A Multi-Center Thai University-Based Surgical Intensive Care Units Study (THAI-SICU Study): Outcome of ICU Care and Adverse Events

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Objective: *Surgical intensive care units (SICUs) are special units for critically ill surgical patients both in the pre and postoperative period. There is little aggregated information about surgical patients who are admitted to the Thai surgical ICU. The objective of this report was to describe patient characteristics, outcomes of ICU care, incidence and outcomes of adverse events in the SICU in the participating SICUs.*

Material and Method: *This multi-center, prospective, observational study of nine university-based SICUs was done. All admitted patients with ages >18 years old were included. Information about patient characteristics, underlying medical problems, indication and type of ICU admission, severity score as ASA physical status in operative patients, APACHE II score and SOFA score, adverse events of interest, ventilator days, ICU and 28 days mortality. The association of outcome and predictors was reported by relative risk (RR) with 95% confidence interval (95% CI). Statistical significant difference was defined by $p<0.05$.*

Results: *During April 2011-January 2013 of total cohort time, a total of 4,652 patients from nine university-based SICUs were included in this study. Mode of patient age was 71-75 year old for both sexes. Median (IQR) of APACHE II scores and SOFA scores were 10 (7-10) and 2 (1-5), respectively. Seventy eight percent of patients were postoperative patients and 50% of them were ASA physical status III. The median of ICU stay was 2 (IQR 1-4) days. Each day of ICU increment was associated with increased 1.4 days of a hospital stay. Three percent of survived at discharge were clinically inappropriate discharge resulting in ICU readmission. Sixty-five percent were discharged home after ICU admission. ICU and 28 days mortality was 9.6% and 13.8%. The seven most common adverse events were sepsis (19.5%), acute kidney injury (AKI) (16.9%), new cardiac arrhythmias (6.2%), acute respiratory distress syndrome (ARDS) (5.8%), cardiac arrest (4.9%), delirium (3.5%) and reintubation within 72 hours (3.0%), respectively. Most of the adverse events occurred in the first five days, significantly less occurred after 15 days of ICU admission. The association between adverse events and 28 days mortality were significant for cardiac arrest (RR, 9.5; 95% CI, 8.6-10.4), respiratory failure [acute respiratory distress syndrome (ARDS) (RR, 4.6; 95% CI, 3.9-5.3), acute lung injury (ALI) (RR, 2.7; 95% CI, 2.1-3.6)], acute kidney injury (AKI) (RR, 4.2; 95% CI, 3.7-4.8), sepsis (RR, 3.6; 95% CI, 3.2-4.2), iatrogenic pneumothorax (RR, 3.2; 95% CI, 2.1-5.1), new seizure (RR, 3.1, 95% CI, 2.2-4.4), upper GI hemorrhage (RR, 3.0, 95% CI, 2.1-4.1), new cardiac arrhythmias (RR, 2.9; 95% CI, 2.4-3.5), delirium (RR, 2.1; 95% CI, 1.7-2.8), acute myocardial infarction (RR, 2.1; 95% CI, 1.4-3.1), unplanned extubation (RR, 2.1; 95% CI, 1.4-3.1), intra-abdominal hypertension (RR, 1.8; 95% CI, 1.2-2.7) and reintubation within 72 hours (RR, 1.5; 95% CI, 1.1-2.1).*

Conclusion: *This is the first large study of surgical critical care in Thailand, which had a systematic patient follow-up program. Most of the patients were elderly. Adverse events were most frequent during the first 5 days of admission and were associated with ICU and 28 days mortality.*

Keywords: *Surgical ICUs, ICU care, Adverse events, Outcomes, Postoperative*

J Med Assoc Thai 2016; 99 (Suppl. 6): S1-S14
Full text. e-Journal: *http://www.jmatonline.com*

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The preoperative, intraoperative, and postoperative periods for surgical patients are independently associated with the risk of adverse events and mortality. For the sick surgical patient, the surgical intensive care unit (SICU) is s special unit which receives critically ill surgical patients both before and after surgery for resuscitation, close monitoring and organ support. An adverse event has been defined by Wilson et al[1] as an unintentional injury or complication that arises from health care management rather than patient's underlying disease and results in disability, death, or prolonged hospital stay. McLanhen et al[2] found that 64% of adverse events in post ICU care can be prevented. Belamo et al[3], studied the incidence and characteristic of postoperative serious adverse events (SAEs) in tertiary hospitals in Australia with the definition of SAEs as acute myocardial infarction, acute pulmonary embolism, acute pulmonary edema, stroke, severe sepsis, acute renal failure and emergency ICU admission. They found that SAEs occurred more commonly after unscheduled surgery in patients older than 75 years of age and that SAEs are associated with longer hospital stay[4].

In Thailand, two large multicenter, observational studies have been completed and published as THAI study[4] and THAI-AIMs study[5] which focused primarily on the intraoperative predictors of the outcome occurring for all surgeries. However, there are scant data available about surgical intensive care unit (SICU) patients regarding ICU organization and system management, outcome of ICU care and adverse events in Thailand. Most of the available information came from a single center[6]. It is essential to have this information to reflex the whole picture of SICU care in Thailand. This multicenter study was done to define university SICUs characteristic and to evidence the result of SICU care (as ICU and hospital mortality), incidence and outcome of adverse events while admitting in the SICU. This would be a pioneer study for evidence of SICU care in Thailand. The information may be generalized and used to identify problems of care for quality improvement, targeting education as well as further research.

Material and Method

After approval from ethical committee or Institutional Review Board (IRB) of each participate site with the Clinical Trials gov. Identification number is NCT 01354197 and consented, this multicenter, prospective cohort by surveillance observation was done in nine university-based SICUs during April 2011 to November 2012. All admitted patients with ages >18 years old during the recruitment period were included in this study. Patients who might not benefit from ICU admission were excluded. These included moribund patients, patients with previous cardiopulmonary resuscitation from elsewhere in the hospital or in the field without return of spontaneous circulation, patients who had an ICU length of stay less than six hours, foreign patients and medical patients.

Detail of case record forms, ethical considerations, priority of ICU admission, adverse events, [drug error, unplanned extubation, reintubation within 72 hour, pneumothorax, pulmonary aspiration, stroke, seizure or myoclonous, upper gastrointestinal hemorrhage, intra-abdominal hypertension, symptomatic deep venous thrombosis, acute lung injury (ALI), acute respiratory distress syndrome (ARDS), acute kidney injury (AKI), cardiac arrest, acute myocardial infarction, new arrhythmias and delirium], and definitions, quality control, data monitoring, and the plan of statistical analysis were described in detail in our preliminary report[7].

