The Use of Determinants of Length of Stay in the Post-anesthesia Care Unit (PACU) at the Philippine General Hospital among Postoperative Patients who Underwent Elective Surgeries to Create a Predictive Model for PACU Length of Stay

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ABSTRACT

Background. The aims of this study were to determine the average length of stay in the Post-anesthesia Care Unit (PACU LOS) in the Philippine General Hospital (PGH) and to create a model that will predict the PACU LOS based on the factors that significantly affect the LOS. Determination and prediction of PACU LOS is essential in resource utilization, and in cost containment and reduction. Addressing the modifiable variables that affect the PACU LOS may lead to an improvement in the LOS of patients in the PACU and, consequently, to better recovery room staffing and a reduced cost for the patients and the hospital.

Methods. A prospective chart review of 400 postoperative patients admitted in the PGH PACU was done. Summary statistics were presented. Using the set of variables found to be significant, a regression model was formulated to estimate the PACU LOS.

Results. The mean PACU LOS was 4.59 hours. There were significant differences in the mean PACU LOS based on the occurrence of complications. There were also significant differences in the median PACU LOS based on the type and duration of surgery, anesthetic technique, and duration of anesthesia. The multiple linear regression model that best predicted PACU LOS included ASA-PS classification, type of surgery, duration of surgery, anesthetic technique, and occurrence of intraoperative or postoperative complications.

Conclusions. The mean PACU LOS of the Philippine Genera Hospital is higher than that of published data. The factors included in the model that best predicts PACU LOS may be studied to improve the PACU LOS.

Key Words: Anesthesia recovery, length of stay, regression analysis, Post-anesthesia Care Unit, PACU

INTRODUCTION

The post-anesthesia care unit (PACU) is an area which facilitates centralization of care by anesthesiologists and specially trained nurses who are skilled in interpreting and responding to the events occurring during recovery from the immediate effects of anesthesia and surgery.[1] Patients who received anesthesia stay in this area until they are deemed fit for discharge to a specialized care unit or to a general ward.

Continuous evaluation and specialized care of postsurgical patients in the PACU contribute to increasing health care expenses. According to the present Practice Guidelines for Post-anesthetic Care, a mandatory minimum stay is not necessary and that the length of stay (LOS) should be determined on a case-by-case basis.[2] Defining

the clinically relevant targets and addressing the modifiable factors that affect the length of stay of a patient in the PACU may increase the efficiency of the healthcare system and decrease costs for both the patient and the hospital.

The definition of prolonged PACU LOS is different in several studies. In a study by Lau et al., the PACU LOS is prolonged if it is more than two hours.[3] On the other hand, Cohen et al. defined prolong PACU LOS as three hours or more.[4]

Few studies have quantified the average LOS of a patient in the PACU. In 1998, Waddle et al. performed an observational study and found that the mean actual length of stay was 95±43 minutes.[5] Dexter et al. in 2005, using an event simulation software, showed that durations were 1.6±0.7 hours for simple cases and 2.6±1.2 hours for difficult cases.[6] A prospective study by Brown et al. in 2008 showed that length of PACU stay was 133.1 ± 91.4 minutes.[7] In a study by Hofman, the length of stay was 190.4 minutes based on 62 observations.[8]

Studies reveal several factors that affect the LOS. In the same study by Waddle et al., the predictors of appropriate PACU LOS were the anesthetic time, anesthetic technique, and amount of intraoperative fluids.[5] Chan et al. identified higher body mass index; abdominal, spine and superficial surgeries; use of general anesthesia; moderate to severe pain score; and use of nurse controlled analgesia as factors that delay discharge from PACU.[9] Imasogie and Chung in 2002 classified the risk factors for prolonged PACU stay after ambulatory surgery into preoperative, intraoperative, and postoperative. The preoperative risk factors included the type of surgery, pre-existing congestive heart failure, and increasing age. Intraoperative risk factors were the duration of surgery, the type of anesthetic, and the occurrence of cardiovascular events. Postoperative risk factors included postoperative nausea and vomiting (PONV), excessive pain, drowsiness, dizziness, and cardiovascular events in the PACU.[10] A study by Kim et al. in 2000 mentioned that intraoperative hypothermia and postoperative complications such as pain, nausea, and vomiting delayed time to discharge.[11]

