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Patient, surgical and clinical factors associated with longer stay in the Post Anaesthesia Care Unit

Abstract

Aim: To explore patient, surgical and clinical factors associated with readiness-for-discharge and total length of stay in the Post Anaesthesia Care Unit (PACU).

Background: Longer stay in the PACU decreases the flow of patients and is associated with increased risk of adverse events. The time to readiness-for-discharge reflects clinical parameters associated with patient flow in the PACU independent of system delays.

Methods: This retrospective cohort study included a randomly selected sample of 244 post-surgical patients admitted to a large private, Australian health service.

Results: The median and average times to readiness-for-discharge were 48 minutes and 56 minutes respectively with a range from 9 to 175 minutes. The total length of stay in the PACU had median and average times of 66 minutes and 73 minutes respectively. Five independent factors associated with longer time to readiness-for-discharge identified in multivariable modelling were: age, surgery duration, post-operative nausea and vomiting, administration of opioids and medical consultation. Additional factors that were determined from univariate analyses to be associated with longer time to readiness-for-discharge from the PACU were hypothermia, moderate or severe pain, major surgery and neurological surgery.

Conclusion: This study found that modifiable and non-modifiable factors are associated with time to readiness-for-discharge. The findings provide a focus for the clinical care of patients in the PACU to optimise the time to readiness-for-discharge and increase patient flow. Understanding factors associated with longer stay helps efficient management of staffing levels and patient flow within the PACU, to improve the quality of care provided.

Keywords: efficiency, length of stay, patient flow, post anaesthesia care unit, post anaesthesia nursing

Introduction

In Australia, between 2016 and 2020, there was a progressive increase (1.7 to 2.8%) in the number of patients on the public surgery waiting list for more than 365 days[1] indicating the inability of public hospitals to keep up with demand.[2] This demand has increased due to the SARS COVID-19 pandemic. The number of admissions for surgery decreased by 9.2 per cent in the 2019–2020 period due to deferral of elective surgery lists, reduced hospital bed capacity and limited availability of consumable resources associated with the pandemic response.[3] This has placed even greater pressure on the health care system to implement measures to reduce waiting lists for elective surgery going forward.

Patients are admitted to a Post Anaesthesia Care Unit (PACU) for continuous observation of their physiological condition – predominantly airway, breathing and cardiovascular status.[4–6] During the immediate post-anaesthesia phase, patients are vulnerable and potentially unstable with an increased risk of adverse events,[4,6,7] and remain in the PACU until they are safe to be transferred to a ward or second-stage recovery unit based on specific discharge criteria.[4,6] Readiness-for-discharge is an aspect of discharge planning that manages and assesses the patient's ability for safe discharge from the PACU. The total length of stay is defined as the time from admission to the PACU until transfer to a receiving unit, it incorporates any clinical time along with system factors associated with transfer.

The length of stay in the PACU can vary according to patient characteristics, surgical factors, occurrence of any complicated clinical events in the recovery period and nonclinical factors.[8–11] Prolonged stay in the PACU decreases patient flow in and out of the PACU,[11,12] increases the risk of adverse events following transfer from the PACU[7,13–15] and was associated with longer hospital admission[13] adding to pressure on the health care system.

Efficient management of an operating suite requires smooth and efficient patient flow across surgical services. Any increase in patient flow increases the number of surgeries that can be performed and, in turn, decreases waiting lists.[16] Key issues in operating theatre under-utilisation that could be attributed to PACU length of stay (LOS) include long turnaround times between surgeries and sessions running over time.[16] Capacity to receive patients into the PACU and bed availability impact patient flow within the PACU.[11] In the public sector alone, a ten per cent increase in current productivity would save $A 208 per hour in salary costs for perioperative surgeons, anaesthetists, nurses and technicians.[16]

The reported average LOS in the PACU varies across countries and organisations due to differences in patient cohorts, protocols and clinical processes.[3,8,14,17,18] Overall LOS is influenced by a combination of time to readiness-for-discharge (clinical factors) and non-clinical or systemic factors such as bed management and transport processes.[10,11,19] Mitigation of both clinical and non-clinical delays that can prolong LOS are integral to efficient management of a PACU. Achieving readiness-for-discharge requires the management and assessment of patients to ensure they have met the PACU discharge criteria including physiological stability and control of pain and nausea,[5,6,20] as well as prompt identification and response to complications or instability.[21] An understanding of the factors that impact the time required to achieve readiness-for-discharge can be used to identify potential improvements in clinical care and PACU flow. To our knowledge, the distinction between time to readiness-for-discharge and LOS overall has not been reported in previous studies.

