SURGERY IN LOW AND MIDDLE INCOME COUNTRIES

Predictors of Mortality and Outcomes of Ventilated Patients Managed in a Resource-Limited Acute Surgical Ward

Tan Jih Huei[1] · Henry Tan Chor Lip[1] · Lim Cheng Hong[1] · Cheah Zi Fang[1] · Chen Sue Ann[1] ·
Lim Hui Rou[1] · Gayathiri Ganesen[1] · Ooi You Jie[1] · Tang Chuin Sing[1] · Nor Azlin[1] · Izwan Muhammad[1] ·
Yuzaidi Mohamad[1] · Rizal Imran Alwi[1] · Tuan Nur Azmah Tuan Mat[1]

Abstract

Background Acute care surgery is an important component of health care in the developed nations. However, in Malaysia, acute care surgery is yet to be recognized as a specific subspecialty service. Due to high demands of limited ICU beds, some patients have to be ventilated in the wards. This study aims to describe the outcomes of acute surgical patients that required mechanical ventilation.

Methods This is a retrospective review of all mechanically ventilated surgical patients in the wards, in a tertiary hospital, in 2020. Sixty-two patients out of 116 patients ventilated in surgical wards fulfilled the inclusion criteria. Demography, surgical diagnosis and procedures and physiologic, biochemical and survival data were analyzed to explore the outcomes and predictors of mortality.

Results Twenty-two out of 62 patients eventually gained ICU admission. Mean time from intubation to ICU entry and mean length of ICU stay were 48 h (0 to 312) and 10 days (1 to 33), respectively. Survival for patients admitted to ICU compared to ventilation in the acute surgery wards was 54.5% (12/22) vs 17.5% (7/40). Thirty-four patients underwent surgery, and the majority were bowel-related emergency operations. SAPS2 score validation revealed AUC of 0.701. More than half of patients with mortality risk < 50% eventually were not admitted to ICU.

Conclusions ICU care for critically ill surgical patients provides better survival. There is a need to improve triaging for intensive care, especially for low-mortality-risk patients using risk scores which are locally validated.

✉ Tan Jih Huei
huei_87@hotmail.com

Henry Tan Chor Lip
relos1402@gmail.com

Lim Cheng Hong
hong596@hotmail.com

Cheah Zi Fang
Cassie.cheah@hotmail.com

Chen Sue Ann
sueannchen@hotmail.com

Lim Hui Rou
huiroulim95@gmail.com

Gayathiri Ganesen
gayathiri1295@gmail.com

Ooi You Jie
yj_ooi4896@hotmail.com

Tang Chuin Sing
tangchuinsing@gmail.com

Nor Azlin
norazlin110875@gmail.com

Izwan Muhammad
Izwanismail99@gmail.com

Yuzaidi Mohamad
yuzamd72@yahoo.com

Rizal Imran Alwi
ribajb@yahoo.com

Tuan Nur Azmah Tuan Mat
tuannurazmah@gmail.com

[1] Department of General Surgery, Hospital Sultanah Aminah, Johor Bahru, Malaysia

Abbreviations

Temp	Temperature
HR	Heart rate
RR	Respiratory rate
SBP	Systolic blood pressure
DBP	Diastolic blood pressure
GCS	Glasgow coma scale
U.O	Urine output
APACHE	Acute Physiologic Assessment and Chronic Health Evaluation
SOFA	Sequential Organ Failure Assessment
TISS	Therapeutic Intervention Scoring System
HIC	High-income countries
LMIC	Low- and middle-income countries

Introduction

Critical care in surgical patients is essential for postoperative recovery as the majority of cases have potentially good recovery with formal ICU care. There is a global trend to recognize intensive care as part of sub-specialized care. This is certainly the case in the developed Western countries who is moving toward a specialized surgical acute ICU care. [1] Alas, the majority of Southeast Asian nations still do not possess such luxury, with limited ICU beds to care for severely ill surgical patients. [2] To alleviate this limitation, out of sheer necessity, surgical wards are often modified and retrofitted with equipment to allow a designated area for "intensive" care. This may include provisions for mechanical ventilation and continuous invasive monitoring. This has led to an increased interest in the field of acute care surgery that may lead to a change of practice in our local institutions. [3, 4]. Moreover, it has been proven before that critical care in resource-poor low- and middle-income countries (LMIC) can be cost-effective. Sepsis and intensive care in these regions are largely underdeveloped, which highlights the need to identify disease patterns and see how different centers perform in the care of critically ill surgical patients.