A study by Gabriel et al. created a predictive model for extended PACU LOS in outpatient surgeries using factors that are already known preoperatively. The final model included the following factors that predict a prolonged PACU LOS: morbid obesity, hypertension, surgical specialty, primary anesthesia type, and scheduled case duration.[12] Elsharydah et al. also created a preoperative predictive model for prolonged PACU LOS after outpatient surgery. General anesthesia, obstructive sleep apnea (OSA), surgical specialty, and scheduled case duration were identified as significant predictors for prolonged PACU stay. The results of this study differ from the first in that OSA, not morbid obesity, is a predictive factor. This was attributed to differences in OSA diagnosis and screening patterns. In addition, local and regional variations in outpatient surgery practice may also have influenced the results of the two models.[13]

A shorter stay in the PACU means reduced cost for the patient. For hospital managers, identification of the determinants of cost is essential in cost containment and reduction. A study by Dexter and Tinker in 1995 showed that post-anesthetic care unit costs are not substantially affected by the decrease in the LOS alone but by the changes in the peak levels of patients in the PACU.[14] Reducing the length of stay decreases the total PACU patient care hours. This, together with optimization of operating room admission rates, contributes to decreasing the peak number of patients in the PACU which leads to a reduction in staffing levels. As personnel cost is a major determinant of PACU expenditure, a 25% reduction in peak levels of patients will decrease staffing levels and will significantly affect costs.[10] In the study of Gabriel et al. (2017), the use of a predictive model to identify patients who are at an increased risk for prolonged PACU LOS could improve resource allocation and case sequencing.[12] In the Philippine General Hospital, equipment use accounts for majority of the cost of PACU stay. This may include the use of multiparameter monitor, forced air warmer, and syringe pumps. Additional charges are made after the first three hours of PACU stay.

Currently, there is no system in predicting the length of stay of a patient in the PACU. The aim of this study was to determine the average LOS in the PACU of the Philippine General Hospital of patients scheduled for elective surgery under anesthesia. Factors that significantly affected PACU LOS were identified and used to create a model that will predict the PACU LOS.

METHODS

Subjects

For this study, a minimum sample size of 252 was required to achieve an effect size of 0.5 and a precision efficacy of 0.9 for a regression model with 11 predictors. The sample size was determined using the Precision Efficacy Analysis for Regression (PEAR) method.[15] All postoperative patients admitted in the PACU at the third floor of the Philippine General Hospital who were qualified based on the inclusion and exclusion criteria were included in the study until a sample size of 400 was reached. Data collection ran for a period of three weeks in March of 2015 to reach the required sample size.

Inclusion Criteria

The inclusion criteria included: a patient of any age and sex, must be admitted in a ward or room, and must be scheduled to undergo an elective surgery under anesthesia at the third-floor operating room complex.

Exclusion Criteria

Patients classified as ASA-PS classification 6, not yet admitted in a ward or room, who will undergo surgery or procedures requiring anesthesia outside the third floor

operating room complex, who will undergo emergency surgery, whose anesthesia converted from one technique to another, who will not be admitted in the third floor PACU, who will be admitted in a critical area after the surgery, or who will develop complications necessitating admission to a critical care area were excluded from this study.

Study Design

This was a prospective observational study.

Data Collection

The primary investigator accomplished the Data Collection Form for the 400 eligible postoperative patients upon their admission in the PACU. The details of this form were based on the anesthesia record of the patient. The date and time the patient is admitted in and discharged from the PACU was based on the official time in the PACU. The following data were collected: date and time of admission in the PACU, case number, ward, bed or room number, ASA physical status classification[16], age, sex, type of surgery and anesthesia, time of start and end of surgery and anesthesia, blood loss in milliliters, fluid balance (difference of fluid input and fluid output) in milliliters, details of intraoperative and/or postoperative complications, and date and time of discharge from PACU.

If an intraoperative or postoperative complication occurred, a brief description of the event and management done was written on the form. The date and time of discharge was defined as the date and time the patient was assessed to have a score of equal to or more than 9 based on the Modified Aldrete Scoring System.[17] This is a commonly used system for patient assessment to standardize discharge from PACU. In addition, for patients who received neuraxial anesthesia, a score of 1 based on the Bromage scale was required prior to discharge. This scale is a standard tool to asses motor block.[18]

The LOS was computed as the duration from the time the patient was admitted to the PACU until the time he or she was discharged by the PACU resident. The time of discharge did not mean the time the patient actually left the PACU.

