeon called by nurses to admit patient before anesthesiologists' orders were followed). One patient (an ASA/PS 3) was admitted because of a coexisting medical disease.

Emergency Room Visits and Hospital Readmissions

Understanding that a deferred complication is not equal to an avoided complication, we queried hospital databases to determine the number of patients readmitted (to the emergency department [ED] or the orthopedics floor) within 1 week after same-day discharge. Over 4 yr, 30 were readmitted; 24 of these were due to bleeding, infection, swelling, or wound-related complications. Of the remaining six patients, one was readmitted for PONV, another for spinal headache. The remaining four were readmitted for surgical site pain, two of which were discharged from the emergency room. One patient had a diagnostic knee arthroscopy with meniscal repair under spinal anesthesia. The other patient had ACL reconstruction under epidural with femoral nerve block. Both of these patients presented 6 days after surgery. Of the two patients requiring hospital readmission, one patient had ACL reconstruction under lumbar plexus and sciatic nerve blocks, presented the day after surgery (presumably after the effects of the nerve block analgesia dissipated), and was discharged the day after readmission. The other patient readmitted for pain underwent meniscal reconstruction under spinal anesthesia with femoral and sciatic blocks. This patient was admitted 2 days after surgery, and was discharged the day after readmission. We were unable to determine

whether other patients were readmitted or evaluated at other hospitals during the first week after surgery.

Limitations of Nurse Staffing Conclusions

In this manuscript, we did not report the frequency of patients in PACU requiring nursing interventions, nor the number of interventions per symptomatic patient. The rationale for this is that the typical 1:2 staffing ratio and the proximity of PACU nurse to PACU patient favors a high probability of appropriate presumptive interventions (*e.g.*, providing multiple doses of intravenous opioid analgesia based on a grimacing patient not yet responding to verbal stimuli). In a SDRU, the same patient would need to regain the capacity to push a nurse call button before receiving the first dose of the same analgesic. Thus, we find it improbable that PACU nursing interventions can be compared with step-down nursing interventions, nor can they likely be summed into a total with a consistent unit of labor intensity.

A second limitation is that the transport of patients with supplemental oxygen during PACU bypass to step-down requires interventions by step-down nurses to (1) change the oxygen supply source from transport tank to a wall-mounted source, and (2) wean off oxygen using pulse oximetry criteria. Our center's guideline was to remove oxygen in PACU-bypassed patients (who required oxygen during transport) 30 min after arrival to step-down, and to check a room-air pulse oximeter saturation 3 min later. Patients saturating 95% or above on room air had oxygen discontinued. Our database did not record which PACU-bypass patients required oxygen during transport, and the number of nursing interventions by step-down nurses while weaning off supplemental oxygen. Having been weaned from supplemental oxygen is a common criterion for PACU discharge, but we did not record which PACU patients required supplemental oxygen after PACU discharge.

Given the totality of the nursing intervention data presented, and the limitations described, we suggest the following staffing precaution. Based on existing PACU staffing literature,[5] even if a successful PACU bypass initiative were implemented in a large surgical suite operating at or above 80% capacity, leading to PACU bypass of 90% of patients or more, PACU nursing staff reductions of two full-time equivalents (FTE) would likely need to be offset by a step-down unit (also at 80% capacity or above) recovery nursing staff increase of at least one FTE.

Conclusions

We believe that patients and their families would, in general, prefer to bypass the traditional recovery room whenever appropriate. Applying our RAPBC criteria allowed 87% of same-day knee surgery outpatients to bypass PACU without adverse consequences. Required nurse staffing patterns with PACU bypass may change, introducing the potential for cost savings. Additional research is needed to confirm our findings.

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Appendix

Regional Anesthesia PACU Bypass Criteria and Scoring System

Parameters	
Movement	Scores:
Purposeful movement of (at least) one lower and one upper extremity	2
Purposeful movement of at least one upper extremity (but neither lower extremity)	1
No purposeful movement	0
	Movement Score:
Blood pressure (after neuraxial anesthesia, measured both before OR exit and in recovery unit before proceeding with PACU bypass)	Scores:
Within 20% of baseline, without orthostatic changes	2
Between 20–40% of baseline, without orthostatic changes	1
Less than 40% of baseline, and/or orthostatic changes	0
	BP Score:
Level of Consciousness	Scores:
Awake, follows commands	2
Arousable, follows commands	1
Obtunded or persistently somnolent	0
	LOC Score:
Respiratory Effort	Scores:
Able to cough involuntarily or on command	2
Only able to cough involuntarily, but not on command	1
Dyspnea or apnea	0
	Respiratory Score:
Pulse Oximetry Score	Scores:
$Spo_2 \geq 95\%$ on room air	2
$Spo_2 \geq 95\%$ with face mask or nasal cannula	1
$Spo_2 < 95\%$	0
	Pulse Oximetry Score
	Total Score:

The minimum score to qualify for PACU bypass is 8.

Patients considered for PACU bypass should not require interventions for pain, PONV, shivering, or pruritis.