The aforementioned reports were published by well-organized surgery care units from Singapore, Thailand and Vietnam. [3] There is a painful paucity of data from Malaysia in the English medical literature. This study involves a review of cases from Hospital Sultanah Aminah, Johor Bahru, which functions as a regional tertiary hospital in the southern part of peninsular Malaysia. It is a training center with staff members ranging from surgical trainees to senior consultants. This hospital is publicly funded and has a multi-disciplinary general ICU but does not have a dedicated surgical ICU. Surgical patients are triaged for ICU admission together with other non-surgical patients. Due to the limited number of ICU beds, many severely ill surgical patients are unable to secure admission to ICU before or following emergency surgery. As a result, acute care bays were established in open wards to provide mechanical ventilation and close monitoring of patients. The nurse-to-patient ratio is one to four, instead of the national standard of one to one nursing (five nurses to one ICU bed). There are no historical data comparisons as there had never been any audit done for performance improvement purposes. This study aims to describe the types of conditions managed in the general surgery ward and explore the risk factors associated with death.

As an additional interesting fact, the study was done during the early phase of COVID-19 pandemic in 2020. At that juncture, the pandemic had a lesser negative impact in acute surgical care, which later skewed resource distribution. Nonetheless, there was a dip in trauma cases due to the movement control order during the pandemic. [5] Detailed demography and patterns of these cohorts of patients will be described in results.

Methods

This is a retrospective study of acute/emergency patients in a general surgical service in Hospital Sultanah Aminah, in the year 2020. Census data of all ill surgical patients needing intubation and mechanical ventilation were included. The data involved both male and female surgical patients. Care was provided by surgical trainees and surgeons, ward nurses and anesthetist and anesthesia trainees (ad hoc basis). The resuscitative efforts including venous access, fluids and electrolytes correction, prescription of medications and bedside procedures were solely the responsibility of surgical teams. Ventilator setting adjustments were done by the anesthesia team (ad hoc basis). The acute bay housing ventilated patients were in an open area without air-handling unit (AHU) facilities.

The data collected retrospectively include demographics (age and gender), surgical diagnoses, comorbidities, duration of mechanical ventilation, ICU length of stay (for those patients who managed to secure a transfer to the ICU), survival, types of surgical procedures/operations, surgical complications, physiologic variables (temperature, heart rate, respiratory rate, blood pressure, GCS), biochemical variables (PF ratio, pH, bicarbonate, white cell count, hematocrit, serum creatinine, potassium, sodium, urea, hemoglobin, bilirubin level), urine output and need for vasopressors. Demographics and physiologic and

Table 1 Medical Comorbidity between Survived vs Death

	Survived $n = 19$	Death $n = 43$
Metabolic Syndrome ± IHD/ ESRF	13 (68.4%)	31 (72.1%)
Liver disease	0 (0%)	2 (4.7%)
Cancer	1 (5.3%)	1 (2.3%)
Lung disease	1 (5.3%)	1 (2.3%)
Nil Comorbidity	4 (21.1%)	8 (18.6%)
Emergency Surgery	12	15
Elective Surgery	1	6

Table 2 Type of procedures related to the study population

Procedures	34 out of 62 cases had a procedure performed
Biliary Reconstruction	1
Cholecystectomy	1
Colon or Rectal Resection	11
Wound Debridement	4
ERCP	2
Gastrectomy	1
Hepatectomy	1
Laparotomy and underrunning	1
Perforated Gastric Ulcer Repair	1
Small Bowel Resection	3
Tracheostomy	7
Thoracoscopic LN resection	1

Table 3 Surgical Diagnosis of the study population

	*59 cases with recorded surgical diagnosis
Burn	5 (8.1%)
Pancreatitis	2 (3.2%)
Septic Abdomen	30 (48.4%)
Trauma	7 (11.3%)
GI Bleed	6 (9.7%)
Ischemic limb	2 (3.2%)
Cancer	5 (8.1%)
Cutaneous abscess	2 (3.2%)
Missing Diagnosis	3 (4.8%)

biochemical variables were analyzed to compare between patients who died and those who survived. SAPS2 score is calculated to estimate the risk of mortality of each patient. Their risk of mortality, ICU length of stay, duration of intubation and the survival outcome were plotted in a clustered bar chart to display the pattern of ICU admission on these patients.