Data Analysis

The pertinent data were encoded and maintained in a spreadsheet using Microsoft Excel; statistical analyses were undertaken using Stata for Windows Version 12.0. Frequency distributions of qualitative data and summary statistics of quantitative data were determined. Data were analyzed on the significant effect on PACU LOS using the following procedure:

(1) In order to determine relationship or association of independent variables with PACU LOS, univariate analyses were carried out using both parametric and nonparametric tests. Post hoc analysis by pairwise comparisons of the different categories of significant variables were also carried out.

(2) Independent variables with significant association with PACU LOS were selected for the regression analysis; some variables which were not significant were still considered since relevant literature identified them as important variables to describe PACU LOS.

(3) Simple linear regression analyses were undertaken to check linearity of the relationship of PACU LOS and each of the independent variables; scatterplots of PACU LOS and quantitative variables and box plots of PACU LOS and qualitative variables were presented to check linearity or normality and presence of outliers.

(4) Multiple linear regression using backward elimination method for model selection was undertaken to identify predictors of PACU LOS. Variable selection was done by initially considering a full model. A predictor with the highest p-value was omitted from the model in order to come up with a reduced regression model; this step was carried out repeatedly until all the predictors in the model were significant. The linear regression was built based on relevant and significant variables.

(5) Residual analysis was undertaken to assess the adequacy of the model and to verify that the assumptions of linear regression were satisfied. The potential effect of multicollinearity was assessed and outliers were detected.

(6) A p-value ≤ 0.05 was considered to be significant.

RESULTS

Table 1 shows the frequency distribution of the qualitative variables considered in the study, the summary statistics of PACU LOS across categories of the qualitative variables, and the results of univariate analyses of qualitative variables associated with PACU LOS. The t-test revealed that, except for sex, there was a significant difference in the mean PACU LOS within the different categories of occurrence of intraoperative complication/s and occurrence of post-operative complication/s. The Kruskal-Wallis test revealed that there was a significant difference in the mean rank of the PACU LOS within the different categories of ASA-PS classification, type of surgery, and anesthetic technique.

Table 2 presents the results of univariate analyses of quantitative variables associated with PACU LOS. The Pearson's Product Moment Correlation revealed that, except for fluid balance, there was a significant association between PACU LOS and age, duration of surgery, duration of anesthesia, and blood loss.

The box plots of PACU LOS and the qualitative variables showed that there were some possible outliers in the distribution of the PACU LOS according to ASA-PS classification, sex, type of surgery, anesthetic technique, occurrence of intraoperative complication/s, and occurrence of postoperative complication/s. The scatterplots of PACU LOS and the quantitative variables also showed that there were possible outliers in the distribution of the PACU LOS according to age, duration of surgery, duration of anesthesia,

Table 1. Univariate Analyses of Qualitative Variables Associated with PACU LOS (N=400)

Variable	n (%)	Mean (SD)	Median	p-value (0.05 level of significance)
ASA-PS Classification				**0.0333**
ASA-PS 1	169 (42.25)	4.25 (1.91)	4.08	
ASA-PS 2	199 (49.75)	4.74 (2.54)	4.22	
ASA-PS 3 and 4	32 (8.00)	5.44 (3.08)	4.58	
Sex				0.8056
Male	164 (41.00)	4.55 (2.56)	4.15	
Female	236 (59.00)	4.61 (2.23)	4.23	
Type of Surgery				**0.0001**
General Surgery 1 (Head and neck surgery)	47 (11.75)	4.15 (1.89)	4.07	
General Surgery 2 (Colorectal surgery)	27 (6.75)	4.59 (1.55)	4.25	
General Surgery 3 (Hepatobiliary surgery)	47 (11.75)	4.64 (1.78)	4.32	
NSS (Neurosurgery)	17 (4.25)	7.61 (5.86)	5.63	
Urology	39 (9.75)	4.10 (1.34)	3.95	
Plastic and Burn	21 (5.25)	3.21 (1.37)	2.90	
Pediatric	13 (3.25)	5.82 (4.91)	4.42	
ORL (Otorhinolaryngology) and Dental	62 (15.50)	4.09 (1.64)	3.84	
Orthopedic	54 (13.50)	4.63 (1.98)	4.19	
Obstetric and Gynecologic	73 (18.25)	4.98 (1.97)	4.67	
Anesthetic Technique				**0.0004**
Inhalational/ TIVA/ MAC/ IV Sedation	16 (4.00)	3.27 (0.91)	3.19	
Inhalational+Neuromuscular blockade reversal	100 (25.00)	4.54 (2.71)	4.15	
Inhalational-Neuromuscular blockade reversal	123 (30.75)	4.41 (2.31)	3.93	
GA+CLEA/ GA+PNB/ GA+Caudal/ GA+CTEA/ GA+Spinal	47 (11.75)	5.40 (3.06)	4.75	
SAB/ CLEA/ SAB-CLEA/ PNB	114 (28.50)	4.68 (1.74)	4.39	
Occurrence of Intraoperative Complication/s				**0.0059**
Yes	20 (5.00)	6.01 (2.28)	5.68	
No	380 (95.00)	4.52 (2.35)	4.14	
Occurrence of Postoperative Complication/s				**<0.0001**
Yes	74 (18.50)	7.29 (3.37)	6.92	
No	326 (81.50)	3.98 (1.51)	3.92	

