# Incidence of Cardiac Arrest and Related Factors in a Multi-Center Thai University-Based Surgical Intensive Care Units Study (THAI-SICU Study)

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***Objective:*** *To describe the incidences, outcomes and determine the risk factor(s) of cardiac arrest in surgical intensive care unit (SICU).*

***Material and Method:*** *We collected data between April 2011 and January 2013. The case record form (CRF) included the CRF 1 (admission, daily screening and discharge data) and the CRF 2 for cardiac arrest events. The patients were followed-up until discharge from SICU or for up to 28 days after admission in SICU.*

***Results:*** *The incidence of cardiac arrest in SICU was 226 in 4,652 patients (4.9%). The APACHE II score at the day with cardiac arrest were 24.1. Initial monitor rhythm during cardiac was asystole (35.4%), bradycardia (22.6%) and pulseless electrical activity (14.6%). The main cause was poor patient condition before admission (51.3%). Most of the cardiac arrest patients (73.9%) had antecedents within 24 hour and the most common antecedents were hypotension, metabolic disturbances and sepsis and/or septic shock. The overall return of spontaneous circulation rate was 23.5%. At hospital discharge, the mortality rate (91.6%) was statistically different between the cardiac arrest and non-cardiac arrest group ($p<0.001$). The Acute Physiologic and Chronic Health Evaluation II score (APACHE II score) (Odds ratio, (OR 1.15, 95% CI 1.11-1.19, $p<0.001$), Sequential Organ Failure Assessment score (SOFA score) (OR 1.12, 95% CI 1.03-1.20, $p = 0.005$) and American Society of Anesthesiologists physical status physical status (ASA PS) $\geq 3$ (OR 2.32, 95% CI 1.33-4.04, $p = 0.003$) were significantly risk factors for cardiac arrest.*

***Conclusion:*** *Cardiac arrest in the SICU was uncommon. Initial non-shockable rhythms were common and mostly had antecedents before cardiac arrest. The APACHE II score, SOFA score and ASA PS $\geq 3$ were independent risk factors for cardiac arrest in SICU.*

***Keywords:*** *Surgical intensive care unit, Cardiac arrest, Outcomes*

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A surgical intensive care unit (SICU) patient has an acute, life-threatening or potentially life-threatening surgical and medical condition(s). Despite high quality of care and the best monitoring technology, cardiac arrest (CA) frequently occurs in SICU. For planning effective management and good outcomes, it is important to know about cardiac arrest. Studies regarding resuscitation outcomes in the ICU have been erratic and discrepantly-defined, resulting in wide ranging survival-to-discharge rates (between 0% and 47.3%)[1-4].

The Thai Anesthesia Incident Monitoring Study (THAI-AIMS)[5], a large, multicenter, observational study, reported that the incidence of cardiac arrest within 24 hour after anesthesia was 14%. In the THAI-SICU study[6] was a multi-center, prospective, cohort observational registry of SICU patients was conducted and the main objectives were to describe the overall outcomes and incidence of adverse events in university-based SICUs in Thailand. Our objective was to determine the incidence of cardiac arrest in SICU, its characteristics, main causes, outcomes and was to ascertain the risk factor(s) for

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cardiac arrest in SICU.

## Material and Method

### *Design and setting*

Data were collected between April 1, 2011 and January 31, 2013 on SICU patients from nine university-affiliated, tertiary-care hospitals. The participant centers of University Ethics Committee and the Thailand Joint Research Ethics Committees (JREC) approved the study. Our Clinical Trials.gov identification number was NCT01354197.

### *Data collection*

The case record form (CRF) in this study was developed by the principle investigators (PI) from each of the nine university-affiliated, tertiary-care hospitals[7]. Patient data were categorized into pre-event, event, and post-event variables (CRF 1: admission, daily screening and discharge data).

During the SICU stay, the daily screening CRF was completed. If a cardiac arrest occurred, the CRF 2 (adverse event form) was completed. The definition of cardiac arrest included all sudden cardiac arrests in the ICU. At discharge from SICU, the discharge CRF was used. Patients were followed-up for up to 28 days after being admitted to ICU.