Aims

The aim of this study was to explore the patient, surgical and clinical factors associated with readiness-for-discharge and total length of stay in the PACU.

Methods

Study design

The design was exploratory and descriptive using retrospective audit of clinical documentation. Human Research Ethics Committee approval was obtained from both the study site (EH2017-173) and university (DUHREC 2017-122).

Setting

This study was undertaken in two acute care sites of the largest private, not-for-profit health care organisation in Victoria, Australia. During the 2016 to 2017 financial year, the organisation performed 112 847 surgical procedures across its nine acute sites. The two sites were selected based on the number of cases and variety of surgical specialities which included cardiac, thoracic, neurological, vascular, general, orthopaedics, gynaecological, urological, plastics, otolaryngological and oral and maxillofacial procedures. These sites performed elective and non-trauma emergency procedures and shared the same protocols for the management of patients in PACU. During the data collection period, Site 1 had 28 operating rooms with 40 PACU bays and Site 2 had 10 operating rooms with 15 PACU bays.

Sample

The target population was all adult and paediatric patients admitted to the PACU following surgery with administration of anaesthesia between 1 January 2016 and 31 December 2016. Excluded were patients who had local or sedation anaesthesia. The overall number of procedures performed in 2016 was 38 407. Three months were randomly selected to account for any seasonal factors and to create an overall representation of surgical procedures at the health service. From a total of 9660 post-surgical patients, a sample was selected using a random number generator. Random selection of patients was stratified according to the relative number of procedures at each site (the ratio of cases from Site 1 and Site 2 was 3:1).

Data collection

A digital case report form (CRF) was used to abstract de-identified data from medical records. Data were collected by one investigator, an experienced operating room nurse familiar with PACU clinical processes and documentation.

Measurements

The main outcome variables were:

1. time to readiness-for-discharge from PACU, defined according to the discharge criteria outlined in Table 1 and measured from time of admission to the PACU until documented recording of readiness-for-discharge
2. total LOS in the PACU, defined as the length of time between recorded time of admission to the PACU and time of transfer to a receiving unit.

Both were measured in minutes. The time that readiness-for-discharge was determined was either clearly recorded in the clinical notes or calculated by the data collector using documented clinical observation data. Documentation of clinical data in PACU occurs every 5–15 minutes.

Data extracted from medical records and used to explore associations with readiness-for-discharge and LOS are summarised and defined in Table 2. These data included: study site, patient characteristics (age, sex, American Society of Anaesthesiologist (ASA) physical status classification system score), surgical characteristics (surgical classification, speciality, anaesthesia technique, duration of surgery) and clinical factors (pain, nausea and vomiting, hypothermia), complex recovery indicators (analgesic administration, request for medical consultation) and time points (admission to and discharge from the PACU).

Table 1: Site-specific readiness-for-discharge criteria

Criterion			
Total discharge score must be >5	Pain	Nil/minimal	2
		Moderate	1
		Severe	0
	Bleeding	Nil/minimal	2
		Moderate	1
		Severe	0
	Post-operative nausea and vomiting	Nil/minimal	2
		Controlled IM/IV	1
		Severe	0
		Total:	
Physiological parameters must not meet MET activation criteria			
Discharge protocol following medication administration: • 15 minutes post administration of IV opioid • 30 minutes post administration of IM opioid or IV vasopressor • 60 minutes post administration of Naloxone.			