For statistical analysis, we used IBM® SPSS® version 26 (Armonk, NY: IBM Corp.). Discrete variables were expressed as counts (percentage) and continuous variables as means ± standard deviation (SD). Independent t-test was used for continuous data. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 62 patients with complete clinical data were included out of 116 patients in the analysis. From the 62 patients, the mean age was 60.14 years (SD = 15.84) (range = 17–83). There were 7 foreigners (11.3%) and 55 Malaysians (88.7%). The overall mortality rate was 69.4% (43/62) with 13 deaths that were due to withdrawal or non-escalation of treatment. Following exclusion of these cases, the actual death rate was 61.2% (30/49). Majority of these deaths had comorbidities attributed to metabolic syndrome with either ischemic heart disorders or renal impairment (Table 1). Common operative procedures performed in these patients were for bowel-related surgical emergencies (Table 2). Major indications for these surgeries were intraabdominal sepsis and abdominal trauma not amenable to non-operative management (Table 3).

From the total of 62 patients, 22 were triaged and admitted to ICU. Ten patients had mortality despite best ICU support. Comparing the mean time from intubation to ICU transfer between those that had mortality (42 h) versus patients that survived (53 h), there was no statistical significance with p value 0.466.

The remaining 40 patients that were not admitted to the ICU were solely managed in the acute surgical bays. Only seven out of the 40 patients survived despite best medical care given in the surgical acute bays. Survival rate for patients triaged to ICU patients is 54.5% (12/22) in comparison with 17.5% (7/40) patients managed in acute surgical bay in the wards with p-value 0.02.