Core data elements included: demographics, characteristics, causes, rate of return of spontaneous circulation (ROSC), survived events and survival-to-discharge. ROSC was defined as the presence of spontaneous pulsation for more than 30 seconds after resuscitation. Survived event indicated sustained ROSC maintained for more than 20 minutes. Survival-to-hospital discharge meant discharged alive[7].

The presumed causes of cardiac arrest defined into 4 groups: (1) medical cause (2) surgical cause (3) anesthetic cause and (4) poor patient diseases or conditions (patients with severe systemic diseases/ several conditions/inadequate preparation to operating room and SICU/emergency situation)[8].

In order to determine the post resuscitation, neurological status, the cerebral performance score (CPC) score was used to assess the neurological outcomes[4]. CPC I indicated good cerebral performance, while CPC II indicated moderate cerebral disability, CPC III indicated severe cerebral disability, CPC IV indicated a vegetative state, and CPC V indicated death. Since overall survival in our cohort was low, we simplified the grouping by categorizing CPC I and II as good neurological outcomes and III, IV and V as poor outcomes.

Well-trained residents or critical care nurses-who worked in SICU during the study period-collected all data. The principle investigator from each study site audited and re-checked the data using the online medical research tool program, OMERET. All online data were clarified using the Central Data Monitoring Unit; at both Chulalongkorn University and at Med Res Net. External surveyors performed quality control and data monitoring.

All patients ($\geq$18 years) admitted in the SICU during the study period are included, if patients having experienced cardiac arrest during admission-were eligible for inclusion for these study. The exclusion criteria should follow the main paper already published.

### *Outcome measures*

The primary outcome measure was incidence of cardiac arrest in SICU; its characteristics, causes and outcomes. The secondary outcome measure was the risk factor(s) for cardiac arrest in SICU.

### *Statistical analysis*

Descriptive numerical and categorical statistics were performed for continuous data with parametric or non-parametric distribution, by calculating the respective mean $\pm$ SD or median and the interquartile range (IQR). An univariate analysis or independent t-test was used to compare numerical variables, while a $\chi^2$ or Fisher exact test was used to compare categorical variables. The OR and 95% CI are reported for the risk factor(s) for new cardiac arrest events. All the tests were 2-tailed. The $p \leq 0.05$ was considered significant. Data were analyzed and exported using the STATA software for Windows (Version 11.0; STATA Inc, College Station, TX).

## Results

A total of 4,652 patients were enrolled over period of 19.7 months. The overall incidence of cardiac arrest was 4.9% (226 of 4,652 patients). Baseline characteristics are presented in Table 1. Patients with cardiac arrest were significantly higher percentage of male (68.6% versus 58.2%, $p$ = 0.002), had higher American Society of Anesthesiologists physical status (ASA PS) $\geq$3 (57.1% versus 11.6%, $p$<0.001) and higher incidence of sepsis (43% versus 18.3%, $p$<0.01) compared to those without cardiac arrest. Cardiac arrest patients had significantly higher Acute Physiologic and Chronic Health Evaluation II score (APACHE II score) on the day with cardiac arrest (APACHE II score was 24.1$\pm$9.3 for cardiac arrest patients versus 11.2 $\pm$ 6.4 for