Results

This part of the study focuses on patient characteristics, outcomes of ICU care, incidence of adverse events, and effect of adverse events on patient outcomes. After a formal invitation in 2010, leaders from nine university SICUs participated in this study: Siriraj (SI), Maharaj Nakhon Chiang Mai (CMU), King Chulalongkorn (CU), Prince of Songkla (PSU), Phramongkutklao (PMK), Ramathibodi (RA), Srinagarind (KKU), Vajira (BMU) and Sirindhorn Medical Center (SWU). All sites are post graduate training and considered large (>800 beds) or very large (>1,000 beds) with the capacity of 4-14 SICU beds. Detail of study flow, number of recruited patients per site, relation between proportion of patient numbers and patient-days, ICU management, ICU characteristics, patient types, primary roles of ICU attending physicians and their specialties, intensivists' positions, trainee rotations, nurse burdens and the proportion of specialties offered, flow of study and in each enrolled sites were described in detail in our previous report[7].

During a 19.7 months period of enrollment (April 2011-November 2012) and 22 months period of the end of cohort (April 2011-January 2013). A total number of 6,548 admitted patients were recruited while

1,894 patients were excluded resulting in 4,654 patients for the analysis process with a total surveillance of 17,579 ICU days. Thirty-eight percent (1,780 patients) were recruited from closed ICUs that had full time intensivists (SI and CMU); these patients were responsible for 8,457 (48%) patient-days.

Most of the patients' expenses (83.23%) were supported by the government as universal coverage and servant medical benefit. Seventy percent of the patients were transferred directly from the operating room or PACU and 17.7% were transferred from general wards. Three-fourths (78.44%) were postoperative patients and in 40%, the principal admitting diagnosis was gastrointestinal disease; in 16%, the admitting diagnosis was cardiovascular diseases. Three-fourth of the patients (73.55%) were admitted with the indication of priority $2^{(8)}$ (impending unstable, admitted for monitoring), 22.9% were priority $1^{(8)}$ (physiologic unstable, reversible underlying disease), and 2.6% had a cardiac arrest before ICU admission (Table 1).

Sixty percent of the patients were male (Table 2). Mean age of the patient were 61.5 years old. The mode of patients' age was 71-75 years old in both gender and 67.6% were older than 55 years old (Fig. 1). Mean body mass index was 23 ± 5.64 kg/m^2. Twenty-five percent of the patients did not have any underlying comorbidities. The 3 most common underlying co morbidities were hypertension (48.75%), diabetes (21.88%), and malignancy (15.6%). The most common current medications were antihypertensive drugs such as adrenergic blocking agent (18.5%), calcium channel blocker (17.2%), ACEI/ARB (14.2%), statins (18.5%) and antiplatelet (16.6%). Fourteen percent received contrast media within 48 hours and 2.6% had a cardiac arrest before ICU admission.

Sixty-three percent never smoked, 24.7% stopped smoking at least one month before hospital admission (median 96 months). Twelve percent were still smoking at the time of admission to the hospital (median 15 pack-years) (Table 2).

The median (IQR) serum hemoglobin concentration was 10.6 (9.3-12.0) gm %, serum albumin level was 2.7 (2.7-3.3) mg/dL, blood sugar was 152 (122-191) mg/dL, creatinine was 0.98 (0.7-1.46), 27.31% had abnormal EKG and 23.06% had bilateral pulmonary infiltration on chest radiographs (Table 3).

Severity of disease in this study were assessed by Acute Physiology Assessment and Chronic Health Evaluation II (APACHE II) score and Sepsis Organ Failure Assessment (SOFA) score which median (IQR) were 10 (7-15) and 2 (1-5), respectively. According to the SOFA score, the respiratory system was the most impaired system in this study followed by renal, neurology, hematology, gastrointestinal, and cardiovascular systems. Mode of APACHE II score was 7-12. The APACHE II score was >12 in 12% of patients. For SOFA score, 22.4% did not have any organ failure before ICU admission, 57.03% had score 1-5, 15.65% had score 6-10, and 5% had score >10.

Half of the postoperative patients (49.06%) were classified as American Society of Anesthesiologists (ASA) physical status III and 31.74% were ASA II (Table 4). Sixty-three percent and 31.5% underwent elective surgery and emergency surgery, respectively. Median (IQR) of the surgical time was 230 (140-340) minutes. Fifty-five percent of patients had intra-abdominal surgery, 11% had peripheral surgery (include peripheral vascular surgery), 7% had head-neck surgery, and 4% had intra-thoracic surgery.

The Median (IQR) of the total prescribed intravenous fluid was 2,740 (1,400-4,520) ml and total output was 850 (400-1,800) ml (Table 5). All patients had positive fluid balance after leaving the operating room of 1,692.5 (748-2,850) ml. Crystalloids were the main fluids used for resuscitation of 1,900 (1,000-3,050) ml but 56.07% also received colloid for fluid resuscitation of 850 (500-1,350) ml. Half of the colloid used (46.03%) was Hydroxyl Ethyl Starch (HES), then gelatin (13.54%) and albumin (0.88%) with a mean volume of 750 (500-1,050) ml, 600 (500-1,000) ml and 500 (250-1,000) ml, respectively. Fifty-two percent received blood and blood components; 48.22% received pack red cell transfusion [volume: 535 (285.5-1,000) ml] (Table 5).

At ICU discharge, 447 (9.61%) patients had died (Table 6). Patients who were admitted after a cardiac arrest had the highest mortality. Eighty-five percent (3,924) of the patients were discharged to a general ward. Three percent (144 patients) were readmitted to the ICU. Among the 110 (2.6%) patients who were considered as an inappropriate patient clinical condition at ICU discharge or premature discharge, 14 (12.73%) out of 110 patients were readmitted to the ICU. While 4,107 (97.39%) patients were considered as appropriate discharges, 99 (2.41%) out of these were readmitted to the ICU, which was significantly lower than the readmission rate for those who were discharged inappropriately ($p<0.01$).