IM= Intramuscular; IV= Intravenous; MET= Medical Emergency Team

Statistical methods

Statistical analyses were performed using IBM-SPSS version 26 and Stata/SE version 16 software. Exploratory data analysis included descriptive statistics of frequencies, mean, median, interquartile range (IQR) and range to summarise patient, surgical, clinical and system factors related to length of stay in the PACU. Variables were either continuous (e.g. length of stay in the PACU and age) or categorical (e.g. sex and ASA score). Normality testing was performed using the Shapiro–Wilk test. The relationships between variables were explored using Pearson's chi-squared tests and, for non-normal continuous variables, using non-parametric tests such as a Mann–Whitney U test or the Kruskal–Wallis test. Correlations of skewed continuous variables were described using Spearman's rho (r_s) analysis.

Negative binomial regression modelling

The outcome variable for regression modelling purposes was the length of time to readiness-for-discharge from the PACU. This variable was measured in minutes and was rounded to the nearest whole number. Due to the right skewed nature of the count data (see Figure 1) and because the conditional variance potentially exceeded the conditional mean, we chose negative binomial regression.

The association of all selected independent variables with the outcome 'readiness-for-discharge from PACU', was examined using backward elimination, multivariable, negative binomial regression modelling. In the first step all independent variables were considered in a multivariable model if found to be significant at a level

Table 2: Definitions for patient, surgical and clinical characteristics in the case report form

Characteristics		Definitions
Patient characteristics	ASA score	American Society of Anaesthesiologists (ASA) physical status classification system score is a pre-anaesthesia co-morbidity assessment. ASA scores range from ASA-1 (normal healthy patient) to ASA-6 (declared brain-dead patient for organ donation). No patients had a score more than ASA-4 (severe systemic disease that is constant threat to life). For the purpose of the analyses, ASA scores were further categorised to healthy/mild systemic disease (ASA-1 and ASA-2) or severe systemic disease (ASA-3 and ASA-4). A patient's ASA is assessed by their anaesthetists prior to surgery.
Surgical characteristics	specialty	Surgical specialties were categorised as ear, nose and throat (ENT), oral and maxillofacial (OMF), plastics, urology, gynaecology, orthopaedic, vascular, general, neurological.
	classification	Surgery was classified as major surgery if general or regional anaesthesia and/or ventilatory support was required, great cavities of the body or orthopaedic intervention involving joints was involved, there was risk of severe bleeding or it was life threatening. Surgery was classified as minor surgery if skin, mucous membrane or superficial tissue was manipulated.
	anaesthetic technique	Anaesthetic technique was categorised as local anaesthetic with sedation, general anaesthetic (GA), spinal anaesthetic, GA with regional block.
	duration of surgery	Duration was measured in minutes as recorded in the surgical nursing notes.
Clinical characteristics	pain	Pain intensity was measured on an 11-point numerical rating scale where 0 represents 'no pain' and 10 'worst pain possible'. For the purpose of the analyses, presence of pain was further categorised as nil/mild (0–3) and moderate/severe (4–10).
	nausea and vomiting	Any post-operative nausea or vomiting (PONV) requiring administration of an anti-emetic medication in PACU.
	hypothermia	Temperature <36^{0}C on arrival to the PACU.
	analgesia	Administration of any analgesia in PACU. This was further categorised to use of opioids in PACU (yes/no).
	medical consultation	Any physiological aberration that required a review by a surgeon or anaesthetist while in PACU.

of $p<0.2$ in univariable, negative binomial regression models. The next step involved removing variables that were determined to be non-significant ($p>0.05$), one at a time, from the multivariable model based on a likelihood ratio test that compared models with and without the independent variable. For the independent variables that remained in the final multivariable, negative binomial regression model, associations were considered statistically significant at a level of significance of 5 per cent. Robust standard errors were used to calculate 95 per cent confidence intervals in the final multivariable model. Five cases were removed from the multivariable modelling because of missing data.