Within Fig. 1, there was an observed trend of patients who had high risk of death (mortality risk > 50%), were not admitted to the ICU and managed in an acute surgical bay in which the eventual outcome of death was high. However, these cohorts of patients had a shorter duration of intubation days (gray bars). There were five patients with mortality risk > 50% that were triaged to ICU (Fig. 2). Among these high-risk patients who were triaged to ICU, there were two breakthrough patients who eventually survived (Fig. 2). Following these results, this clearly shows that ICU care leads to improved survivability even in patients with high risk of mortality.
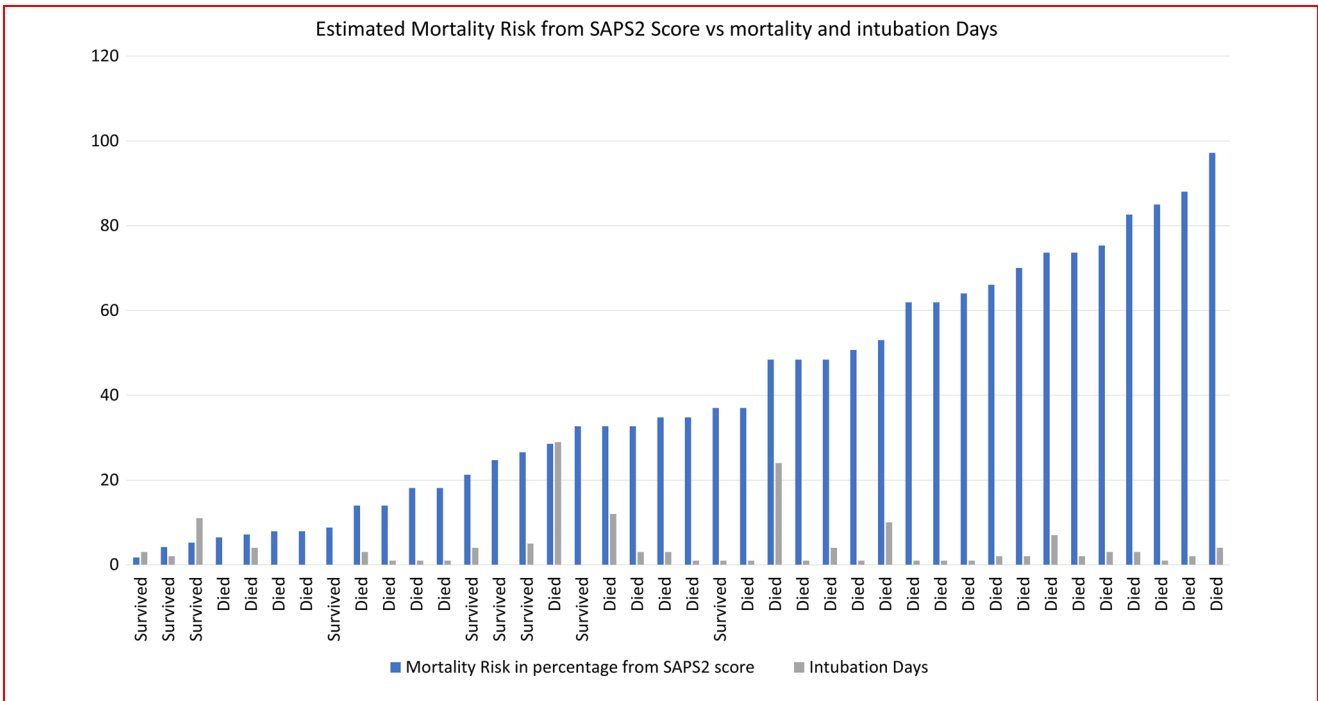
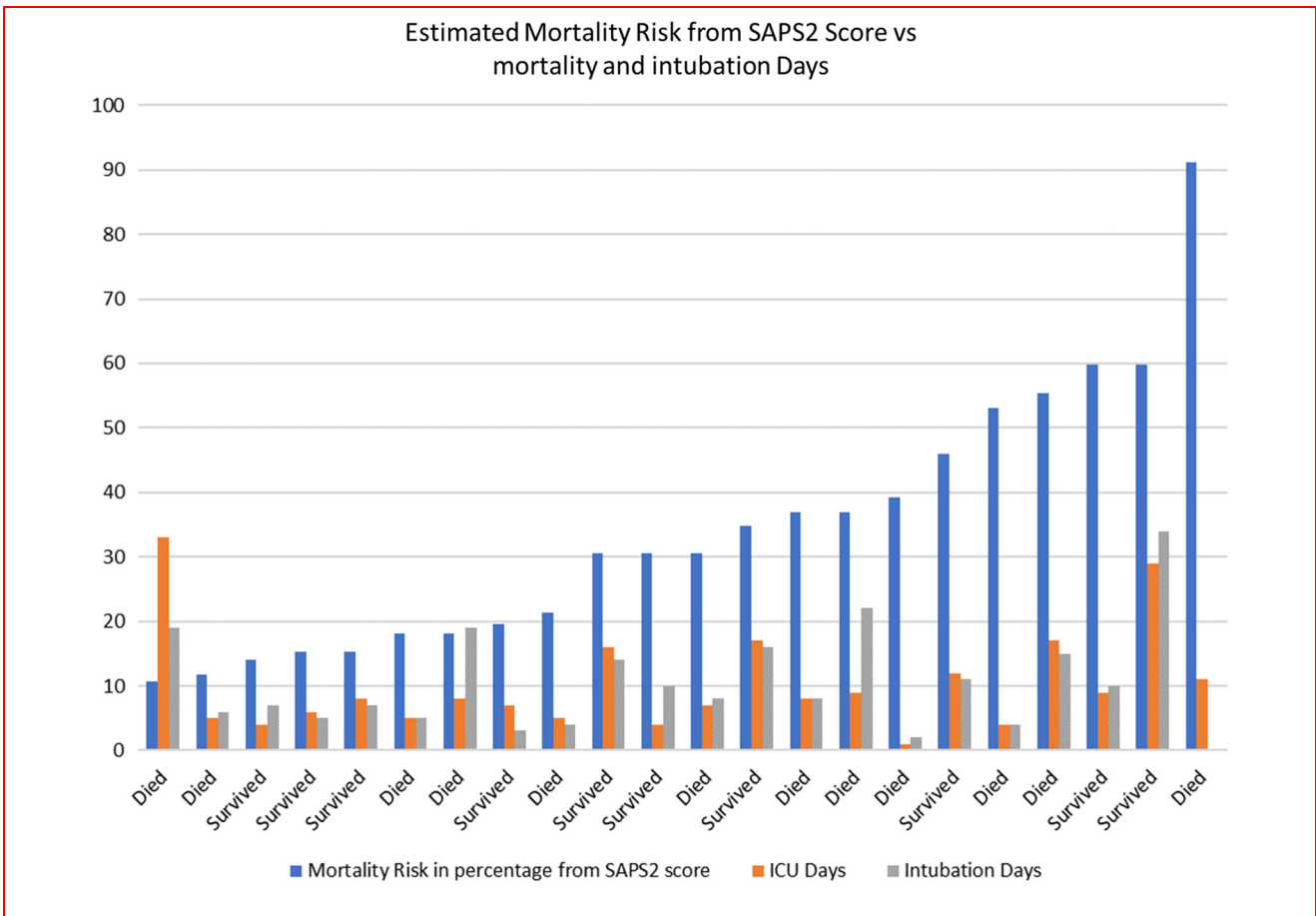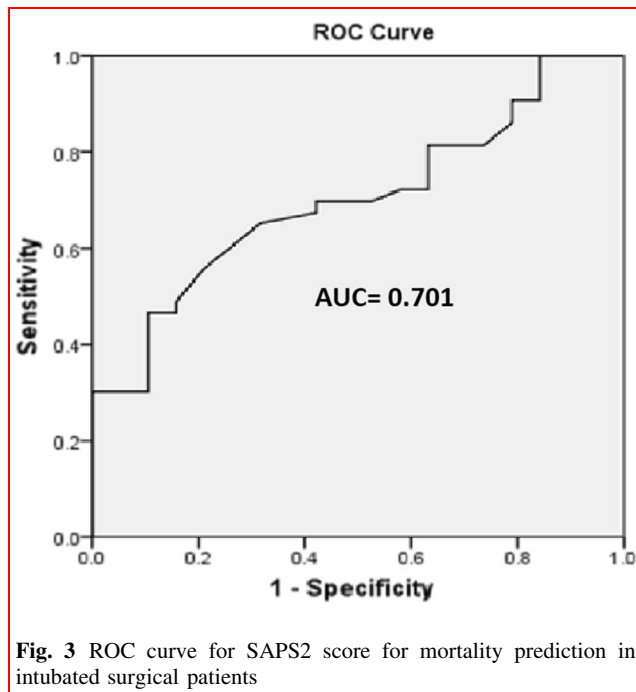**Fig. 1** Mortality Risk estimated from SAPS2 Score versus Survival and intubation days (Ward Patients)