At 28 days after ICU admission, 642

Table 1. Detail of ICU admission and principle of diagnosis

Characteristic (n = 4,652)	n (%)
Type of reimbursement (payment)	
Universal coverage	2,127 (44.8)
Servant medical benefit	1,790 (38.5)
Social security	291 (6.3)
Patient (self) pay	324 (7.0)
Insurance	39 (0.8)
Others	81 (1.7)
Admission source	
Operating room or PACU[a]	3,235 (69.54)
General ward	794 (17.07)
Emergency room	477 (10.25)
Others	144 (3.12)
Type	
Operative	3,649 (78.44)
Non-operative	1,003 (21.56)
Principle diagnosis	
Cardiovascular	739 (15.89)
Respiratory	361 (7.76)
Gastrointestinal	1,869 (40.18)
Neurological	236 (5.07)
Metabolic	82 (1.76)
Renal/genitourinary	2 (0.04)
Obstetrics and gynecology	373 (8.02)
Musculoskeletal/skin	124 (2.67)
Hematological diseases	310 (6.66)
Sepsis	172 (3.70)
Trauma	327 (7.03)
Others	57 (1.23)
Indication of admission	
Priority 1	1,056 (22.86)
Priority 2	3,398 (73.55)
Priority 3	133 (2.88)
Priority 4A	23 (0.50)
Priority 4B	10 (0.22)
Readmission within 72 hours	123 (2.64)

PACU = Post Anesthesia Care Unit; Priority 1 = Physiologic unstable, reversible underlying disease; Priority 2 = Impending unstable, admitted for monitoring; Priority 3 = Physiologic unstable, irreversible underlying; Priority 4A = No anticipate benefit from ICU; Priority 4B = Terminal and irreversible facing imminent dead[8]

Table 2. Patient baseline characteristic and smoking history

Characteristics (n = 4,652)	n (%)
Male	2,724 (58.7)
Age (years)	
Mean (SD)	61.8 (17.3)
Median (IQR)	64.0 (51.0-75.0)
Body mass index (kg/m^2)	
Mean (SD)	23.0 (5.6)
Median (IQR)	22.3 (19.6-25.2)
Underlying diseases*	
None	1,176 (25.3)
Hypertension	2,268 (48.8)
Coronary artery disease	460 (9.9)
Vascular disease	268 (5.8)
Other CVS disease	478 (10.3)
Previous stroke	276 (5.9)
Chronic obstructive pulmonary diseases	212 (4.6)
Asthma	75 (1.6)
Other RS disease	134 (2.9)
Diabetes	1,018 (21.9)
Chronic kidney disease	442 (9.5)
Malignancy	727 (15.6)
Others	323 (6.9)
Current medications	
None	1,649 (35.5)
Anti-platelet	772 (16.6)
Anticoagulant	251 (5.4)
ACEI or ARB	660 (14.2)
Beta blocker	875 (18.8)
Calcium channel blocker	799 (17.2)
Statin	859 (18.5)
NSAID	44 (1.0)
Steroid & immunosuppressive	181 (3.9)
Unknown	692 (14.9)
Radio-contrast exposure within 48 hours	588 (14.3)
Cardio-pulmonary arrest within 24 hours	121 (2.7)
Smoking status	
Never	2,947 (63.4)
Still smoker	557 (12.0)
Ex-smoker	1,148 (24.7)
Smoke quantity in pack-year, medain (IQR)	15 (6$\pm$30)
Ex-smoke duration in months, medain (IQR)	96 (18$\pm$240)

* One patients might have more than one

(13.80%) patients had died. Two hundred and two patients (4.77%), 770 (16.55%) and 3,018 (64.88%) patients were still in ICU, in hospital, or were discharged home, respectively. Most of the patients in this study had a short ICU and hospital length of stay with a median (IQR) of 2 (1-4) and 15 (9-26) days, respectively. Each additional day in ICU was associated with an increment of 1.38 days of hospital length of stay (95% CI, 1.24-1.53; p<0.01; Fig. 2).

Six percent of the patients had tracheostomy done before discharge from ICU, 168 (3.98%) patients breathed with T-piece, and 202 (4.79%) patients needed

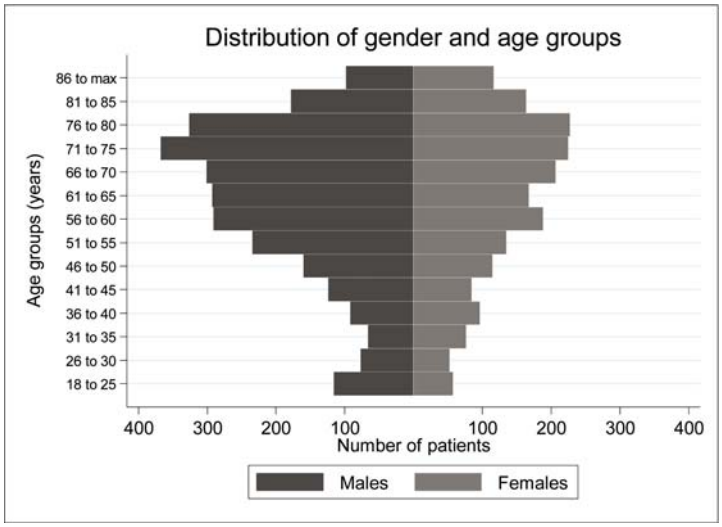

Fig. 1 Distribution of gender and age group.

Table 3. Baseline laboratory results

Baseline investigation	Values
Blood gas and chemistry	Median (IQR)
Partial arterial oxygen pressure (PaO_2) mmHg	152 (104-201)
Inspiratory oxygen fraction (FiO2)	0.4 (0.4-0.5)
Hemoglobin (mg/dL)	10.6 (9.3-12)
Albumin (g/dL)	2.7 (2.7-3.3)
Blood sugar (mg/dL)	152 (122-191)
Creatinine (mg/dL)	0.98 (0.7-1.46)
EKG (n = 4,652)	n (%)
Normal	3,127 (68.0)
Abnormal	1,256 (27.3)
No data	210 (4.6)
Chest x-ray (n = 4,652)	n (%)
Normal	3,443 (76.9)
Local infiltration	509 (11.4)
Bilateral infiltration	523 (11.7)

Table 4. Detail of postoperative patients

Characteristic (n = 3,649)	n (%)
ASA classification	
Class I	235 (6.6)
Class II	1,131 (31.7)
Class III	1,834 (50.3)
Class IV	398 (11.2)
Class V	51 (1.4)
Type of surgery	
Emergency	1,148 (31.5)
Elective	2,311 (63.3)
Not define	190 (5.2)
Site of surgery	
Upper and lower abdomen	2,608 (73.2)
Intra-thoracic	188 (4.0)
Head-neck & maxillofacial	437 (12.3)
Spine	148 (3.2)
Peripheral surgery	268 (7.3)
Operative duration in minutes, median (IQR)	230 (140-340)

respiratory support on ICU discharge. Fifty-four (1.5%) patients were reintubated within 72 hours and 34 out of 54 (63%) patients were readmitted to the ICU.

Following 17,579 days of surveillance, we found 3,142 adverse events. The most common adverse events were sepsis (19.5%), new cardiac arrhythmias (6.2%), cardiac arrest (4.9%), ARDS (3.7%), delirium (3.5%) and reintubation within 72 hours (3.0%). The other adverse events included ALI, intra-abdominal hypertension, acute myocardial infarction, unplanned extubation, upper gastrointestinal hemorrhage, new seizure, iatrogenic pneumothorax, deep vein thrombosis, new stroke, drug error, pulmonary emboli and pulmonary aspiration and they were each found in less than 3% (Table 7 and Fig. 3). Most of the adverse events occurred during the first five days, and significantly fewer occurred after the 15th day of ICU admission (Fig. 4).