ASA-PS: American Society of Anesthesiologists Physical Classification System; TIVA: total intravenous anesthesia; MAC: monitored anesthesia care; IV: intravenous; GA: general anesthesia; CLEA: continuous lumbar epidural anesthesia; PNB: peripheral nerve block; CTEA: continuous thoracic epidural anesthesia; SAB: subarachnoid block.

Table 2. Univariate Analyses of Quantitative Variables Associated with PACU LOS (N=400)

Variable	Mean (SD)	Median	Range of Values	p-value (0.05 level of significance)
Length of Stay in PACU (hours)	4.59 (2.36)	4.19	1.22 to 22.83	—
Age	42.62 (20.03)	44	0.08 to 84	**0.0159**
Duration of Surgery	2.56 (1.69)	2.17	0.17 to 10.08	**0.0002**
Duration of Anesthesia	3.32 (2.48)	2.86	0.08 to 35.25	**<0.0001**
Blood Loss (% Blood Volume)	8.67 (18.60)	3.54	0 to 300	**0.0003**
Fluid Balance (mL)	203.43 (779.88)	132	-2262.00 to 5861.67	0.2950

blood loss, and fluid balance. Outliers may be attributed to individual differences in the responses to the effects of surgery, anesthesia, and complications. While some samples with outliers were removed, the remaining sample size was still larger than the required sample size.

As one of the preliminary steps in regression model building, simple linear regression analyses were undertaken. In order to come up with a full model, linear terms for the variables ASA-PS classification, sex, type of surgery, anesthetic technique, occurrence of intraoperative complication/s, occurrence of postoperative complication/s, age, duration of surgery, duration of anesthesia, and blood loss, a quadratic term for fluid balance, and no interaction terms were considered.

Multiple linear regression using backward elimination method for model selection was employed to identify a parsimonious combination of relevant variables in predicting PACU LOS. Assumptions of linearity, normally distributed errors, and uncorrelated errors were checked and fulfilled. Table 3 presents the regression model matrix which contains the beta weights, standard errors, and significance values for all models. Only the duration of surgery, occurrence of intraoperative complication/s, and occurrence of postoperative complication/s were identified as significant predictors for the PACU LOS. However, the R2 value markedly decreased from 45.32% (full model) to 39.90% (reduced model containing three predictors) which suggests that the reduced model may not sufficiently estimate the mean PACU LOS. Thus, another model was considered, the one with the highest adjusted R2 or coefficient of determination, which indicated the percentage of variability in PACU LOS that can be explained by the regression model, and at the same time with the lowest Root Mean Square Error (Root MSE), which measured the differences between predicted values of the model and observed values.

Table 3. Multiple Linear Regression Model Matrix Comparing the Full and Reduced Models

