Rapid System Review Score—A Tool to Measure Predictive Interventions in Patients Admitted to the Postanesthesia Care Unit

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Purpose: *The Rapid System Review (RSR) score was developed to predict the number of postanesthesia care unit (PACU) interventions. We hypothesized that if RSR score was < 0, no PACU interventions were expected; however as the RSR score increased, the number of PACU interventions would also increase.*
Design: *Observational clinical study.*
Methods: *The RSR score was tabulated as 0 to 3, 4 to 6, 7 to 9, 10 to 12, and 13 to 15. The corresponding number of PACU interventions was expected to be 1 to 3, 4 to 6, 7 to 9, 10 to 12, and 13 to 15.*
Findings: *The Pearson correlation coefficient comparing RSR score and PACU interventions was 0.9 (P < 0.0001). The result was statistically significant.*
Conclusions: *These results suggest that as RSR score changes, the number of interventions would also alter proportionally.*

Keywords: *PACU, interventions, RSR score.*

THE POSTANESTHESIA CARE unit (PACU) is an important clinical area dealing with patients immediately after their surgery and anesthesia.[1] Care for patients in the PACU includes interventiuons for postoperative pain, nausea, vomiting, and hypothermia or hyperthermia as well as monitoring for early postoperative complications. Upon arrival to PACU, patients may have a residual effect of anesthesia still on board. Fluctuations of neurological, respiratory, cardiovascular, and metabolic systems are very frequent. Patient factors, duration of surgery, and events in PACU can be predictive of subsequent early postoperative ward clinical deterioration.[2] Combining multiple continuously measured parameters in a classified algorithm may benefit in detection of early signs of deterioration.[3]

Previous scoring systems such as the Aldrete Score and the Post-Anesthetic Discharge Scoring System have[4-6] dealt with patient's readiness for discharge. Street et al[7] showed a structured discharge criteria tool, the PACT, which enhanced nurses' recognition and response to patients who experienced clinical deterioration, reduced length of stay for patients who experienced an adverse event in PACU, and was cost-effective.[7] However, no scoring system was developed to predict the total number of PACU interventions required before patient's discharge. Interventions delivered by the PACU nurses may appear to be standard of care, but predictability, timeliness, and proper categorization of interventions better describe the role of postanesthesia nurses and enhance patient satisfaction.

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Aim

A Rapid System Review (RSR) score was developed based on the patient's baseline physiological status and postoperative clinical condition. We hypothesized that if the RSR score was < 0, no PACU interventions were expected; however as the RSR increased, the number of PACU interventions was also expected to increase. The secondary outcome was to evaluate if these patients achieved their baseline health status at discharge from PACU.

Method

This study was designed and is reported according to the strengthening the reporting of observational studies in epidemiology (STROBE) guidelines. An institutional review board approval was obtained along with a waiver of the requirement of written, informed consent. The study was conducted in the PACU at the Veterans Affairs Health Care System, Oklahoma City, from January 2017 to November 2018. A total of 100 patients were investigated. The study population included patients aged between 21 and 90 years, who required admission to PACU. Patients who were expected to go directly to intensive care unit or outpatient surgical area postoperatively were excluded from the study.

Protocol for RSR Score Formula Investigation

The process involved three steps (Table 1).

Step 1: Estimating Baseline Preoperative Score

Patients' baseline physiological status was assessed based on 11 criteria. Respiratory system was assessed by checking if airway was patent, patient's respiratory rate was 10-20/min, and peripheral hemoglobin oxygen saturation was 97-100% as shown by pulse oximetry.

Cardiovascular system was assessed by checking if the patient had a heart rate of 50-100/min and a systolic blood pressure of 100-160 mmHg. Neurological system was assessed by checking if patient was awake and had any neurological deficit. Body temperature was checked to see if it was 36-37°C. Patients were enquired for absence of diabetes mellitus, pain, nausea, and vomiting. One point was allocated for each criterion.