The association between adverse events and 28-day mortality was significant for cardiac arrest (RR, 9.5; 95% CI, 8.5-10.4), respiratory failure [ARDS (RR,

Table 5. Intraopertaive fluid intake/output (n = 3,649)

Parameters (n = 3,649)	n (%)	Median (IQR) ml
Fluid balance		
Total intake	3,649 (100)	2,740 (1,400-4,520)
Total output	3,649 (100)	850 (400-1,800)
Fluid balance	3,649 (100)	1,692.5 (784-2,850)
Intake items		
Crystalloid	3,599 (99.0)	1,900 (1,000-3,050)
Colloids	2,046 (56.1)	850 (500-1,350)*
Gelatin	494 (13.5)	600 (500-1,000)*
Albumin	58 (1.6)	275 (100-650)*
5% Albumin	32 (0.9)	500 (250-1,000)*
20% Albumin	28 (0.8)	175 (50-450)*
25% Albumin	3 (0.1)	125 (100-500)*
Starches	1,716 (47.0)	750 (500-1,050)*
Penta-starch	195 (5.3)	550 (500-1,000)*
Tetra-starch	1,559 (42.7)	750 (500-1,000)*
Transfusions	1,933 (53.0)	719 (350-1,500)*
Pack red cell	1,760 (48.2)	535.5 (287.5-1,000)*
Fresh frozen plasma	884 (24.2)	695 (457-1,000)*
Platelet	354 (9.7)	310 (250-500)*
Output items		
Estimate blood loss	3,649 (100)	500 (200-1,150)*
Total urine output	3,649 (100)	315 (110-650)*

* Only in that group of fluid or colloid

Table 6. Outcome of ICU care

Outcome variables (n = 4,652)	n (%)
At ICU discharge	
Death	447 (9.6)
Alive	4,205 (90.4)
To general ward	3,837 (82.5)
To step down unit	209 (4.5)
To others	99 (2.2)
Still stay in ICU at 28 days	60 (1.3)
ICU discharge (alive) indications	
Appropriate good	4,107 (97.4)
Inappropriate	110 (2.6)
Type of respiratory assistance at ICU discharge	
Spontaneous breathing	3,847 (91.2)
T piece	168 (4.0)
Mechanical ventilator	202 (4.8)
Length of stay (days)	
ICU, median (IQR)	2 (1-4)
Hospital, median (IQR)	15 (9-26)

4.6; 95% CI, 3.9-5.3), ALI (RR, 2.7; 95% CI, 2.1-3.6)], AKI (RR, 4.2; 95% CI, 3.7-4.8), sepsis (RR, 3.6; 95% CI, 3.2-4.2), iatrogenic pneumothorax (RR, 3.2; 95% CI, 2.1-5.1), new seizure (RR, 3.1; 95% CI; 2.2-4.1), upper gastrointestinal hemorrhage (RR, 3.0; 95% CI, 2.1-4.1), new cardiac arrhythmias (RR, 2.9; 95% CI, 2.4-3.5), delirium (RR, 2.1; 95% CI, 1.7-2.8), acute myocardial infarction (RR, 2.1; 95% CI, 1.4-3.1), unplanned extubation (RR, 2.1; 95% CI, 1.4-3.1), intra-abdominal hypertension (RR, 1.8; 95% CI, 1.2-2.7) and reintubation within 72 hours (RR, 1.5; 95% CI, 1.1-2.1); Table 7, Fig. 5.1 and 5.2).

Discussion

Despite the diversity of SICUs' management in this study[7], but 40% (1,780) of the patients were recruited from closed ICU with full time intensivists. The result of this study also reflex the information about sick patients in SICU with maximal ICU care[6,9-11].

Eighty percent of the patients' health care paying in this study was supported by the government. Most of the patient were aging population (mean age 62 years old) which was higher than our previous report[6]. Half of the patient had at least one underlying disease such as hypertension, diabetes and malignancy.

Table 7. Incidence and density of adverse events

Adverse events	Incidence rate (% of total)	Incidence density (per 100 patient-day)	ICU mortality RR (95% CI)	*p*-value	28-days mortality RR (95% CI)	*p*-value
Drug error	10 (0.2)	0.06	2.1 (0.6-7.2)	0.246	2.2 (0.8-5.6)	0.108
Unplanned extubation	57 (1.2)	0.31	1.9 (1.0-3.3)	0.035	2.1 (1.4-3.1)	0.001
Reintubation within 72 hours	141 (3.0)	0.78	1.6 (1.1-2.4)	0.027	1.5 (1.1-2.1)	0.015
Iatrogenic pneumothorax	25 (0.5)	0.14	3.0 (1.6-5.6)	0.001	3.2 (2.1-5.1)	<0.001
Pulmonary emboli	4 (0.1)	0.02	2.6 (0.5-14.3)	0.269	1.8 (0.3-9.9)	0.493
Pulmonary aspiration	3 (0.1)	0.02	4.8 (0.7-17.3)	0.128	2.4 (0.5-12.0)	0.280
New stroke	11 (0.2)	0.06	1.9 (0.5-6.7)	0.318	1.3 (0.4-4.6)	0.666
New seizure	45 (1.0)	0.25	3.8 (2.5-5.7)	<0.001	3.1 (2.2-4.4)	<0.001
Upper gastrointestinal hemorrhage	55 (1.2)	0.30	3.3 (2.2-5.0)	<0.001	3.0 (2.1-4.1)	<0.001
Intra-abdominal hypertension	71 (1.5)	0.39	2.6 (1.7-3.9)	<0.001	1.8 (1.2-2.7)	0.009
Deep vein thrombosis	14 (0.3)	0.08	2.2 (0.8-6.1)	0.117	2.1 (0.9-4.8)	0.085
Acute lung injury	97 (2.1)	0.53	3.4 (2.5-4.6)	<0.001	2.7 (2.1-3.6)	<0.001
Acute respiratory distress syndrome	174 (3.7)	0.95	6.4 (5.4-7.6)	<0.001	4.6 (3.9-5.3)	<0.001
Sepsis	907 (19.5)	4.97	4.8 (4.0-5.7)	<0.001	3.6 (3.2-4.2)	<0.001
Acute kidney injury	786 (16.9)	4.31	5.5 (4.6-6.5)	<0.001	4.2 (3.7-4.8)	<0.001
Cardiac arrest	226 (4.9)	1.23	16.9 (14.8-19.2)	<0.001	9.5 (8.6-10.4)	<0.001
Myocardial infarction	66 (1.4)	0.37	2.4 (1.5-3.8)	<0.001	2.1 (1.4-3.1)	<0.001
New arrhythmia	287 (6.2)	1.57	3.7 (3.0-4.5)	<0.001	2.9 (2.4-3.5)	<0.001
Delirium	163 (3.5)	0.89	2.6 (2.0-3.5)	<0.001	2.1 (1.7-2.8)	<0.001