**Table 1.** Patient demographics of cardiac arrest and non-cardiac arrest groups in the THAI-SICU study

| Variable | Cardiac arrest (n = 226) | Non-cardiac arrest (n = 4,426 | *p*-value |
|---|---|---|---|
| Sex, n (%) | | | |
| Male | 155 (68.6) | 2,574 (58.2) | 0.002 |
| Female | 71 (31.4) | 1,852 (41.8) | |
| Age; mean ± SD | 60.1±18.9 | 61.8±17.2 | 0.148 |
| Age <65 years | 128 (56.6) | 2,306 (52.0) | |
| Age ≥65 years | 98 (43.3) | 2,120 (48.0) | |
| ASA classification, n (%) | | | <0.001 |
| I | 0 (0.0) | 235 (6.9) | |
| II | 16 (13.5) | 1,115 (31.7) | |
| III | 35 (29.4) | 1,713 (49.8) | |
| IV | 47 (39.4) | 351 (10.5) | |
| V | 21 (17.7) | 27 (1.0) | |
| VI | 0 (0.0) | 3 (0.1) | |
| Emergency | 89 (74.2) | 1,059 (31.7) | <0.001 |
| Coexisting disease, n (%) | | | |
| Hypertension | 84 (37.2) | 2,184 (49.3) | <0.001 |
| Malignancy | 43 (19.03) | 684 (15.4) | 0.149 |
| Diabetes mellitus | 36 (15.9) | 982 (22.2) | 0.026 |
| Chronic renal failure | 22 (9.7) | 420 (9.5) | 0.902 |
| Previous stroke | 21 (9.3) | 255 (5.8) | 0.028 |
| Vascular disease | 19 (8.4) | 249 (5.6) | 0.080 |
| Other cardiovascular disease | 18 (7.9) | 353 (8.0) | 0.995 |
| Chronic obstructive pulmonary disease | 13 (5.7) | 199 (4.5) | 0.377 |
| Coronary artery disease | 12 (5.3) | 448 (10.1) | 0.018 |
| Congestive heart failure | 5 (2.2) | 102 (2.3) | 0.928 |
| Organ transplantation | 4 (1.8) | 21 (0.5) | 0.009 |
| Asthma | 3 (1.3) | 72 (1.6) | 0.727 |
| HIV positive or AIDS | 3 (1.3) | 15 (0.3) | 0.020 |
| Immune disease | 3 (1.3) | 53 (1.2) | 0.861 |
| Other respiratory disease | 1 (0.4) | 133 (3.0) | 0.025 |
| None of these conditions | 52 (23.0) | 1,124 (25.4) | 0.421 |
| Site of operation | | | |
| Upper abdomen | 61 (27.0) | 1,240 (28.0) | 0.738 |
| Lower abdomen | 48 (21.2) | 1,234 (277.9) | 0.029 |
| Extremities | 15 (6.6) | 370 (8.4) | 0.359 |
| Thoracic | 14 (6.2) | 174 (3.9) | 0.092 |
| Sepsis, n (%) | 97 (43) | 810 (18.3) | <0.001 |
| APACHE II score [median (IQR)] | 24.11±9.30 | 11.2±6.4 | <0.001 |
| SOFA score [median (IQR)] | 8 (5-12) | 2 (1-5) | <0.010 |
| Duration of surgery, minutes [median (IQR)] | 145 (105-260) | 240 (150-350) | <0.001 |
| Sites of ICU (n, %) | | | <0.001 |
| A | 40 (17.7) | 937 (21.2) | |
| B | 11 (4.8) | 408 (9.2) | |
| C | 8 (3.5) | 584 (13.2) | |
| D | 4 (1.8) | 415 (9.4) | |
| E | 49 (21.7) | 349 (7.9) | |
| F | 4 (1.8) | 141 (3.2) | |
| G | 23 (10.2) | 778 (17.6) | |
| H | 15 (6.6) | 386 (8.7) | |
| I | 72 (31.9) | 428 (9.6) | |
| ICU mortality, n (%) | 206 (91.1) | 240 (5.4) | <0.001 |
| Hospital discharge mortality, n (%) | 207 (91.6) | 344 (8.2) | <0.001 |
| 28-days mortality, n (%) | 209 (92.5) | 433 (9.8) | <0.001 |

ASA = American Society of Anesthesiologists; SICU = Surgical intensive care unit; APACHE = Acute physiology and chronic health evaluation; SOFA = Sequential organ failure assessment; IQR = Interquartile range

non-cardiac arrest patients, $p<0.001$) and higher Sequential Organ Failure Assessment score (SOFA score). SOFA score was 8 (5-12) for cardiac arrest patients versus 2 (1-5) for non-cardiac arrest patients, $p<0.010$). Cardiac arrest patients also had significantly higher ICU mortality (91.1% versus 5.4%, $p<0.001$) and higher 28-day hospital mortality (92.5% versus 9.8%, $p<0.001$). Cardiac arrest was commonly found at the first 24 hours (30.5%) and 76.5% of cardiac arrest occurred within 5 days after ICU admission.