Step 2: Estimating Postoperative Score

Postoperative score was calculated by adding (1) comorbidity, (2) surgery and anesthesia, and (3) PACU scores.

1. Comorbidity score: Presence of comorbidities was reviewed involving sleepiness, confusion, agitation, obesity, obstructive sleep apnea, use of continuous positive airway pressure device, smoking, asthma, chronic obstructive pulmonary disease, congestive heart failure, atrial fibrillation, use of cardiac implantable electronic device, valvular heart disease, use of supplemental oxygen, alcohol use, substance abuse, cirrhosis, postoperative nausea or vomiting, gastroesophageal reflux disease, motion sickness, vertigo, seizure disorder, stroke, renal disease, and sepsis. One point was allocated for each unfavorable criterion. Two points were allocated each for hemodialysis dependence, unresponsiveness, and endotracheal intubation.
2. Surgery and anesthesia score: Point allocation varied from 1 to 4 depending on the degree of complexity of surgery and anesthesia. One point each for surgeries on the surface of the body, surgery duration < 1 hour, monitored anesthesia care, regional anesthesia, use of one vasoactive medication, central venous pressure monitoring, and invasive arterial pressure monitoring. Two points each for videoscope-assisted surgeries, surgery duration >1 hour and < 2 hours, epidural or spinal anesthesia, and use of two vasoactive medications. Three points each for open surgical procedures, surgery duration >2 hours and < 4 hours, general anesthesia, and the use of three vasoactive medications. Four points each for surgery duration >4 hours and use of four vasoactive medications.
3. PACU score: Point allocations are from zero to 3 depending on the patient's health.

Zero points for an awake patient, with patent airway, respirator rate 10-20/min, heart rate

Table 1. Rapid System Review Score Calculating Chart

Preoperative Score	P	Comorbidity Score	P	Surgery Score	P	PACU Score	P
Awake	1	Confused	1	Surface	1	Awake	0
Airway patent	1	Sleepy	1	Videoscope	2	Sleepy	1
Resp. rate 10-20/minute	1	Agitated	1	Open	3	Agitated	2
Heart rate 50-100/minute	1	Unresponsive	2	Duration < 1 hour	1	Unresponsive	3
SBP 100-160 mmHg	1	Obesity	1	Duration 1-2 hours	2	Airway patent	0
Sp02 97%-100%	1	OSA	1	Duration >2 to 4 hours	3	Oral, nasal airway	1
No pain	1	CPAP	1	Duration >4 hours	4	Laryngeal mask airway	2
No nausea/vomiting	1	ETT	2	Anesthesia MAC	1	ETT	3
No neurological disease	1	Smoking	1	Regional	1	Resp. rate 10-20/minute	0
No diabetes mellitus	1	COPD, asthma	1	Epidural/spinal anesthesia	2	Resp. rate < 10 or >20/minute	1
Body temperature 36-37°C	1	CHF	1	General anesthesia	3	Diff. breathing, bronchospasm	1
Total		Atrial fibrillation	1	Vasoactive medication 1	1	Heart rate 50-100/minute	0
		CIED	1	Vasoactive medication 2	2	Heart rate < 50 or >100/minute	1
		Valvular disease	1	Vasoactive medication 3	3	SBP 100-160 mmHg	0
		Oxygen	1	Vasoactive medication 4	4	SBP < 100 or >160 mmHg	1
		Alcohol	1	CVP monitoring	1	Sp02 97%-100%	0
		Substance abuse	1	Invasive art. monitoring	1	Sp02 < 97%	1
		Cirrhosis	1	Total		No pain	0
		PONV	1			Pain [+]	1
		GERD	1			No nausea/vomiting	0
		Motion sickness	1			Nausea/vomiting [+]	1
		Vertigo	1			No new neurological disease	0
		Seizure	1			Seizure, stroke, new deficit	1
		Stroke	1			No DM or BG 70-200 mg/dl	0
		Renal disease	1			BG < 70 or >200 mg/dl	1
		Hemodialysis	2			Body temperature 36-37°C	0
		Sepsis	1			Body temperature < 36 or >37°C	1
		Total				Total	