Variable	Level or Category	Full Model (All Predictors)	Reduced Model (Age, Duration of Anesthesia, Blood Loss, Fluid Balance and Sex omitted) (Reduced)
		Beta (SE)	Beta (SE)
ASA Classification	1 (Reference)	0	0
	2	0.102 (0.168)	0.135 (0.151)
	3 and 4	0.486 (0.372)	0.479 (0.364)
Age	—	0.00134 (0.00417)	—
Sex	Male (Reference)	0	0
	Female	0.0995 (0.155)	—
Type of Surgery	GS 1 (Reference)	0	0
	GS 2	0.407 (0.344)	0.371 (0.341)
	GS 3	0.602* (0.261)	0.564* (0.250)
	NSS	1.352* (0.657)	1.295* (0.627)
	Urology	0.0744 (0.306)	0.00423 (0.291)
	Plastic and Burn	-0.533 (0.332)	-0.649* (0.314)
	Pediatric	0.990* (0.406)	0.848* (0.343)
	ORL and Dental	0.185 (0.274)	0.117 (0.264)
	Orthopedic	0.316 (0.318)	0.283 (0.300)
	OB and Gyne	0.519 (0.291)	0.490 (0.283)
Duration of Surgery	—	0.0812 (0.189)	0.152*** (0.0414)
Anesthetic Technique	Inhal/TIVA/MAC/IV (Ref.)	0	0
	Inhal+Reversal	0.259 (0.264)	0.277 (0.259)
	Inhal-Reversal	0.607* (0.265)	0.655* (0.258)
	GA comb.	0.484 (0.295)	0.495 (0.293)
	SAB comb./PNB	0.678** (0.248)	0.668** (0.246)
Duration of Anesthesia	—	0.0665 (0.165)	—
Blood Loss	—	-0.00319 (0.00806)	—
Fluid Balance	(Linear term)	-0.00006 (0.00013)	—
	(Quadratic term)	6.6e-08* (3.3e-08)	—
Intraop Complication	Yes (Reference)	0	0
	No	-0.960** (0.341)	-0.933** (0.338)
Postop Complication	Yes (Reference)	0	0
	No	-2.631*** (0.303)	-2.682*** (0.297)
Constant	—	6.052*** (0.582)	6.239*** (0.539)
Number of Observations		395	395
Coefficient of Determination, R²		0.453	0.448
Adjusted R²		0.418	0.422
Root Mean Square Error (RMSE)		1.407	**1.402**

*$p<0.05$, **$p<0.01$, ***$p<0.001$

The reduced model in Table 3 presents the model with the most parsimonious predictor variables which includes ASA-PS classification, type of surgery, duration of surgery, anesthetic technique, occurrence of intraoperative complication/s, and occurrence of postoperative complications. These variables significantly predicted the PACU LOS (F (18,376)=13.74, p<0.0001, adjusted R2=0.4220). This indicated that 42% of the variance in PACU LOS can be explained by this model which, according to Cohen[19], is a large effect. The final multiple linear regression model is presented below:

PACU LOS (time in hours) = 6.24 + 0.14 (ASA-PS 2*) + 0.48 (ASA-PS 3 and 4*) + 0.37 (GS 2*) + 0.56 (GS 3*) + 1.30 (NSS*) + 0.0042 (Uro*) − 0.65 (Plastic and Burn*) + 0.85 (Pedia*) + 0.12 (ORL and Dental*) + 0.28 (Ortho*) + 0.49 (OB and Gyne*) + 0.15 (Duration of surgery in hours) + 0.28 (Inhalational+reversal*) + 0.66 (Inhalational-reversal*) + 0.50 (GA+regional*) + 0.67 (regional*) − 0.93 (absence of intraoperative complication*) − 2.68 (absence of postoperative complication*)
* Give a value of 1 for YES and 0 for NO

DISCUSSION

The overall mean LOS in the PACU in the Philippine General Hospital was 4.59 ± 2.36 hours. The highest values for the mean PACU LOS were seen in patients with ASA-PS 3 and 4 (5.44 ± 3.08 hours), those who underwent a neurosurgical procedure (7.61 ± 5.86 hours), those who received a combined general anesthesia and regional anesthesia (5.40 ± 3.06 hours), and those who had intraoperative or postoperative complication/s (6.01 ± 2.28 and 7.29 ± 3.37 hours, respectively). There was no significant difference in the mean of PACU LOS between males and females. There was also no significant difference in the mean rank of PACU LOS among the different amounts of fluid balance. On the other hand, there were significant differences in the mean PACU LOS between the categories of occurrence of intraoperative complication/s and occurrence of postoperative complication/s. There were also significant differences in the median PACU LOS among the different categories of type of surgery, duration of surgery, anesthetic technique, and duration of anesthesia.