ICU = intensive care unit; RR = risk ratio or relative risk; 95% CI = 95% confidence interval

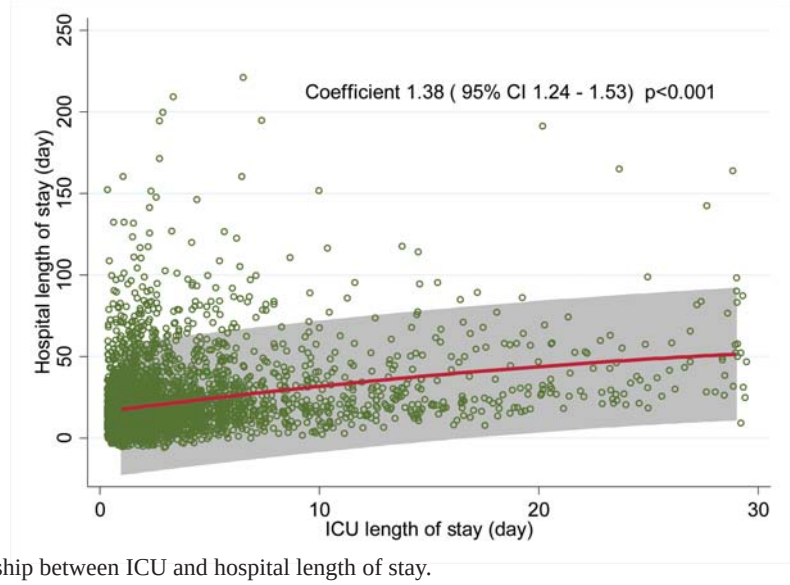

Fig. 2 Relationship between ICU and hospital length of stay.

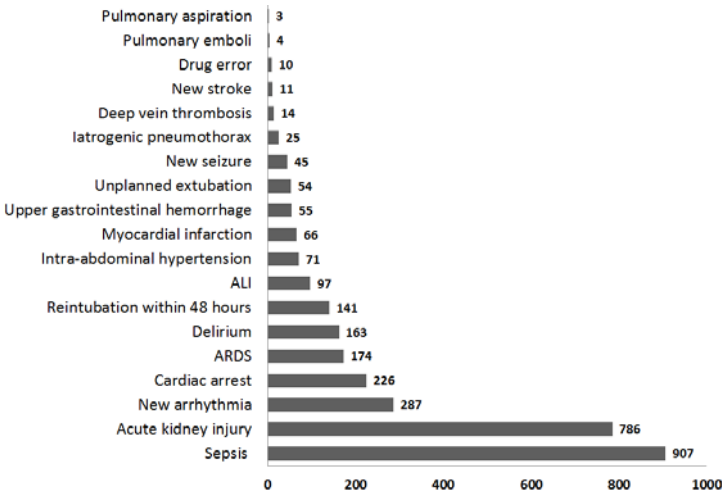

Fig. 3 Incidence of adverse events according to the frequency.

This is important information for the government to prepare for the care of sick aging population in the SICU which could have more adverse events, mortality and prolonged ICU length of stay[3,12,13].

Even though 63% of the patients never smoke, but 12% did not stop smoking before hospital admission and 25% used to smoke with high amount and long duration which can cause complications especially in the perioperative period[14]. Smoking is an important factor affecting outcome in SICU.

Most of the patients were transferred from the operating room or recovery room and 17% were transferred from the general ward. Three percent experienced post cardiac arrest which had the highest ICU mortality. As outcomes of these groups of patients depend on postoperative care and care after the event[15]. It is important to explore more in these groups of patients especially those who were transferred from the general ward and post cardiac arrest regarding the predicting factors and outcomes for quality improvement.

Sixty percent of the patients were male with almost normal BMI (22-23 kg/m^2). But baseline serum albumin level was quite low as 2.7 mg/dL. The low serum albumin level indicates the poor nutrition status resulting in increased morbidity in this particular group

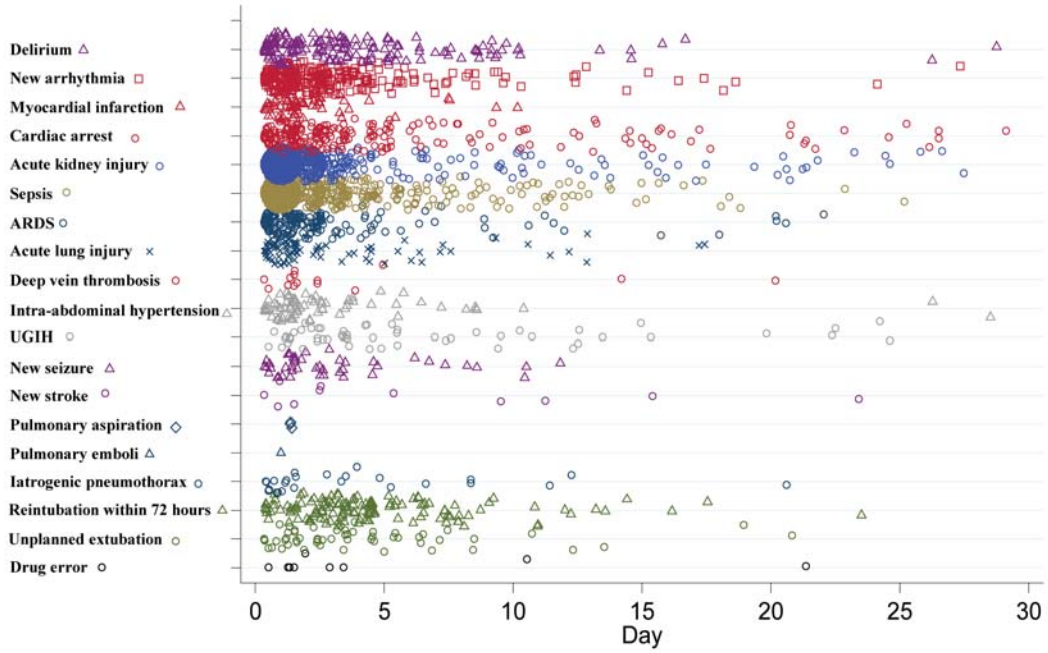

Fig. 4 The density of first day of adverse events occurrence on the day of ICU admission.

of patients who are elderly[13] and have sepsis[16]. Most of the patients had moderately severe illnesses. Respiratory system was the most organ dysfunction, then renal system despite most of the patient did not have previous chronic kidney disease. More information is also needed in patients with postoperative AKI.