Fig. 2 Mortality Risk estimated from SAPS2 Score versus Survival, ICU days and intubation days (ICU Patients)

Table 4 Physiologic parameters versus survival (ICU patients)

	Death mean (SD)	Survived mean (SD)	*P* value
Temp	37.58 (0.758)	37.51 (0.530)	0.805
HR	110.20 (19.49)	115.92 (33.20)	0.637
RR	21.38 (2.88)	25.73 (8.17)	0.170
SBP	132.10 (24.33)	141.67 (23.922)	0.365
DBP	73.50 (13.142)	74.58 (25.152)	0.904
GCS	11.50 (4.72)	13.75 (2.63)	0.173
U.O (ml/hr)	41.22 (27.08)	43.28(25.83)	0.861

Table 5 Physiologic parameters versus survival (Ward patients)

	Death mean (SD)	Survived mean (SD)	*P* value
Temp	37.28 (0.723)	36.93 (0.468)	0.230
HR	106.73 (23.96)	78.71 (37.429)	0.015
RR	30.36 (11.12)	24.00 (5.774)	0.156
SBP	112.82 (29.726)	136.00 (33.146)	0.074
DBP	63.91 (18.094)	76.96 (18.916)	0.096
GCS	12.50 (3.91)	12.2857 (4.309)	0.898
U.O (ml/hr)	31.21 (40.69)	65.00(25.98)	0.047

Fig. 3 ROC curve for SAPS2 score for mortality prediction in intubated surgical patients

Anesthesia Support

This current study identified that the average time required from intubation to ventilator connection is 3.26 h (range 0–21H). Mean time from intubation to transfer to ICU was 47.67 h (0 to 312H), mean length of stay in ICU was 10.23 days (1 to 33 days), and the mean days of ventilatory support were 6.96 days (1 to 34).

Physiologic variables

In this study, relatively higher heart rate and lower urine output were significantly associated with death in patients treated in ward; however, physiologic parameters did not associate with overall survival for those that were treated in ICU (Tables 4 and 5).