The higher median PACU LOS of patients who underwent colorectal, hepatobiliary, nerurosurgical, orthopedic, obstetric or gynecologic surgeries compared with patients who underwent plastic or burn surgery may be because the former procedures are longer in duration and more extensive than the latter. Longer and more extensive procedures may result in greater blood loss and more complications, requiring a longer period of observation postoperatively. The higher median PACU LOS of regional anesthesia compared to general anesthesia or monitored anesthesia care may be due to the residual sensory or motor

blockade. Procedures lasting more than 4 hours had higher median PACU LOS compared with procedures lasting for less than or equal to 2 hours. This may be due to the complications that arise with prolonged surgery and the need for a longer observation time.

The set of factors affecting the PACU LOS revealed in this study is similar to some of the factors identified in the past studies. Previous studies have identified the following factors to affect the PACU LOS: presence of congestive heart failure (which may be classified as at least ASA-PS 3)[10], type of surgery[10], duration of anesthesia and surgery (which were revealed to be highly correlated in the current study as shown in the correlation matrix)[5,10], anesthetic technique[5,10], occurrence of intraoperative cardiovascular events (hypertension, bradycardia and tachyarrhythmias)[10] and postoperative nausea and vomiting, excessive pain, drowsiness, hypothermia, and occurrence of postoperative cardiac events (which may be classified under postoperative complications).[10,11] The evidence on which anesthetic technique prolongs the PACU LOS is conflicting. One study showed that general anesthesia increased the PACU LOS[5] while another claimed the same with spinal or epidural anesthesia.[10] The increase in the PACU LOS with general anesthesia was attributed to the use of propofol, vecuronium, or fentanyl while the increase in the PACU LOS with regional anesthesia was due to the increased time to voiding.

This study yielded the multiple linear regression model below:

PACU LOS (time in hours) = 6.24 + 0.14 (ASA-PS 2*) + 0.48 (ASA-PS 3 and 4*) + 0.37 (GS 2*) + 0.56 (GS 3*) + 1.30 (NSS*) + 0.0042 (Uro*) − 0.65 (Plastic and Burn*) + 0.85 (Pedia*) + 0.12 (ORL and Dental*) + 0.28 (Ortho*) + 0.49 (OB and Gyne*) + 0.15 (Duration of surgery in hours) + 0.28 (Inhalational+reversal*) + 0.66 (Inhalational-reversal*) + 0.50 (GA+regional*) + 0.67 (regional*) − 0.93 (absence of intraoperative complication*) − 2.68 (absence of postoperative complication*)
* Give a value of 1 for YES and 0 for NO

For example, a patient with the following characteristics: ASA-PS 1, undergoing an orthopedic surgery for 1.67 hours, under regional anesthesia and with no intraoperative or postoperative complications will have a predicted LOS of 3.8 hours based on the following equation: PACU LOS (time in hours) = 6.24 + 0.28 + (0.15*1.67) + 0.67 − 0.93 − 2.68.

Based on the multiple linear regression model, the PACU LOS increases on the average by 0.48 hour (or around 29 minutes) for patients with ASA-PS 3 and 4. The increase in the PACU LOS of patients with higher ASA-PS classification may be due to the increased risk of perioperative complications which in turn predicts a longer stay in the PACU. Patients who underwent neurosurgery stay longer in the PACU by 1.30 hours (or around 78 minutes). The prolonged PACU LOS may be due to intraoperative

and postoperative complications from the procedure; the need for a longer period of observation postoperatively may also contribute. The increase in the PACU LOS with the increasing duration of surgery (0.15 hour or around 9 minutes for every hour) may be due to the complications that arise with prolonged surgery. In relation to this, the need for a longer time to ascertain that the patient is stable enough to be transferred to a general ward probably also explains the increase in the PACU LOS. The use of regional anesthesia increases the PACU LOS on the average by 0.67 hour (or around 40 minutes). The increased PACU LOS with regional anesthesia may be due to the prolonged sensory or motor blockade that results from the technique. The factors that may contribute to the prolonged blockade may include the amount and drug class of the local anesthetic agent used and the adjuvants combined with the local anesthetic (e.g. adrenergic agonists and opioids). The reversal of neuromuscular blockade results in an increase of the PACU LOS by only 0.28 hour (or around 17 minutes) compared to 0.66 hour (or around 39 minutes) in cases where no reversal was done. The longer PACU LOS of patients who received no reversal of neuromuscular blockade may be due to the residual effects of paralysis. Residual paralysis would affect the scoring of motor activity and breathing in the Modified Aldrete Score. The occurrence of intraoperative or post-operative complication/s lengthens the PACU LOS probably due to the time needed to intervene and stabilize the patient. The common intraoperative complications encountered in this study included hypotension, hypertension, and tachycardia. The postoperative complications that frequently occurred included shivering, vomiting, hypotension, and decreased urine output.