P, points; Resp, respiration; SBP, systolic blood pressure; Sp02, hemoglobin oxygen saturation; OSA, obstructive sleep apnea; CPAP, continuous positive airway pressure; ETT, endotracheal tube; COPD, chronic obstructive pulmonary disease; CHF, congestive heart failure; CIED, cardiac implantable electronic device; PONV, postoperative nausea and vomiting; GERD, gastroesophageal reflux disease; MAC, monitored anesthesia care; CVP, central venous pressure; art, arterial pressure; PACU, postanesthesia care unit; Diff, difficulty; DM, diabetes mellitus; BG, blood glucose.

50-100/min, systolic blood pressure 100-160 mmHg, hemoglobin saturation 97-100%, body temperature 36-37°C, blood glucose 70-200 mg/dl, and absence of pain, nausea/vomiting, or new neurological problems. One point each for sleepiness, use of oral or nasal airway, respiratory rate less than 10/min or greater than 20/min, difficulty breathing, bronchospasm, heart rate less than 50/min or greater than 100/min, systolic blood pressure less than 100 mmHg or greater than 160 mmHg, hemoglobin saturation less than 97%, blood glucose less than 70 mg/dl or greater than 200 mg/dl, body temperature less than 36°C or greater than 37°C, and presence of nausea/vomiting, pain, seizure, stroke, or new neurological deficit. Two points each for agitation and use of laryngeal mask airway. Three points each for unresponsiveness and endotracheal intubation. The PACU score is assessed every 15 minutes upon arrival to PACU until discharge or up to 2 hours (whichever is the earliest).

Step 3: Estimating RSR Score

RSR Score = Postoperative score minus preoperative score

RSR score was tabulated as 0 to 3, 4 to 6, 7 to 9, 10 to 12, and 13 to 15. The corresponding number of PACU interventions was expected to be 1 to 3, 4 to 6, 7 to 9, 10 to 12, and 13 to 15. If the RSR score was less than zero, no PACU interventions were expected.

Interventions Patients May Receive While in PACU

Interventions were classified as verbal instructions (eg, take a deep breath as part of treatment of hypoxia), medication administration (eg, medications to treat cardiorespiratory fluctuations, nausea or vomiting, pain), investigations to evaluate (eg, point-of-care blood glucose measurement to patients with diabetes mellitus, arrange chest X-ray for patients after bronchoscopy, urinary bladder scan in patients who did not void urine) and treat (eg, placement of urinary catheter, treat hypoglycemia or hyperglycemia) vital parameters triggered by clinical examination, and alarms set for patient monitoring. Simple interventions that are considered as standard of care for all patients were not included (such as, attaching PACU monitors to patients, initial patient assessment, continuing sequential compression stockings, supplemental oxygen for first 15 minutes, giving ice chips or sips of water, discontinuing monitoring on discharge) (Table 2).

Data Collection

Data were collected by the investigators at the time of patient discharge from the PACU. A review of patient anesthesia records, PACU nurse flow sheets, continuous clinical monitor recordings of the patient vital signs, triggered alarms and events (CARESCAPE monitor B850; GE medical systems, Germany), and the computerized patient record system was completed. All data were entered on a form, and completed forms were collected for data entry and analysis using Microsoft Excel.

Statistical Method and Data Analysis

The study population was expected to contain fewer female patients and no pediatric cases. The sample size was estimated to be 100, with a desired precision of ± 0.05 and a confidence level of 0.95. Categorical data (male/female) were expressed as a percentage. Continuous data were presented as mean $\pm$ standard deviation (SD).