In postoperative patients, which account for 78.44%, half of their preoperative physical status were classified as ASA physical status III (severe systemic disturbance from any causes)[17] with the mean operative time were 2-3 hours. As this was a study in general surgical ICU, therefore, the cardiothoracic and neurosurgical patients were excluded. Perioperative fluid management has an important effect on the patient outcome in general surgical ICU[18,19]. The unfavorable outcomes were significant increase of morbidity and mortality in the group of patients who have accumulative fluid more than 5% of body weight at ICU admission[19]. Median (IQR) of intra-operative fluid was 2,740 (1,400-4,520) ml. All admitted patients had positive fluid balance from the operating room of 1,692.5 (748-2,850) ml which might have some effect on ICU outcomes. Crystalloid was the main fluid resuscitation and 56.7% also received colloid solutions of with the median of 850 (IQR 500-1,350) ml. Half of the used colloid was hydroxyethyl starch (HES) then gelatin (13.54%) with the median of 750 (IQR 500-1,050) ml and 600 (IQR 500-1,000) ml subsequently. Albumin was rarely used (0.88%) in this study. These synthetic colloids of HES and gelatin have been found to have serious effect on kidney function mostly from accumulation in the kidney. Most of the effect depends on amount of these colloid used and baseline kidney function. In any case, most of the information was in septic patients but there will still be less information about surgical patient and the safety of these synthetic colloids that needs to be explored further[20-22]. Almost half of the patients received 2 units (535 ml) of blood transfusion with the maximum of 4 units (1,000 ml) intra-operative. With the blood conservation and outcome of perioperative blood transfusion[23], it is interesting to know more about the blood transfusion and ICU outcome.

In this study, ICU mortality and 28 days mortality were 9.6% and 13.8%, respectively which were lower than the result in previous study[6]. Anyhow, ICU mortality usually varies according the study population and ICU organization and patient's care. Post cardiac arrest patient admitted to the ICU had the highest mortality. At ICU discharge, only 64.9% were able to be discharged home and 3% were readmitted to the ICU. Inappropriate discharge and reintubation within 72 hours were factors associated with

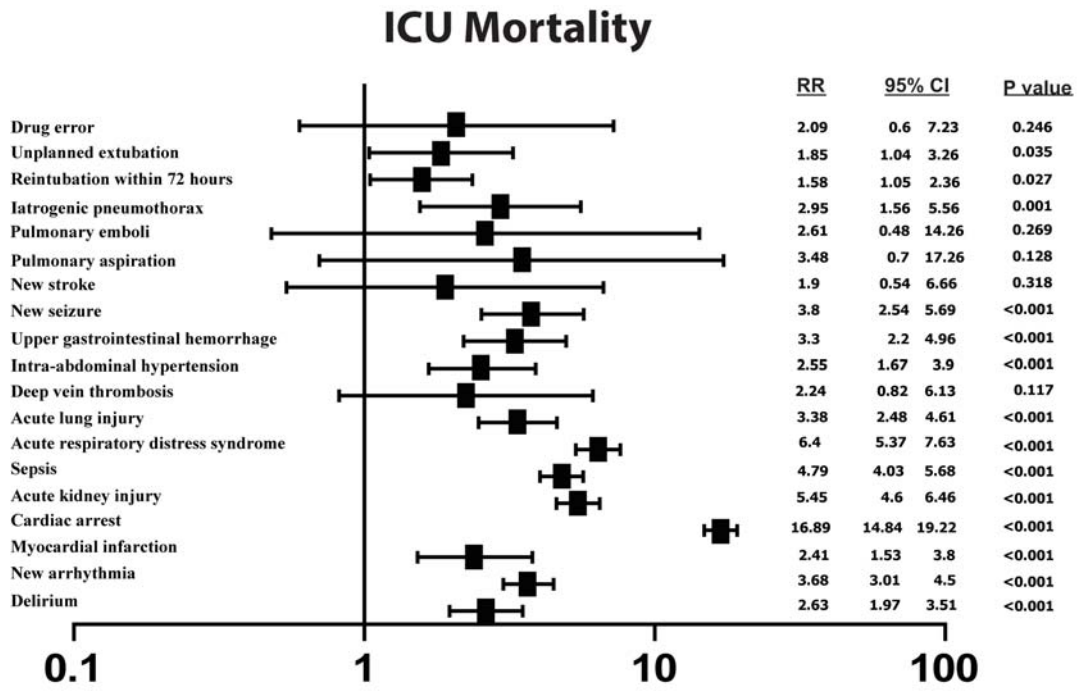

Fig. 5.1 Relative risk of adverse events on ICU mortality.

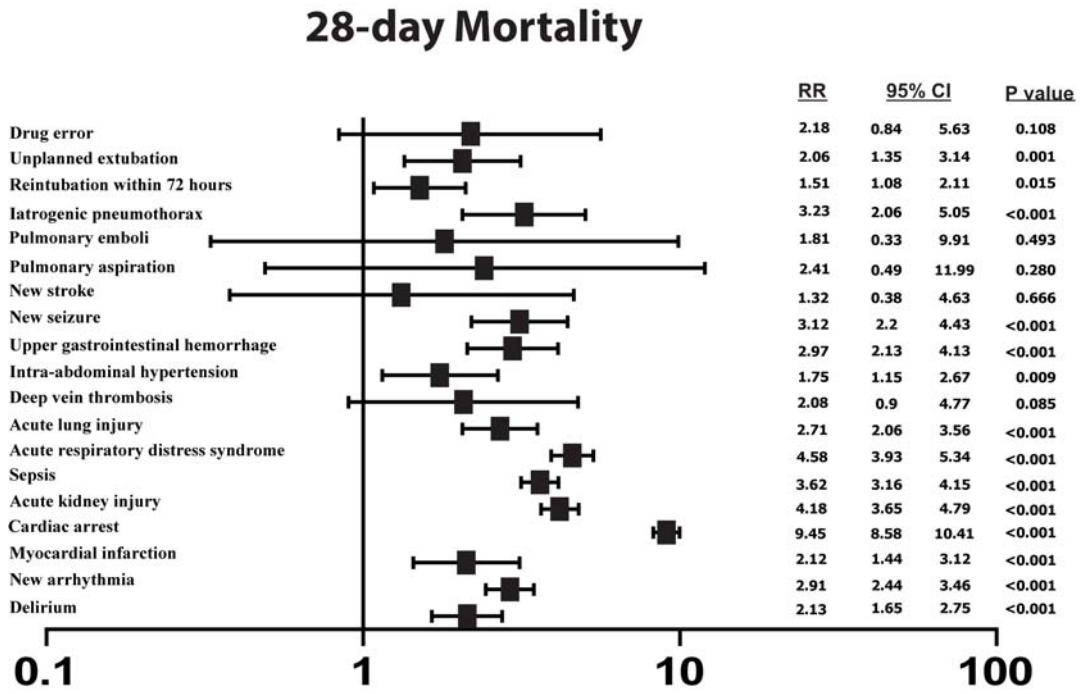

Fig. 5.2 Relative risk of adverse events on 28-days mortality.