The mean PACU LOS from this study (4.59 ± 2.36 hours) is higher than the published data. Studies abroad showed a PACU LOS that ranged only from 1.18 to 3.17 hours.[5,6,7,8] The modifiable factors that affect the PACU LOS may be identified as clinically relevant targets to increase efficiency in the Philippine General Hospital. As mentioned, the PACU LOS increases on the average by about 39 minutes for a patient who did not receive a neuromuscular blocker reversal agent as opposed to around 17 minutes for those who did. In other words, the omission of neuromuscular blockade reversal increases the PACU LOS by about 229%. Hence, the regular reversal of neuromuscular blockade may be advised. The regression model also reveals that, on the average, the use of regional anesthesia increases the PACU LOS by about 40 minutes which is actually the highest among the different anesthetic techniques. This increase, as mentioned previously, may be attributed to the prolonged blockade brought about by the amount and type of agents used. Thus, the judicious use of such agents may improve the PACU LOS of patients who will undergo regional anesthesia. The absence of intraoperative or postoperative complication/s decreases the PACU LOS. Hence, the prevention of peri-operative complications is very important.

By addressing the modifiable variables that affect the PACU LOS, an improvement in the LOS of patients in the PACU may be expected. This may translate to reduced cost for the patients and the hospital. Expenditures for a patient admitted to the PACU of the Philippine General Hospital include at least Php 150 per hour of stay in the PACU, Php 75 for linen and Php 1330 for the use of monitors for the first three hours. Other expenses may include the use of forced air warmer (Php 600 for the first three hours) and syringe pump (Php 460 for the first three hours). As the mean PACU LOS from this study is more than 3 hours, additional expenses are incurred: Php 150 per hour of stay in the PACU, Php 440 per hour for monitor use, Php 150 per hour for the use of forced air warmer, and Php 150 per hour for the use of syringe pump.

CONCLUSION

The mean LOS in the PACU in the Philippine General Hospital in this study was 4.59 hours. This value is higher than those in published studies. Patients with intraoperative or postoperative complications had significantly higher mean PACU LOS. Patients of different type of surgery, duration of surgery, anesthetic technique, and duration of anesthesia had significantly different median PACU LOS.

Only the duration of surgery, occurrence of intra-operative complication/s, and occurrence of postoperative complication/s were found to be significantly predictive of the PACU LOS in the reduced regression model. Consideration of the model with the highest R^2 value and lowest Root MSE value included the ASA-PS classification, type of surgery, and anesthetic technique among the predictive factors of the PACU LOS.

Recommendation
The results of this study may be biased for the following reasons. Although the study was conducted at a month when there was a high volume and variety of cases, the study employed a total enumerative sampling method. Thus, results may be affected by temporal trends. A larger sample size will produce a better predictive model in consideration of temporal trends.

Future studies may improve the model through cross-validation using new samples. As the study was done in a single institution, the variety of patients and surgical cases may be different from other hospitals. The model may be improved through validation using samples from other centers.

Due to the limited number of data, some of the categories within the ASA classification, type of surgery, and anesthetic technique were merged. A larger population may be needed to keep the categories discrete. In this way, the categories may be analyzed separately and the factors that predict the PACU LOS will be more specific.

The factors that affect the duration of surgery, occurrence of intraoperative complication/s, and occurrence

of postoperative complication/s may be studied to improve the LOS of the patients in the PACU. In addition, the analysis of the causes for the increased PACU LOS in patients who received no reversal of muscle relaxant and in patients who received regional anesthesia may be beneficial.

Other factors that may be investigated for their effect on PACU LOS include fluid balance (eliminated when a parsimonious model was selected) and timing of surgery (only elective cases were included in the study). In addition, the effect of nonclinical or systems factors such as transportation issues and unavailability of beds in critical care areas on PACU LOS may also be studied to better improve resource management.

Statement of Authorship

MTBA conceived and designed the research, collected and analyzed data, drafted, revised and wrote the final manuscript. EKV assisted in research design, edited and approved final version of manuscript.

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