The predictive power using the SAPS2 score to identify patients at high risk of death was analyzed, which revealed the AUC value of 0.701. This shows that the SAPS2 score has a fairly good predictive power to predict death in our local Malaysian population (Fig. 3).

Discussion

Management of critically ill surgical patients has been well described with evidence from established databases of high-income countries (HIC) although data from low- and middle-income countries (LMIC) are lacking. The currently available literature reported that HIC had low mortality rates, superior triaging scores and long-term follow-up. This fact spurred this study which is to explore the burden of critical illness in LMIC. [6] Surgical patients generally have better survival rates when compared to medical-related patients even if they have comorbidities. [1] This led to the interest to report on our postoperative care and outcomes of surgical patients in a hospital with limited ICU resources. [4] In this current study, we explore the burden and outcomes of severely ill surgical patients in a Malaysian tertiary center. Half of the study population consists of intraabdominal sepsis and bowel surgeries which were the most common emergency operative procedures. This trend is similar to most ICU admissions in other local regional centers where intra-abdominal sepsis is the commonest case load. [7]

The resource constraint due to ventilator availability was evident when we observed the average time required from intubation to ventilator is 3 h (range 0–21H). During this waiting period, the nurses and surgical house officers had to perform manual hand bagging.

Cost-effective analysis in patients who were triaged to ICU admission based on survivability has been widely discussed, [8] which is the comparative cost of salvaging a

patient's recovery versus the cost expended in a futile case which ends in death. For this purpose of achieving maximum cost-effective benefit, multiple scoring systems have been devised, namely the Acute Physiologic Assessment and Chronic Health Evaluation.

(APACHE) for disease severity, Sequential Organ Failure Assessment (SOFA) score for organ dysfunction and Therapeutic Intervention Scoring System (TISS) for the number of therapeutic interventions. Naturally, patients with higher disease scores, multi-organ dysfunction and need of multiple therapeutic intervention have a higher mortality and incur greater cost for ICU care. Due to the diversity of different healthcare systems and policies in each nation, validation of acute care risk scores in a local setting is important to allow accurate triaging of patients with higher possibility of survival for admission to ICU. Accuracy of mortality prediction is important for triaging and may help to save cost to the already burdened healthcare system. In this current analysis, we identify SAPS2 score that performed fairly accurate to predict those with higher risk of mortality. By applying SAPS2 score, we observed a total of five patients with mortality prediction of greater than 50% that were admitted to ICU. Two out of five patients survived, but they had longer periods of mechanical ventilation (Fig. 2). In our center, there is a lack of risk score application in triaging surgical patients for ICU admission. It is rather based on the subjective judgments of the attending intensivist and surgeon (Fig. 3). Retrospectively scoring the risk of mortality in our sample population, there were more than 50% of patients with predicted mortality risk of less than 50 percent that were not admitted to ICU (Fig. 1). Consistent with the evidence of higher survivability for patients who were admitted to ICU, [8] our series shows a survival rate of 54.5% if admitted to ICU against 17.5% when acute care was delivered in wards.

As our center still heavily relies on handwritten clinical case notes, this study was limited due to missing data in multiple patients who had to be excluded from the final analyses. Despite best efforts, only 3/5th of the study population was included for data analysis. This may adversely impact the accuracy of the results of this study. There are plans to initiate a prospective database in future to allow more accurate data collection which may be used for quality improvement programs. Another limitation in this study is the COVID-19 pandemic, which caused an observed reduction in trauma cases due to lockdowns and later caused a skew in the distribution of resources toward delivering care for COVID-19 patients. This also led to a drastic reduction in trauma cases, which may not project the true numbers of acute care in trauma cases in our center. Lastly, as our healthcare system is publicly funded and there are limited beds available at all times, precedence

was given to local acutely ill patients for ICU admission. This left the seven critically ill foreigners (11.3%) recorded in current series to have a lower priority for ICU admission in accordance with national policy.

Conclusion

ICU admission for critically ill surgical patients seems to produce a better survival rate. There is a need to improve objective triaging and better resource allocation to deliver intensive acute care in critically ill surgical patients, especially in patients with relative low mortality risk scores. Improvisation and utilization of modified risk scores in LMIC following validation may improve patient selection for ICU admission.

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