Characteristics of cardiac arrest patients in SICU were presented in Table 2. Most of cardiac arrest was diagnosed by a monitor display alarm (71.2%) and non-palpable pulse (50.4%). The most common initial rhythms of cardiac arrest were asystole (35.4%), bradycardia (22.6%) and pulseless electrical activity (PEA) (14.6%). The main cause of cardiac arrest was poor patient conditions before ICU admission (51.3%). The majority (73.9%) of cardiac arrest patients had evidence of antecedents including hypotension, metabolic disturbances, sepsis and/or septic shock or alteration of consciousness within 24 hour prior to the event.

Results and outcomes of cardiac arrest were showed in Table 3. The rate of overall return of ROSC (sustained and unsustained ROSC) after cardiac arrest was 23.5% (53 of 226). The respective rate of sustained ROSC, survival-to-ICU discharge and survival-to-hospital discharge was 17.7%, 8.9% and 8.4%. The average duration of resuscitation was 24.3 min (0-146 min). The respective mortality rate of cardiac arrest at immediately period and 24 hour after cardiopulmonary resuscitation (CPR) was 76.5% and 87.6% (Table 3).

At the time of ICU discharge, 18 of the 20 survivors had a CPC score of I-II (90%), while 2 of 20 survivors had a CPC score of IV (10%) (Table 3).

The univariable and multivariable regression analysis of the risk factors for cardiac arrest were presented in Table 4. APACHE II score, SOFA score, ASA PS $\geq$3, sepsis, post-operative emergency surgery and AKI were significant risk factors for univariable logistic regression. However, APACHE II score (OR 1.15, 95% CI 1.11-1.19, $p<0.001$), SOFA score (OR 1.12, 95% CI 1.03-1.20, $p = 0.005$) and ASA PS $\geq$3 (OR 2.32, 95% CI 1.33-4.04, $p = 0.003$) were independent risk factors of cardiac arrest in SICU in multivariable logistic regression analysis.

**Table 2.** Characteristics of cardiac arrest in SICU (n = 226)

| Time event | Number (%) |
|---|---|
| Event location | |
| During transfer from operating room | 5 (2.2) |
| During procedure in SICU | 5 (2.2) |
| At rest in SICU | 182 (80.5) |
| Not define | 34 (15.0) |
| Witness of event | |
| Nurse | 154 (68.1) |
| Surgeon | 30 (13.3) |
| Resident | 29 (12.8) |
| Anesthesiologist | 9 (4.0) |
| Other (intensivist) | 4 (1.8) |
| Suspected sign* | |
| No pulse | 114 (50.4) |
| Monitor display alarm | 161 (71.2) |
| Not define | 34 (15.0) |
| Initial rhythm documented cardiac arrest | |
| Asystole | 80 (35.4) |
| Bradycardia | 51 (22.6) |
| Pulseless electrical activity | 33 (14.6) |
| Ventricular tachycardia | 10 (4.4) |
| Ventricular fibrillation | 3 (1.3) |
| Other | 8 (3.5) |
| Not define | 41 (18.1) |
| Previous cardiac arrest within 24 hour | 28 (12.4) |
| Main cause* | |
| Poor patient conditions | 116 (51.3) |
| Medical cause | 101 (44.7) |
| Surgical cause | 35 (15.5) |
| Anesthetic cause | 0 (0) |
| Cardiac arrest with antecedents | 167 (73.9) |
| Antecedents present prior cardiac arrest* | |
| Hypotension | 124 (54.9) |
| Metabolic disturbances | 102 (45.1) |
| Sepsis and/or septic shock | 97 (42.9) |
| Alteration of conscious | 89 (39.4) |
| Hypoxemia | 66 (29.2) |
| Pulse rate >140 bpm | 51 (22.6) |
| Hypovolemic shock with uncontrolled bleeding | 48 (21.2) |
| Respiratory rate >36 bpm | 39 (17.3) |
| New cardiac arrhythmias | 23 (10.2) |
| Pulse rate <40 bpm | 21 (9.3) |
| Cardiogenic shock | 10 (4.4) |
| Other | 10 (4.4) |
| Myocardial ischemia | 8 (3.5) |
| Threatened airway | 1 (0.4) |
| Respiratory rate <5 bpm | 0 (0) |