readmission. With the crowded ICU environment, some of the ICU patients were discharged inappropriately and were readmitted to the ICU with poor outcomes[24,25]. More information is needed to know about this group of patients for developing quality improvement program to deal with

inappropriate ICU discharge and reintubation. Smischney et al[25] introduced ICU check list before discharging the patients that might help decrease the inappropriate ICU discharge and readmission to the ICU.

ICU length of stay was found to be significantly correlated with hospital length of stay as each day of ICU increment was associated with 1.38 days of hospital length of stay. Information is needed in order to decrease ICU length of stay, which is the most expensive part of the hospital expense[26]. Anyhow, inappropriate discharge will result in readmission or mortality on the floor.

Most of the adverse event occurred in the first five days, significantly less occurred after 15 days of ICU admission. Sepsis (49.5%), AKI (16.90%) and adverse events of cardiovascular system (11.03%) were the three most adverse events found in this study. While adverse events from the treatment such as drug error were found only in 0.75%. This figure may be underestimated as we did not follow near miss events[27] and the incidence reported from each site.

Fig. 5.1 and 5.2 represented the whole picture of the effect of adverse events on ICU and hospital mortality. All the adverse events had a significant increase ICU and 28 days mortality. Anyhow some of the adverse events such as drug error, pulmonary emboli, pulmonary aspiration, new stroke, deep vein thrombosis, did not reach statistical significant level. This could be explained from the low incidence and low sample size of these adverse events. Patients survived from cardiac arrest in the ICU had highest relative risk of mortality. In patient with acute lung injury progressing to be ARDS the RR of mortality increased from 2.7 to 4.5. AKI and sepsis also were adverse events with high incidence and high mortality despite most of the patients' baseline investigations did not have chronic kidney disease. In this study, some of the adverse events such as delirium had been regrettably resulting in high mortality (RR 2.13)[28]. However, survival from the adverse events depends on ICU and hospital care after the events. More information is needed in all adverse events especially ones with high incidence and high mortality such as cardiac arrest, ARDS, AKI, sepsis including delirium especially predicting factors and care after the events.

Finally, this is a multicenter trial with high number of database; there might be some error despite the training process and quality control. The incidence of some adverse events such as abdominal hypertension, deep venous thrombosis were lower than expected as the study of incidence of these adverse events is complicated and needs specialized investigation. Long-term follow-up of 90 days could not be done as these would need a lot more resources, even though this is a good indicator.

Conclusion

This is the first large study of surgical critical care in Thailand which had a systematic patient follow-up program. Most of the patients were elderly. Adverse events were most frequent during the first 5 days of admission and were associated with ICU and 28 days mortality. The information from this study can be used as a plan for care and to prioritize improvement in preventing adverse events in these patients. The results also prompt further study of predictors of adverse events and long-term follow-up to 90 days.

What is already known on this topic?

More aging population was admitted to the SICU. Smoking still was a significant habit found. Post cardiac arrest patient admitting to the ICU had highest mortality. There was a significant correlation between ICU length of stay and hospital stay. Inappropriate patient clinical condition at ICU discharge could result in ICU readmission. Sepsis, AKI, ARDS, new cardiac arrhythmias and cardiac arrest were the common adverse events which were found more in the first 5 days and gradually decreased in the 15 days of ICU admission. ALL adverse events result in high mortality especially cardiac arrest. Attention should be paid to patients who had delirium which also could result in increased ICU mortality.

What this study adds?

Aging population will be found more in SICU. There was significant correlation between ICU and hospital length of stay. Smoking still was a habit found that could result in increase adverse events and ICU mortality. Sepsis, AKI, ARDS, and delirium were the common adverse events founds and found more in the first 5 days and gradually decrease in the 15 days of ICU admission. Post cardiac arrest, both pre- and during ICU admission resulting in highest mortality.

Acknowledgements

The present study funding was supported by the Royal College of Anesthesiology of Thailand, National Research Council of Thailand (NRCT), Mahidol University, Chulalongkorn University, Chiang Mai University, Khon Kaen University, Prince of

Songkla University, Navamindradhiraj University, Phramongkutklao Hospital and Srinakharinwirot University. Data processing was performed by the Medical Research Network of the Consortium of Thai Medical Schools (MedResNet). The authors give thanks to all of the nurses and research assistants involved in the present study. The Publication fee was provided by the Medical Association of Thailand (Prasert Prasarttong-Osoth).

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Potential conflicts of interest

The abstract of this study was presented at the 35th International on Intensive Care and Emergency Medicine, March 2015, Brussels, Belgium.

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การศึกษาสหสถาบันในหออภิบาลผู้ป่วยหนักทางศัลยกรรมของโรงพยาบาลมหาวิทยาลัยในประเทศไทย (THAI-SICU study): ผลของการรักษาและภาวะแทรกซ้อนที่เกิดขึ้นระหว่างรับการรักษาในหออภิบาล

สุณีรัตน์ คงเสรีพงศ์, กวีศักดิ์ จิตตวัฒนรัตน์, ธรรมศักดิ์ ทวิชศรี, สุนิสา ฉัตรมงคลชาติ, สัณฐิติ โมรากุล, เพชร วัชรสินธุ์, วราภรณ์ เชื้ออิน, สุจารีย์ ภู่พิพัฒน์ภาพ, ชัยพฤกษ์ กุสุมาพรรณโญ, กลุ่มศึกษา THAI-SICU

วัตถุประสงค์: หอผู้ป่วยหนักศัลยกรรมเป็นหออภิบาลที่มีลักษณะจำเพาะของผู้ป่วยศัลยกรรมที่ให้การดูแลผู้ป่วยในช่วงก่อนและหลังผ่าตัด แต่ยังไม่มีการศึกษาไปข้างหน้าแบบสหสถาบันของผู้ป่วยศัลยกรรมที่มารับการรักษาในหออภิบาลผู้ป่วยหนักศัลยกรรม วัตถุประสงค์ของรายงานนี้เพื่อพรรณนาถึงลักษณะของผู้ป่วยที่เข้ารับการรักษา ผลลัพธ์ของการรักษา และอุบัติการณ์และผลลัพธ์ของภาวะแทรกซ้อนที่เกิดขึ้นระหว่างที่เข้ารับการรักษาและผลลัพธ์