Results

The average time to readiness-for-discharge from the PACU was 56.0 minutes with a range of 9 minutes to 175 minutes. The average total LOS in the PACU for all patients was 73.3 minutes with a minimum of 15 minutes and maximum of 215 minutes. The difference in time between readiness for discharge

and LOS was determined to be a system delay; for most patients (62%, n=151/244) this system delay was more than five minutes. The average system delay was 17.3 minutes, ranging from zero to 130 minutes. The median (IQR) for time to readiness-for-discharge was 48 (IQR 33–70) minutes and for LOS was 66.5 (IQR 46–89) minutes. The median system delay was ten minutes (IQR 5–24, indicating that half of the patients were transferred from PACU within ten minutes of being assessed as ready-for-discharge. Higher frequencies of patients were assessed as ready-for-discharge at 30, 35, 45 and 60 minutes compared to other times (Figure 1). These times corresponded with assessment by the PACU nurse. A dedicated transport nurse assisted with the transfer of patients from the PACU for 59 per cent (n=144/244) of patients. The median system delay for patients with a transport nurse was ten minutes (IQR 5–20), which was significantly less than for those without a transport nurse (median 15, IQR 5–30 minutes; Mann–Whitney U=4985.5, p<0.001).

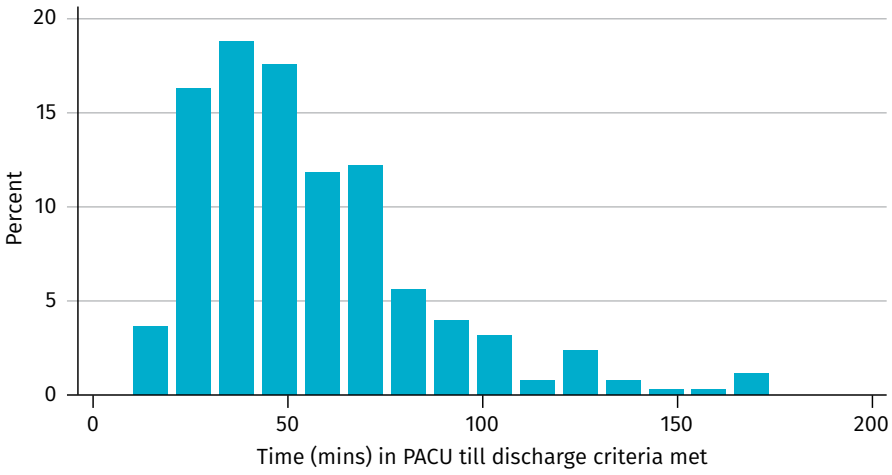

Figure 1: Distribution of time to readiness-for-discharge from the PACU (minutes)

Time to readiness-for-discharge

Patient and surgical characteristics found to be associated with longer time to readiness-for-discharge from the PACU are shown in Table 3. Older age was a significant factor for longer time to readiness-for-discharge (p=0.007). Paediatric patients had the shortest median time of 40 minutes, while the age group of 80 or more years had a median time of 59 minutes. Patients with higher acuity (ASA score of 3 or 4), had longer times to readiness-for-discharge compared to patients with an ASA score of 1 or 2; however, this was not statistically significant at a level of 5 per cent (p=0.056). There was no significant difference in time to readiness-for-discharge from the PACU based on gender (p=0.630) or study site (p=0.220).

Time to readiness-for-discharge was significantly correlated with duration of surgery where longer duration of surgery had a positive correlation with a longer time to readiness-for-discharge (r_s= 0.396). The median duration of surgery was 42 (IQR 21–76) minutes. Significant differences (p ≤0.001) in time to readiness-for-discharge from the PACU were also found according to surgical classification, specialities and anaesthesia technique used. Patients undergoing major surgery had a longer median time to readiness-for-discharge than patients undergoing minor surgery (62 vs 40 minutes). The oral and maxillofacial speciality had the shortest median time to readiness-for-discharge (35 minutes) and the neurological speciality had the longest median time (72 minutes). Patients who had local anaesthesia with sedation had the shortest median time to readiness-for-discharge (25 minutes). The median time to readiness-for-discharge for patients who were administered general anaesthesia alone was 47 minutes compared to 58 minutes for patients who were administered spinal anaesthesia alone. The longest median time to readiness-for-discharge was 69 minutes for patients who had general anaesthesia and regional anaesthesia combined.