* Can should more than 1choice; SICU: Surgical intensive care unit; Hypotension: systolic blood pressure < 90 mmHg; hypoxemia: a partial pressure of oxygen in arterial blood ($PaO_2$) of less than 80 mmHg; bpm: beats or breaths per minute

## Discussion

The overall incidence of cardiac arrest in this study was 4.9% (485: 10,000 ICU admissions), which

was significantly higher than the incidence of perioperative cardiac arrest in THAI-AIM study (30.8: 10,000). This finding corresponded to a previous study that the incidence of cardiac arrest in ICU was higher than general ward[5]. In addition, the incidence of cardiac arrest in Thai SICU was higher than those of previous studies (range, 0.5-2.9%)[8-13]. However, this incident was lower than other studies (22.1-27.9%)[14,15]. This showed that the incidence of cardiac arrest varies widely, depending on differences in the population, definitions used, characteristics studied, patient co-morbidity and the types of medical personnel working in the SICU.

**Table 3.** Results and outcomes after cardiac arrest

| Variables | Number (%) |
|---|---|
| Reason for stop CPR, (n = 226) | |
| ROSC | 42 (18.6) |
| Death | 69 (30.5) |
| DNAR | 115 (50.9) |
| Results of CPR, (n = 226) | |
| Sustained ROSC | 40 (17.7) |
| Unsustained ROSC | 13 (5.8) |
| Never achieved ROSC | 173 (76.5) |
| Immediate outcomes (within 24 hours) (n = 226) | |
| Good cerebral recovery | 8 (3.5) |
| Disable | 9 (4.0) |
| Remained unconscious | 11 (4.9) |
| Death | 198 (87.6) |
| Final outcomes (ICU discharge) (n = 226) | |
| Complete recovery | 6 (2.7) |
| Disable | 9 (4.0) |
| Remained unconscious | 5 (2.2) |
| Death | 206 (91.1) |
| CPC of survived patients (n = 20) | |
| CPC I | 8 (40.0) |
| CPC II | 10 (50.0) |
| CPC III | 0 (0.0) |
| CPC IV | 2 (10.0) |
| CPC V | 0 (0.0) |

CPC = Cerebral performance score; ROSC = Return of spontaneous circulation; DNAR = Do not attempt resuscitate orders; SICU = Surgical intensive care unit

This study found that independent risk factors of cardiac arrest were ASA PS ≥3, higher APACHE II score, and higher SOFA score. Higher ASA PS increased risk of cardiac arrest in previous studies[16-18] because higher ASA PS could be related to severe disease and multiple co-morbidities. Most of cardiac arrest patients were ASA PS III-V and most of this incident occurred postoperatively. An ASA PS V was commonly associated with the highest mortality rate[16,17]. Generally, APACHE II and SOFA scoring system have been often used to predict risk of ICU mortality[19-21]. Apart from that, this study showed the higher APACHE II score, the higher SOFA score and increased risk of cardiac arrest in ICU. Higher APACHE II and higher SOFA score correlated with severe illness, organ dysfunction and poor outcome[21]. These results can provide additional prognostic information among ICU patients. An increase in one point of APACHE II score was associated with an increase in the possibility of death after cardiac arrest about 9%[21]. APACHE II score is a good predictor of illness severity as well as outcome of cardiac arrest.