ในหออภิบาลผู้ป่วยหนักศัลยกรรมที่เข้าร่วมการศึกษา

วัสดุและวิธีการ: *การศึกษานี้เป็นการศึกษาแบบสหสถาบันไปข้างหน้าในหออภิบาลผู้ป่วยหนักศัลยกรรมในผู้ป่วยอายุ >18 ปี โดยรวบรวมข้อมูลเกี่ยวกับลักษณะของผู้ป่วยและโรคประจำตัวของผู้ป่วย ข้อบ่งชี้และชนิดของการเข้ารักษาในหออภิบาล ความรุนแรงของโรค (APACHE II score, SOFA score) และ ASA physical status ในผู้ป่วยที่ได้รับการผ่าตัด ภาวะแทรกซ้อนที่ทำการศึกษาและผลลัพธ์ รวมถึงระยะเวลาที่ต้องใช้ เครื่องช่วยหายใจ อัตราตายในหอผู้ป่วยหนักและที่ 28 วัน*

ผลการศึกษา: *ในช่วงเดือนเมษายน พ.ศ. 2554 ถึง เดือนมกราคม พ.ศ. 2556 มีผู้ป่วยจำนวน 4,652 คนจากหออภิบาลผู้ป่วยหนักของโรงพยาบาล มหาวิทยาลัย 9 แห่งเข้าร่วมในการศึกษา ผู้ป่วยส่วนใหญ่อยู่ในกลุ่มผู้สูงอายุโดยมีระดับฐานนิยมระหว่าง 71-75 ปี ทั้งชายและหญิง และมีระดับความรุนแรงของโรคอยู่ในเกณฑ์ปานกลาง โดยมีค่า APACHE II score และค่า SOFA score ที่ 10 (ค่าพิสัยควอไทล์ 7-15) และ 2 (ค่าพิสัยควอไทล์ 1-5) ตามลำดับ ร้อยละ 74.88 เป็นผู้ป่วยหลังผ่าตัดซึ่งครึ่งหนึ่งเป็น ASA physical status 3, ผู้ป่วยส่วนใหญ่รับการรักษาในหออภิบาลประมาณ 2 วัน (ค่าพิสัยควอไทล์ 1-4) และพบความสัมพันธ์อย่างมีนัยสำคัญของวันนอนในหออภิบาลและวันนอนในโรงพยาบาล โดยร้อยละ 65 ของผู้ป่วยสามารถ กลับบ้านได้หลังเข้ารับการรักษาในหออภิบาล ร้อยละ 2.3 ของผู้ป่วยถูกจำหน่ายออกจาหออภิบาลขณะยังมีชีวิตพบว่า มีอาการทางคลินิกไม่เหมาะสมทำให้ ร้อยละ 12.73 ของผู่ป่วยกลุ่มนี้ต้องกลับเข้ารักษาในหออภิบาลอีกครั้ง การศึกษานี้พบอัตราตายในหออภิบาลร้อยละ 9.6 และ 13.8 ตามลำดับ เจ็ดอันดับภาวะแทรกซ้อนที่พบบ่อยเรียงตามลำดับคือ เซฟสิส (ร้อยละ 19.5), ภาวะไตวายเฉียบพลัน (ร้อยละ 16.9), หัวใจเต้นผิดจังหวะ (ร้อยละ 6.2), ภาวะหายใจล้มเหลว (ร้อยละ 5.8), ภาวะหัวใจหยุดเต้น (ร้อยละ 4.9), ภาวะเพ้อคลั่ง (ร้อยละ 3.5) และใส่ท่อช่วยหายใจซ้ำภายใน 72 ชั่วโมง (ร้อยละ 3.0), โดยภาวะแทรกซ้อนส่วนใหญ่พบอุบัติการณ์หนาแน่นใน 5 วันแรกที่ผู้ป่วยเข้ารับการรักษาในหออภิบาล และน้อยลงอย่างมีนัยสำคัญหลังวันที่ 15, ความสัมพันธ์ระหว่างภาวะแทรกซ้อนและการเสียชีวิตที่ 28 วัน อย่างมีนัยสำคัญ คือ หัวใจหยุดเต้น (RR, 9.5; 95% CI, 8.6-10.4), ภาวะหายใจล้มเหลวรุนแรงชนิด ARDS (RR, 4.6; 95% CI, 3.9-5.3), ภาวะหายใจล้มเหลวปานกลางชนิด ALI (RR, 2.7; 95% CI, 2.1-3.6)], ภาวะไตวายเฉียบพลัน (RR, 4.2; 95% CI, 3.7-4.8), เซฟสิส (RR, 3.6; 95% CI, 3.2-4.2), ลมรั่วในปอด (RR, 3.2; 95% CI, 2.1-5.1), โรคลมชัก (RR, 3.1, 95% CI, 2.2-4.4), ภาวะเลือดออกในทางเดินอาหาร (RR, 3.0, 95% CI, 2.1-4.1), หัวใจเต้นผิดจังหวะ (RR, 2.9; 95% CI, 2.4-3.5), ภาวะเพ้อคลั่ง (RR, 2.1; 95% CI, 1.7-2.8), กล้ามเนื้อหัวใจตาย (RR, 2.1; 95% CI, 1.4-3.1), ถอดท่อช่วยหายใจไม่เป็นไปตามแผนการรักษา (RR, 2.1; 95% CI, 1.4-3.1), ความดันในช่องท้องสูง (RR, 1.8; 95% CI, 1.2-2.7) และการใส่ท่อช่วยหายใจใหม่ภายใน 72 ชั่วโมง (RR, 1.5; 95% CI, 1.1-2.1)*

สรุป: *การศึกษานี้เป็นการศึกษาเกี่ยวกับผู้ป่วยวิกฤตที่เข้ารับการรักษาในหอผู้ป่วยวิกฤตที่ใหญ่ในประเทศไทยที่มีการติดตามผู้ป่วยอย่างเป็นระบบ ผู้ป่วยส่วนใหญ่เป็นผู้ป่วยสูงอายุ ภาวะแทรกซ้อนที่พบมักพบภายใน 5 วันแรกของการเข้ารับการรักษา และภาวะแทรกซ้อนเกือบทั้งหมดมีผลทำให้อัตราตายในหอผู้ป่วยหนักและที่ 28 วันสูงขึ้นอย่างมีนัยสำคัญ*