Clinical factors found to be associated with longer time to readiness-for-discharge from the PACU are shown in Table 4. Seven percent (n=18) of patients reported mild pain, 28.7 per cent (n=70) moderate pain and 8.6 per cent (n=21) severe pain in the PACU. Patients reporting moderate or severe pain had a median time to readiness-for-discharge of 68 minutes; significantly (p<0.001) longer than patients with nil or mild pain with a median of 40 minutes. Half (50.4%, n=124) of the patients received analgesics in PACU. Analgesics administered were opioids (86.3%, n=107), paracetamol (49%, n=61), nonsteroidal anti-inflammatory drugs (4%, n=5) and other adjuncts such as gabapentin and clonidine (7.2%, n=9). Patients who were administered opioids in the PACU had a significantly longer median time to readiness-for-discharge compared to those who did not (65 vs 35 minutes; p=<0.001). For a patient who experienced post-operative nausea and vomiting (PONV), the median time to readiness-for-discharge was

Table 3: Patient and surgical characteristics with associated time to readiness-for-discharge from the PACU

	All patients N=244 n (%)	Readiness for discharge (minutes) Median [IQR]	p value*
Study site			0.220
site A	172 (70.5)	46 [32–70]	
site B	72 (29.5)	52 [35–74]	
Sex			0.510
female	121 (49.6)	48 [35–70]	
male	123 (50.4)	47 [32–70]	
Age (years)			0.007
<18	16 (6.6)	40 [29–45]	
18–39	68 (27.9)	40 [32–63]	
40–59	74 (30.3)	50 [35–70]	
60–79	68 (27.9)	60 [37–85]	
80+	18 (7.4)	59 [32–60]	
ASA score			0.056
healthy/mild systemic disease (ASA-1 and ASA-2)	185 (75.8)	45 [33–69]	
severe systemic disease (ASA-3 and ASA-4)	59 (24.2)	58 [36–85]	
Surgical classification			<0.001
minor	143 (58.6)	40 [30–55]	
major	101 (41.4)	62 [47–85]	
Surgical specialty			<0.001
OMF	28 (11.5)	35 [30–43]	
plastics	13 (5.3)	42 [30–60]	
ENT	16 (6.6)	45 [40–60]	
urology	36 (14.8)	46 [31–63]	
gynaecological	16 (6.6)	50 [44–69]	
orthopaedic	90 (36.9)	55 [35–72]	
vascular	9 (3.7)	60 [30–90]	
general	30 (12.3)	68 [35–87]	
neurological	6 (2.5)	72 [60–83]	
Anaesthesia technique			<0.001
local anaesthesia with sedation	7 (2.9)	25 [17–31]	
GA	204 (83.6)	47 [33–70]	
spinal anaesthesia	12 (4.9)	58 [46–71]	
GA with regional block	21(8.6)	69 [44–83]	

*Mann–Whitney U test for two groups and Kruskal–Wallis test for more than two groups; ASA = American Society of Anaesthesiologists; OMF = oral and maxillofacial; ENT = ear, nose and throat GA = general anaesthesia

significantly longer (p=0.001) than for those who did not experience PONV (79 vs 46 minutes). Similarly, when a patient was hypothermic on arrival into PACU, the median time to readiness-for-discharge was significantly longer compared to a patient who was normothermic (55 vs 44 minutes; p=0.007) (see Table 4).

Complex recovery from anaesthesia was indicated by a documented medical consultation in the PACU and occurred for 22.5 per cent (n=55) of patients. The median time to readiness-for-discharge from the PACU was significantly longer for those patients who had a medical consultation in the PACU compared to those who did not (81 vs 45 minutes; p<0.001). The most common reasons for PACU nurses to request a medical consultation were related to pain management (30.9%, n=17/55) and blood pressure irregularities (25.5%, n=14/55), while 14.5% (n=8/55) of patients required medical consultation for respiratory distress. Some patients (21.8%, n=12/55) required medical consultation for other clinical reasons including neurological changes (n=3), blood loss (n=2), severe PONV (n=2), low urine output (n=2), urine retention (n=1), chest pain (n=1) and incomplete reversal of neuromuscular blockade (n=1). The remaining four patients (7.3%) required medical consultations for non-clinical reasons such as completion of documentation.

Identifying factors using negative binomial regression

Factors that remained independently significant for longer stay in the PACU, without including system delays, were identified by negative binomial regression of time to readiness-for-discharge from the PACU (Tables 5a and 5b). The nine variables found to be significantly associated with time to readiness-for-discharge were included in the analysis. Age, medical consultation in the PACU, PONV, administration of opioids, duration of surgery, surgical classification, pain and hypothermia remained significant predictors at a level of p<0.2 in the multivariable regression model (Table 5a). ASA score (p=0.992) was not an independent predictor and was not included in the final model. The final multivariable regression model and corresponding exponentiated model are detailed in Table 5b. The final analysis suggested potentially five independent predictors of time to readiness-for-discharge. Compared to the reference group of patients aged 18–39 years, those aged 60–79 years appear to have a 16.5 per cent increase in the time to readiness for discharge. If a medical consultation was required in PACU, time to readiness-for-discharge increased by 41 per cent. If a patient had PONV or if opioids were administered, time

Table 4: Clinical factors and complex recovery indicators with associated time to readiness-for-discharge from the PACU

	All patients N=244 n (%)	Readiness for discharge (minutes) Median [IQR]	p Value**
Pain in PACU* (n=242)			<0.001
nil–mild	152 (62.8)	40 [30–58]	
moderate–severe	90 (36.2)	68 [50–85]	
Analgesia in PACU			<0.001
Yes	124 (50.8)	60 [45–80]	
No	120 (49.2)	35 [30–50]	
Opioids administered			<0.001
Yes	106 (43.4)	65 [50–85]	
No	138 (56.6)	35 [30–50]	
PONV in PACU			<0.001
Yes	20 (8.2)	79 [55–104]	
No	224 (91.8)	46 [33–67]	
Hypothermia on arrival to PACU (n=241)			0.007
Yes	106 (44.0)	55 [40–76]	
No	135 (56.0)	44 [32–65]	
Medical consultation in PACU			<0.001
Yes	55 (22.5)	81 [47–100]	
No	189 (77.5)	45 [32–60]	

*Maximum pain score recorded in PACU: 0–3 = nil–mild; 4–10 = moderate–severe
**Kruskal–Wallis test

Table 5a: Negative binomial regression models for time to readiness-for-discharge from the PACU

Readiness for discharge (minutes)	Univariate (N=244)			Multivariable model (N=239)		
Variable	Coeff	95% CI	p-value	Coeff	95% CI	p-value
Age (years)						
<18 years	-0.27	-0.54, -0.01	0.043	-0.17	-0.39, 0.04	0.113
18–39 years (ref)	0			0		
40–59 years	0.13	-0.03, 0.29	0.112	0.08	-0.05, 0.22	0.214
60–79 years	0.24	0.08, 0.40	0.003	0.12	-0.03, 0.26	0.111
80+ years	0.08	-0.17, 0.33	0.546	0.08	-0.15, 0.30	0.496
Medical consultation in PACU	0			0		
Yes	0.47	0.33, 0.60	<0.001	0.32	0.19, 0.44	<0.001
PONV in PACU	0			0		
Yes	0.40	0.18, 0.62	<0.001	0.18	-0.01, 0.36	0.061
Opioids administered in PACU	0			0		
Yes	0.46	0.35, 0.57	<0.001	0.19	0.04, 0.35	0.015
Duration of surgery (minutes)	0.004	0.002, 0.005	<0.001	0.001	0.000, 0.003	0.011
Surgical classification						
Minor (ref)	0			0		
Major	0.37	0.26, 0.49	<0.001	0.1	-0.02, 0.22	0.087
ASA score						
ASA-1 and ASA-2 (ref)	0			0		
ASA-3 and ASA-4	0.17	0.02, 0.31	0.023	0	-0.13, 0.13	0.992
Pain in PACU (N=242)						
nil/mild (ref)	0			0		
moderate/severe	0.42	0.30, 0.54	<0.001	0.14	-0.02, 0.31	0.084
Hypothermia on arrival to PACU (N=241)	0			0		
Yes	0.12	-0.01, 0.24	0.066	0.08	-0.01, 0.18	0.096
Constant				3.54	3.43, 3.66	<0.001

Coeff = beta coefficient; PACU = Post Anaesthesia Care Unit; PONV = post-operative nausea and/or vomiting; ASA Score = American Society of Anesthesiologists physical status classification system score

to readiness-for-discharge increased by 24 per cent and 36 per cent respectively (when adjusted for other factors in the model). For every one minute increase in duration of surgery, the time to readiness-for-discharge increased by 0.2 per cent (see Table 5b).

Discussion

The findings from this study have distinguished factors associated with time to readiness-for-discharge from the PACU from total length of stay in the PACU that typically includes system delays, thus reflecting more clearly the clinical parameters associated with patient flow.

The median time to readiness-for-discharge was 48 minutes and median total LOS in the PACU was 66 minutes. The average total LOS in the PACU for all patients was 73.3 (SD 36.6) minutes, with a range of 15 to 215 minutes. This compares favourably with previously reported average total LOS between 78 and 120 minutes.[8,14,22–24] There is variability in what is considered a prolonged LOS in the PACU.[8,9,22,23,25] The findings of the current study are more representative of patient flow within a large hospital PACU as adult and paediatric patients were included as well as both major and minor surgeries. Most previous studies have reported one patient group or surgical procedure.

The median system delay was ten minutes (IQR 5–25) and 33 per cent of patients had a system delay of greater than 20 minutes. The focus on time to readiness-for-discharge from the PACU, rather than the overall LOS, allowed the factors associated with clinical readiness to be explored. This is an important distinction because system delays can be unique to particular organisational resources and processes that may need local solutions.[8,14,17,18] For example, we found that use of a transport nurse significantly reduced system delays by 33 per cent from a median of 15 to ten minutes.

The association between age and LOS in the PACU is not a consistent finding in previous studies. In a qualitative study, nurses felt that the duration of stay in PACU was related to patients' physiological score and comorbidities and the increased vigilance required[26] rather than age alone. Patients with higher ASA scores, indicating higher

Table 5b: Final multivariable model and exponentiated model for time to readiness-for-discharge from the PACU

Readiness for discharge (minutes)	Final multivariable model (N=239)			Exponentiated model (N=239)		
Variable	Coeff	95% CI*	p-value	Exp(b)	95% CI*	p-value
Age (years)						
<18 years	-0.172	-0.36, 0.02	0.076	0.842	0.70, 1.02	0.076
18–39 years (ref)	0			1		
40–59 years	0.116	-0.02, 0.25	0.099	1.124	0.98, 1.29	0.098
60–79 years	0.153	0.02, 0.29	0.028	1.165	1.02, 1.33	0.028
80+ years	0.102	-0.09, 0.30	0.309	1.108	0.91, 1.35	0.309
Medical consultation in PACU	0			1		
Yes	0.34	0.19, 0.49	<0.001	1.407	1.21, 1.63	<0.001
PONV in PACU	0			1		
Yes	0.22	0.04, 0.40	0.019	1.245	1.04, 1.49	0.019
Opioids administered in PACU	0			1		
Yes	0.31	0.20, 0.42	<0.001	1.361	1.22, 1.52	<0.001
Duration of surgery (minutes)	0.002	0.001, 0.003	0.001	1.002	1.001, 1.003	0.001
Constant	3.58	3.47, 3.69	<0.001			

Coeff = beta coefficient; Exp(b) = exponentiated beta coefficient; PACU = Post Anaesthesia Care Unit; PONV = post-operative nausea and/or vomiting.

*Robust standard errors used to determine 95% CI (confidence interval)

relative risk, are known to have longer stays in the PACU.[8,9] Previous studies have demonstrated that longer duration of surgery has higher odds ($p<0.001$) of longer stay in the PACU[8] with a significant correlation between LOS in the PACU and surgical duration ($rs=0.013$; $p=0.010$).[9] Longer time to readiness-for-discharge was also significantly associated with complicated events in the PACU where medical consultation was required, including clinical deterioration, respiratory distress, alterations in blood pressure, dysrhythmias, altered conscious state and blood loss. These clinical and complicated events require interventions and evaluation of the care provided, such as airway support, analgesia, active warming or antiemetics.[6] A complex recovery or adverse events in PACU have been shown to be associated with increased LOS in the PACU and in hospital[13,27] and increased risk of clinical deterioration on the ward.[7,14,15]

Post-operative pain management and control of PONV that includes assessing, monitoring and providing medication are key roles of the PACU nurse.[5] In a study of patients undergoing hernia repair or cystoscopy in the USA, pain, PONV and delay in voiding were noted as being the top three reasons for a longer stay in the PACU.[28] Ganter et al.[17] found that if a patient was pain free and had no PONV, the stay in the PACU was half that of patients who were vomiting and had severe pain on arrival to the PACU. While the incidence of PONV in the current study was low, the association with longer stay in the PACU for those patients with PONV remains. The findings showed an increase in time to readiness-for-discharge of 24 per cent associated with PONV and 36 per cent with administration of opioids. Although administration of opioids in PACU was an independent predictor of longer time to readiness-for-discharge, the site-specific protocols associated with the time patients need to remain in PACU after the use of opioids are likely to have contributed to the longer stay in PACU. The use of prophylactic anti-emetics and analgesics during surgery is recommended.[29]

Hypothermia increases the risk of adverse events such as surgical site infections, bleeding and cardiac events as well as negatively affecting patients' experience of comfort.[30,31] A Brazilian study showed that oncology patients, undergoing general surgery, had a significantly longer LOS in the PACU if they had a low temperature.[32] In our univariate analyses moderate to severe pain and hypothermia were significantly associated with increased time to readiness-for-discharge from the PACU. In the final regression model however, hypothermia was not an independent predictor of longer time to readiness-for-discharge. Further research is needed to fully understand the relationships between factors associated with hypothermia and processes of care that may contribute to hypothermia in patients arriving in the PACU. Nevertheless, the findings highlight the clinical importance of prevention and treatment of hypothermia in the operating suite for the optimal care of the patient.

A clearer understanding of non-modifiable and modifiable characteristics associated with time to readiness-for-discharge from PACU can inform planning and scheduling of operating lists and anticipation of patient flow. In addition, this understanding can focus the clinical care of patients in PACU on pre-operative assessment, intra-operative care and the early recognition and management of PONV, pain and clinical deterioration.

Strengths and limitations

The study had limitations relating to the single case study design and use of retrospective medical record data. A single case study design does not allow for external validity and lacks generalisability. However, this study has provided a rich account of factors that impact on patient flow through the PACU at a large private health service provider where almost 40 000 surgical procedures are conducted per year. The use of retrospective medical record data is known to contribute to selection and recall bias. This study used a rigorous random selection process and excluded cases where more than ten per cent of variables were missing data. The factors that were associated with system delays were difficult to report due to lack of documentation and the retrospective nature of the study. It was noted that the receiving unit may be an important factor in longer stay in the PACU but this is an area for future research. The strengths of this study included the full real-world sample of cases in the throughput of the two sites, such as both adults and paediatric as well as elective and emergency cases.

Conclusions

The findings of this exploratory study have identified modifiable and non-modifiable patient, surgical and clinical factors associated with a longer stay in the PACU, in particular, time to readiness-for-discharge. Older age, higher acuity, longer duration and major surgery, neurosurgical specialty, general anaesthesia with regional block, PONV, moderate to severe pain and administration of opioids, hypothermia on arrival to PACU and need for medical consultation in PACU were all associated with an increase in time to readiness-for-discharge. Age, duration of surgery, PONV, administration of

opioids in PACU and need for medical consultation remained independent predictors of time to readiness-for-discharge in multivariable analyses.

Implications for perioperative practice

This study provides a focus for the clinical care of patients in the PACU. The review of scheduling to account for older patient age and longer duration of surgery may assist to predict the patient flow in and out of the PACU. Prevention, early recognition and prompt treatment of PONV, clinical deterioration and pain are vital in perioperative clinical care and reduce time in the PACU. Prophylactic measures such as the use of antiemetics and multimodal analgesia to minimise PONV and post-operative pain may reduce the incidence and, in turn, reduce the time to readiness-for-discharge. Recognition and response to clinical deterioration and requirements for medical consultation are also independent factors that require the PACU nurse to be vigilant and prompt in assessment and actions to reduce the length of stay. Understanding the factors associated with longer stay facilitates nursing management of staffing levels and patient flow within the PACU, to improve the quality of care provided.

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