Table 2. Distribution of Interventions and Time Spent in PACU

	PACU	Time (min)							
PACU Interventions	**Admit**	**1-15**	**16-30**	**31-45**	**46-60**	**61-75**	**76-90**	**91-105**	**106-120**
Verbal instruction	4	7	10	11	4	3	0	0	0
Assess and treatment for hypoxia	1	14	52	38	30	15	4	4	1
Assess and treatment for combativeness	4	0	0	0	0	0	0	0	1
Treatment for respiration < 10/min	0	0	0	0	1	0	0	0	0
Treatment for pain	6	33	47	32	13	5	2	1	0
Treatment for HR < 50 or >100/min	0	1	0	1	1	0	0	0	0
Treatment for SBP < 100 or >160 mmHg	0	5	8	1	2	0	0	0	0
Treatment for nausea/vomiting	0	4	7	2	1	0	0	0	0
Treatment for hypoglycemia/hyperglycemia	0	1	0	0	0	0	0	0	0
Assess and treatment for shivering	1	3	0	0	0	0	0	0	0
Diagnostic test	6	25	7	2	1	0	0	0	0
Call surgeon for advice	0	0	1	0	0	0	0	0	0
Restart new intravenous catheter	0	1	0	0	0	0	0	0	0
Care of invasive monitoring	1	1	2	1	2	1	1	0	0
Second RN assistance needed	9	8	5	2	1	0	1	0	0
Manipulate upper respiratory tract	5	16	8	3	4	0	0	0	0
Check lower respiratory tract	2	4	3	0	1	0	0	0	0

PACU, postanesthesia care unit; min, minutes; HR, heart rate; SBP, systolic blood pressure; RN, registered nurse.

Statistical data analysis was performed using the GraphPad Prism (version 7) software (GraphPad Software Inc., La Jolla, CA). Pearson correlation coefficient was used to evaluate trend and two-tailed paired Student *t* test with *P* values to evaluate significance. A *P* value < 0.05 was deemed statistically significant.

Results

A total of 100 patients participated in the study. Male (81%), female (19%), American Society of Anesthesiologists' Patient Classification System, Class 1 (ASA-1; 0%), ASA-2 (35%), ASA-3 (55%), and ASA-4 (10%). At the end of the study, all 100 patients were discharged from PACU. Seventy-one patients were discharged to an inpatient ward for continuing clinical care, and the remaining 29 patients were transferred to the postsurgical ward before being discharged home.

Primary Outcome: Correlation Between RSR Score and PACU Interventions

The Pearson correlation coefficient (R2) between the RSR score and the actual interventions was 0.9. The RSR score was tabulated as 0 to 3, 4 to 6, 7 to 9, 10 to 12, and 13 to 15. The corresponding mean (±SD) of PACU interventions were 2.39 (±0.69), 5.03 (±1.05), 7.90 (±1.21), 11.83 (±0.41), and 14.00 (±1.00), respectively. A total of 12 patients with an RSR score < 0 did not require any interventions in the PACU. This suggests that as RSR score increased from 0 to 15, the number of interventions would also increase. The *P* value was 0.0001. The result was statistically significant at $P < 0.05$. There was no difference between male and female patients with regard to the number of interventions and their corresponding RSR score (Figure 1).

Secondary Outcome: Comparison of RSR Scores in PACU and Discharge

The mean RSR score in PACU and at discharge was 4.60 (SD: ±3.61; 95% confidence interval: 3.89 – 5.30) and 2.91 (SD: ±3.01; 95% confidence interval: 2.32 – 3.50), respectively. The two-tailed paired Student *t* test comparing the two revealed t = 3.60, $P = 0.0004$. The result was statistically significant at $P < 0.05$. A total of 29 patients who were transferred to the postsurgery ward before being discharged home reached an RSR score less than zero (suggesting less likelihood of further interventions) (Figure 2).

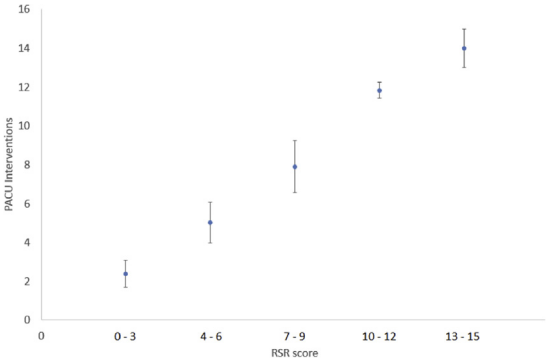

Figure 1. Relationship between RSR score and PACU interventions. The RSR score was tabulated as 0 to 3, 4 to 6, 7 to 9, 10 to 12, and 13 to 15. The corresponding mean (±standard deviation [SD]) of PACU interventions were 2.39 (±0.69), 5.03 (±1.05), 7.90 (±1.21), 11.83 (±0.41), and 14.00 (±1.00), respectively. Pearson correlation coefficient; $R^2 = 0.9$ ($P = 0.0001$). The result was statistically significant at $P < 0.05$. RSR, Rapid System Review; PACU, postanesthesia care unit. This figure is available in color online at www.jopan.org.

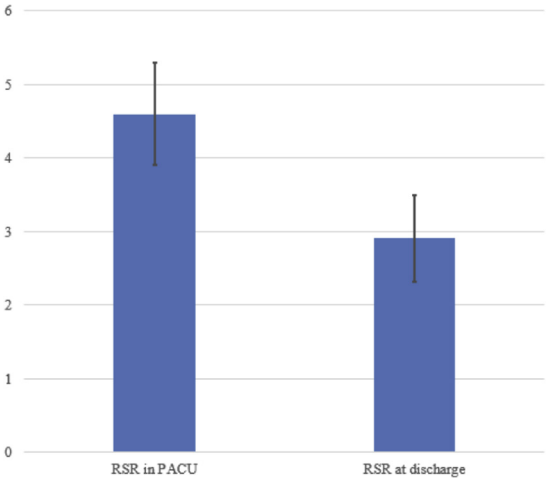

Figure 2. The mean RSR score in PACU and at discharge was 4.60 (SD: ±3.61; 95% CI: 3.89 – 5.30) and 2.91 (SD: ±3.01; 95% CI: 2.32 – 3.50), respectively. The two-tailed paired Student *t* test comparing the two, revealed t = 3.60, $P = 0.0004$. The result was statistically significant at $P < 0.05$. RSR, Rapid System Review; PACU, postanesthesia care unit. This figure is available in color online at www.jopan.org.

Table 3. Relationship Between Specific Type of Surgery, RSR Score, and Number of Patients

	RSR Score					
Type of surgery	**< 0**	**0-3**	**4-6**	**7-9**	**10-12**	**13-15**
Infusaport placement	2	3	1			
Excision of tumor over thigh		1				
Cataract surgery	2					
Ankle debridement, allograft		1				
Excision of foot nevus	1					
Angiogram, interventions		1				
Manipulation under anesthesia of knee	1					
Hip steroid injections	1					
Transurethral resection of bladder tumor			1	1		
Cystoscopy, ureteroscopy, stent	1	3	1			
Laser lithotripsy	1	1				
Shoulder arthroscopy			1	1		
Knee arthroscopy		5		2		
Ankle arthroscopy		1				
Endoscopic retrograde cholangiopancreatography		1	2			
Turbinate reduction/septoplasty/sinus surgery		1	3	2	1	1
Endobronchial ultrasound, biopsy			4	2		
Percutaneous endoscopic gastrostomy			1			
Laparoscopic cholecystectomy	2		1			
Laparoscopic inguinal hernia repair		1	1			
Laparoscopic tubal ligation		1				
Total abdominal hysterectomy			1			
Lumbar spine surgery			3	2	1	1
Mastoidectomy/tympanoplasty		1				
Parotidectomy					1	
Above-knee amputation			1	1		
Below-knee amputation			1			
Transmetatarsal amputation				1		
Metatarsal resection/bunionectomy				2		
Open inguinal hernia repair			2		1	
Total hip arthroplasty		2	2	2		1
Total knee arthroplasty		2	1		1	
Hand joint surgery		1				
Open reduction internal fixation of ankle			1			
Anterior cervical spine surgery				1		
Epigastric/ventral hernia repair		1		1		
Neck fistula closure				1		
Excision lipoma over back/neck	1				1	
Pectoralis muscle flap to mandible		1		1		
Mastectomy/mastopexy				2		
Pilonidal cyst excision				1		

RSR, Rapid System Review.

Discussion

The main reason for doing this study was to develop a simple scoring system (RSR score) which was highly predictive of possible interventions needed in PACU, which in turn may help (1) fast-track controlled pain medications, (2) avoid delays at point-of-care pharmacy stations, (3) anticipate need for appropriate staffing, and (4) develop an algorithm for smooth functioning of PACU nurses. Predicting the total number of nursing interventions for patients in PACU was challenging. The

physiological condition of the patient upon arrival to PACU was expected to depend on their preexisting comorbidities, type of surgical procedure, anesthesia technique, and emergence from anesthesia. Petersen et al.[2] also showed in their study that the association between PACU events and preoperative factors provided relatively imprecise models, but including preoperative, operative, and PACU factors led to models with strong receiver operative curve values. These findings suggest that prediction of the need for high-acuity care cannot be made from preoperative assessment alone. In our study, we first assessed the patient's preoperative physiological status based on 11 criteria. Then, presence of comorbidities was noted. The type of surgery and anesthesia technique was assessed based on complexity and duration of surgery. Upon admission to PACU, the patient's initial clinical condition was assessed and a postoperative score was obtained by adding the comorbidity, surgery and anesthesia, and PACU scores. The RSR score was obtained by subtracting postoperative score from the preoperative score.

Explanation of Point Allocation

These criteria were selected as they can be monitored continuously to make predictions regarding emerging deterioration in hospitalized patient. As severity of the problem increased, the risk of clinical deterioration was expected to be high. Appropriate importance was given to each criterion.[2,8]

A major concern in the quality of patient care is the safe timing of patient discharge in relation to recovery from general anesthesia or conscious sedation.[9] Patients admitted to our PACU are usually discharged within an hour either to an inpatient ward for continuing clinical care or to the postsurgery ward before discharge home, when they achieve an Aldrete score of 8-10. Sometimes their stay would extend up to 2 hours if ward beds are not readily available or patients are not ready for discharge. Therefore, our study was designed to predict the number of interventions in PACU up to 2 hours. Twenty-nine patients who were discharged to the outpatient surgery ward reached RSR score less than zero (suggesting less likelihood of further interventions). Seventy-one patients with RSR score >0 who were discharged to an inpatient ward for continuing clinical care required further interventions. Further study is needed to see if these patients reached an RSR score of <0 and how long it took to reach this point. The type of PACU interventions varied as patients became more alert emerging from the effects of anesthesia and surgery. The number of interventions performed during the first hour in PACU was more than that of the second hour (Table 2). Management of early postoperative pain was crucial in view of preexisting comorbidities. Prompt treatment of one issue (eg, acute pain with opioid medication) increased the likelihood of detection and management of new issue (eg, hypoxia). This led the RSR score at PACU admission to increase further. The trend between the RSR score and PACU interventions still continued. The study showed no correlation between types of surgery among patients who received the same RSR score (Table 3). With the help of this study, we were able to convince the pharmacy personnel to arrange controlled medications at bedside portal in PACU.

Limitations

1. No pregnant women or children participated in the study.
2. Simple interventions that were considered standard of care for all patients may vary among different facilities particularly those dealing with children and pregnant women.

Conclusions

In conclusion, this study clearly demonstrated that a cumulative assessment of patients' preoperative baseline health, preexisting comorbidities, complexity of surgery, and anesthesia, as well as clinical condition of the patient upon admission to PACU, plays a crucial role in predicting the total number of PACU interventions. An individual component of this chain of assessment cannot precisely summarize the patients PACU needs.

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