The present study found that there was higher ICU and hospital mortality after cardiac arrest. This

**Table 4.** The univariable and multivariable regression analysis for risk factors of cardiac arrest in SICU

| Variable | Univariable analysis | | | Multivariable analysis | | |
|---|---|---|---|---|---|---|
| | OR | 95% CI | *p*-value | OR | 95% CI | *p*-value |
| APACHE II score | 1.20 | 1.18-1.22 | <0.001 | 1.15 | 1.11-1.19 | <0.001 |
| SOFA score | 1.33 | 1.29-1.37 | <0.001 | 1.12 | 1.03-1.20 | 0.005 |
| Male | 1.57 | 1.18-2.09 | 0.002 | 1.04 | 0.65-1.66 | 0.860 |
| ASA physical status ≥III | 10.71 | 7.34-15.64 | <0.001 | 2.32 | 1.33-4.04 | 0.003 |
| Sepsis | 3.36 | 2.55-4.41 | <0.001 | 1.35 | 0.78-2.35 | 0.286 |
| Post-operative emergency surgery | 5.75 | 4.44-7.45 | <0.001 | 1.34 | 0.73-2.44 | 0.344 |
| AKI | 4.50 | 3.42-5.92 | <0.001 | 0.95 | 0.54-1.69 | 0.875 |

SICU = Surgical intensive care unit; ASA = American Society of Anesthesiologists; APACHE = Acute physiology and chronic health evaluation; AKI = Acute kidney injury; OR = odds ratio; CI = confidence interval

finding was higher than those in previous studies[10,14,22,23]. In addition, the survival-to-hospital discharge rate in this study was 8.4%, which was lower than other ICU settings in previous studies, varying between 15.3% and 83.9%[10,14,22,23]. A few possible reasons could explain why there was a high mortality rate in this study. Firstly, most of cardiac arrest patients had poor medical conditions before admission and more than half of patients had DNAR order. Secondly, most of initial rhythms during cardiac arrest were non-shockable rhythms including asystole, bradycardia and PEA, which was associated with higher mortality in previous studies[24]. A retrospective study reported that non-shockable rhythms increased the risk of death within 24 hours after cardiac arrest by 5.7 times. This result was consistent with previous studies that patients with shockable rhythms had more favorable outcomes than those with non-shockable rhythms[14]. This study also found that patients who died after cardiac arrest had significantly higher ASA PS $\geq$3, higher APACHE II score, higher SOFA score, higher incidence of AKI, and undergoing higher percentage of emergency surgery than survivors (not presented in the table).

A majority of patients in this study (73.9%) had physiological antecedents prior to the cardiac arrest within 24 hour. This finding was corresponded to results of several studies[10,14,15,25]. These common antecedents were abnormal physiological changes including hypotension, tachycardia, tachypnea and abnormal conditions or co-morbidity such as various types of shock, hypoxemia or abnormality of serum electrolytes[14,15,25]. Frequent assessment and early recognition of patient deterioration particularly in high risk patients may help to identify patients with impending cardiac arrest and allow for providing treatment to prevent cardiac arrest[10].

This study was a large multi-center study for determining incidence and risk factors of cardiac arrest in SICU in Thailand. However, there were some limitations in this study. Firstly, there was high proportion of DNAR patients, which accounted for 50% of cardiac arrest patients. This can result in overestimation of mortality rates. Secondly, this study did not include some information such as duration of resuscitation, time of cardiac arrest, the amount of therapeutic hypothermia that helped to explain rates of ROSC and survival rate. Finally, the incidence of cardiac arrest varied among sites of SICU. This may reflect variations in the severity of disease, the quality of team resuscitation and training programs of medical personnel at the different sites.

**Conclusion**

The incidence of cardiac arrest in Thai-SICU was 4.9% and significant risk factors of cardiac arrest were ASA PS $\geq$3, higher APACHE II score, and higher SOFA score. Knowledge of risk factors of cardiac arrest and common physiological antecedents before cardiac arrest help medical personnel identify high risk patients and provide for intensive medical surveillance in order to prevent cardiac arrest and improve patient outcomes.

**What is already known on this topic?**

In Thailand, the data on cardiac arrest in SICUs in Thailand are not available. Most recent studies in other countries were done in MICU and perioperative period.

**What this study adds?**

The study showed the incidence, main causes, outcomes and the significant risk factor(s) of cardiac arrest in SICU in Thailand. The data should be useful in the prevention and sound management by multi-disciplinary care team.

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**Potential conflicts of interest**

None.

**References**

1. Myrianthefs P, Kalafati M, Lemonidou C, Minasidou E, Evagelopoulou P, Karatzas S, et al. Efficacy of CPR in a general, adult ICU. Resuscitation 2003; 57: 43-8.
2. Enohumah KO, Moerer O, Kirmse C, Bahr J, Neumann P, Quintel M. Outcome of cardiopulmonary resuscitation in intensive care units in a university hospital. Resuscitation 2006; 71: 161-70.
3. Landry FJ, Parker JM, Phillips YY. Outcome of cardiopulmonary resuscitation in the intensive care setting. Arch Intern Med 1992; 152: 2305-8.
4. Rabinstein AA, McClelland RL, Wijdicks EF, Manno EM, Atkinson JL. Cardiopulmonary resuscitation in critically ill neurologic-neurosurgical patients. Mayo Clin Proc 2004; 79: 1391-5.
5. Charuluxananan S, Suraseranivongse S, Jantorn P, Sriraj W, Chanchayanon T, Tanudsintum S, et al. Multicentered study of model of anesthesia related adverse events in Thailand by incident report (The Thai Anesthesia Incidents Monitoring Study): results. J Med Assoc Thai 2008; 91: 1011-9.
6. Chittawatanarat K, Chaiwat O, Morakul S, Pipanmekaporn T, Thawitsri T, Wacharasint P, et al. A multi-center Thai university-based surgical intensive care units study (THAI-SICU study): methodology and ICU characteristics. J Med Assoc Thai 2014; 97 (Suppl 1): S45-54.
7. Jacobs I, Nadkarni V, Bahr J, Berg RA, Billi JE, Bossaert L, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries: a statement for healthcare professionals from a task force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian Resuscitation Council, New Zealand Resuscitation Council, Heart and Stroke Foundation of Canada, Inter American Heart Foundation, Resuscitation Councils of Southern Africa). Circulation 2004; 110: 3385-97.
8. Braz LG, Modolo NS, do Nascimento P Jr, Bruschi BA, Castiglia YM, Ganem EM, et al. Perioperative cardiac arrest: a study of 53,718 anaesthetics over 9 yr from a Brazilian teaching hospital. Br J Anaesth 2006; 96: 569-75.
9. Efendijev I, Raj R, Reinikainen M, Hoppu S, Skrifvars MB. Temporal trends in cardiac arrest incidence and outcome in Finnish intensive care units from 2003 to 2013. Intensive Care Med 2014; 40: 1853-61.
10. Rozen TH, Mullane S, Kaufman M, Hsiao YF, Warrillow S, Bellomo R, et al. Antecedents to cardiac arrests in a teaching hospital intensive care unit. Resuscitation 2014; 85: 411-7.
11. Fleisher LA, Beckman JA, Brown KA, Calkins H, Chaikof E, Fleischmann KE, et al. ACC/AHA 2007 guidelines on perioperative cardiovascular evaluation and care for noncardiac surgery: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 2002 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery): Developed in Collaboration With the American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Rhythm Society, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society for Vascular Medicine and Biology, and Society for Vascular Surgery. Circulation 2007; 116: 1971-96.
12. Maia PC, Abelha FJ. Predictors of major postoperative cardiac complications in a surgical ICU. Rev Port Cardiol 2008; 27: 321-8.
13. Lee HK, Lee H, No JM, Jeon YT, Hwang JW, Lim YJ, et al. Factors influencing outcome in patients with cardiac arrest in the ICU. Acta Anaesthesiol Scand 2013; 57: 784-92.
14. