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Administration/Decision Making

A high-volume trauma intensive care unit can be successfully staffed by advanced practitioners at night☆,☆☆,★

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ABSTRACT

Purpose: It remains unknown whether critically ill trauma patients can be successfully managed by advanced practitioners (APs). The purpose of this study was to examine the impact of night coverage by APs in a high-volume trauma intensive care unit (ICU) on patient outcomes and care processes.

Materials and methods: During the study period, our ICU was staffed by APs during the night shift (7 PM-7 AM) from Sunday to Wednesday and by resident physicians (RPs) from Thursday to Saturday. On-call trauma fellows and attending surgeons in house supervised both APs and RPs. Patient outcomes and care processes by APs was compared with those admitted by RPs.

Results: A total of 289 patients were identified between July 2013 and February 2014. Median lactate clearance rate within 24 hours of admission was similar between study groups (10.0% vs 9.1%; $P = .39$). Advanced practitioners and RPs transfused patients requiring massive transfusion with a similar blood product ratio (packed red blood cell:fresh frozen plasma) (2.1:1 vs 1.7:1; $P = .32$). In a multiple logistic regression analysis, AP coverage was not associated with any clinical outcome differences.

Conclusions: Our data suggest that, with adequate supervision, a high-volume trauma ICU can be safely staffed by APs overnight.

1. Introduction

It has been more than a decade since the Accreditation Council for Graduate Medical Education required residency programs in the United States to implement the resident duty-hours regulations [1]. These regulations have significantly influenced the quality of life, education, and training of resident physicians (RPs) [2-4]. Because of the serious shortage of the RP workforce, many surgical programs have been struggling to maintain the quality of care and patient safety [5-7]. Advanced practitioners (APs), that is, nurse practitioners and physician assistants, have been identified as one of the solutions to replace RPs [8].

An increasing role for APs in various surgical specialties was supported by previous studies [9,10]. In trauma care, APs are an integral part of the team, performing multiple tasks including daily rounds, chart documentation, and discharge planning [11,12]. In addition, APs have also been shown to successfully perform the initial assessment and resuscitation of trauma patients in the emergency department under the supervision of trauma surgeons [13]. The management of severely injured patients in the intensive care unit (ICU), however, requires extensive medical knowledge and experience in multiple invasive bedside procedures. Very little data are currently available regarding the utilization of APs for trauma patient management in the ICU, especially for overnight coverage.

The purpose of the present study was to examine the impact of APs on the outcomes of trauma patients admitted to the ICU at night. We hypothesized that APs would be able to successfully manage critically ill trauma patients in the ICU at night without a negative impact on the patient outcomes.

2. Materials and methods

After approval by the Institutional Review Board of the University of Southern California, we conducted a retrospective study using the institutional trauma registry of Los Angeles County + University of Southern California medical center from July 2013 to February 2014. Los Angeles County + University of Southern California medical center is an

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academic level 1 trauma center with one of the largest trauma patient volumes in the United States. It has a 30-bed closed-type surgical ICU where critically ill trauma, emergency general surgery, and other surgical subspecialty patients are admitted. The average number of ICU admissions after trauma is approximately 130 patients per month. Advanced practitioners (nurse practitioners) in our surgical ICU have either emergency medicine or critical care nursing backgrounds. Although they are in their practice as APs for less than 5 years, they all have more than 10 to 15 years of experience as nurses. Advanced practitioners and RPs participate in the weekly didactic critical care review course as well as case-based teaching rounds on a daily basis.

During the study period, all patients were managed by a dedicated surgical ICU team that consists of a critical care attending physician, surgical critical care fellows, and junior-level RPs and APs from 7 AM to 7 PM. At 7 PM, patients are handed off to a night-float AP (Sunday to Wednesday) or RP (Thursday to Saturday) who covered the entire ICU under the supervision of an on-call in-house trauma fellow and attending trauma surgeon. Same AP covered consecutive 4 nights from Sunday to Wednesday and same RP covered 3 nights from Thursday to Saturday. By protocol, RPs and APs were required to notify fellows and/or attending surgeons for a predefined list of clinical situations (Table 1).

We included trauma patients admitted to the surgical ICU between 7 PM and 3 AM. The decision for ICU admission was made at the discretion of the on-call attending trauma surgeon. The patients were divided into 2 groups by day of ICU admission (AP group: Sunday to Wednesday, RP group: Thursday to Saturday). Patient baseline characteristics, injury profile, care processes in the ICU, and clinical outcomes were collected from the trauma registry and medical chart. Primary outcome for this study was inhospital mortality rate. Secondary outcomes included the length of hospital stay (LOS), ICU LOS, mechanical ventilation days, and lactate clearance rate within 6 hours. Lactate clearance rate was calculated using a previously described formula [14]. We reported the mean values for parametric continuous variables and median values for nonparametric data. In univariate analyses, we compared the outcomes between 2 groups using the Student *t* test or Mann-Whitney *U* test for continuous variables and χ^2 test or Fisher exact test for categorical variables as appropriate. Subsequently, multiple logistic regression models were created for each outcome adjusting for clinically significant potential confounders. We reported odds ratios and 95% confidence intervals for all variables.

3. Results

During the 8-month study period, a total of 289 trauma patients were included. Of those, 162 patients (56.1%) were admitted when the APs provided ICU night coverage, and 127 patients (43.9%) were admitted when the RPs provided ICU night coverage. Patient and injury characteristics were shown in Table 2. Although the median age is similar between the 2 groups, RPs admitted a larger number of elderly patients (age ≥65 years) compared to APs (9.9% vs 18.9%; $P = .028$). Approximately, one third of patients were considered severely injured (Injury Severity Score ≥25) in each group. Approximately 40% of patients were intubated and required ventilator management.

Patients in RP group received transfusion therapy more frequently than AP group (Table 3). Massive transfusion (MT) defined as greater than or equal to 10 packed red blood cell (PRBC) in 24 hours was required in nearly 40% of patients in the AP group who received blood products compared to 24% in RP group. In patients who received MT, PRBC and fresh frozen plasma (FFP) were transfused at a similar rate (2.1:1 vs 1.7:1; $P = .32$). Using univariate analysis, inhospital mortality was higher in RP group than AP group (6.2% vs 12.6%; $P = .058$). The median lactate clearance rate was greater than 10% in each group (13.2% vs 14.7%; $P = .71$). There was no significant difference in the other outcomes. After adjusting for clinically significant covariates using logistic regression, the type of primary provider in the ICU (RPs vs APs) was not significantly associated with inhospital mortality (odds ratio, 2.78; 95% confidence interval, 0.86-9.01; $P = .09$) (Fig. 1).

4. Discussion

This study evaluated the impact of night time surgical ICU coverage by APs on the outcome of trauma patients at a high-volume trauma center. We found that the type of primary ICU provider (APs vs RPs) was not associated with differences in patient outcome. Our data also suggest that APs and RPs provide equivalent initial resuscitation following our institutional protocol. These findings support a growing role for APs in the management of critically ill trauma patients.

In the United States, the number and role of APs in the ICU have significantly expanded in last few decades [15]. It is expected that larger number of APs will be hired to provide adequate 24/7 ICU coverage in the future. Previous studies support the use of APs in the critical care

Table 1
List of conditions requiring fellow and/or attending notification

Decision to intubate patient
Decision to extubate, self-extubation, or unplanned extubation
Need for change in ventilator setting, increasing oxygen requirement
Decision to order CT angiogram for suspected pulmonary embolism
Hypotension unresolved by fluid resuscitation (>2 L)
Decision to start vasoactive agents or titration approaching the maximum dose
Decision to start blood transfusion
Low urine output (<0.5 mL/kg/h) >2 h
Decision to start or add new antibiotics, new onset of fever with tachycardia or hypotension
Acute change in mental status (↓GCS >2 points), or neurologic examination
Elevation of intracranial pressure (>20 mm Hg) >15 min
Decision to start hypertonic saline for traumatic brain injury or resuscitation
Death of patient including brain death
Decision to place an arterial line, central venous line, or other invasive procedure
Active bleeding from surgical wound including temporary abdominal closure dressing
Decision to start therapeutic anticoagulation

CT indicates computed tomography; GCS, Glasgow Coma Scale.

Table 2
Patient and injury characteristics

	All patients (n = 289)	AP group (n = 162)	RP group (n = 127)	*P*
Median age (IQR)	40 (25-57)	36 (25-54)	43 (25-61)	.12
Age ≥65 y	40/289 (13.8%)	12/162 (9.9%)	27/127 (18.9%)	.028
Male sex	225/289 (77.9%)	127/162 (78.4%)	98/127 (77.2%)	.80
Blunt injury	223/289 (77.2%)	128/162 (79.0%)	95/127 (74.8%)	.40
Median ISS (IQR)	17 (10-26)	17 (10-26)	16 (9-26)	.57
Admission SBP <90	17/289 (6.0%)	11/159 (6.9%)	6/122 (4.9%)	.49
Admission HR >100	114/289 (40.3%)	66/158 (41.8%)	48/125 (38.4%)	.57
Admission GCS <9	58/289 (20.1%)	35/162 (21.6%)	23/127 (18.1%)	.46
Admission hemoglobin ≤9	5/289 (1.7%)	2/162 (1.2%)	3/127 (2.4%)	.66
Ventilator requirement	118/289 (40.8%)	68/162 (42.0%)	50/127 (39.4%)	.66

IQR indicates interquartile range; ISS, Injury Severity Score; SBP, systolic blood pressure; HR, heart rate; GCS, Glasgow Coma Scale.

Table 3
Care processes and clinical outcomes

	AP group (n = 162)	RP group (n = 127)	*P*
Transfusion in 24 h	28/162 (17.3%)	35/127 (27.6%)	.036
PRBC, mean ± SD	2.1 ± 6.6	3.1 ± 11.6	.048
FFP, mean ± SD	1.2 ± 4.4	2.2 ± 9.9	.055
Platelets, mean ± SD	1.3 ± 4.5	2.2 ± 9.0	.35
Cryoprecipitate, mean ± SD	1.1 ± 8.4	1.2 ± 7.0	.64
MT[a]	11/28 (39.3%)	8/35 (22.9%)	.16
PRBC/FFP, mean ± SD	2.1 ± 0.9	1.7 ± 0.4	.32
Hospital mortality	10/162 (6.2%)	16/127 (12.6%)	.058
Hospital LOS, median (IQR)	9.0 (5.0-24.0)	9.0 (5.0-17.0)	.71
ICU LOS, median (IQR)	4.0 (3.0-7.2)	4.0 (2.0-6.0)	.49
Ventilation days, median (IQR)	0.0 (0.0-3.0)	0.0 (0.0-2.0)	.49
Lactate clearance,[b] median (IQR)	13.2 (−6.1 to 51.6)	14.7 (−9.7 to 44.5)	.71

[a] Massive transfusion: greater than or equal to 10 PRBC within 24 hours after admission
[b] Lactate clearance: [(lactate t0) − (lactate t6)]/(lactate t0) × 100.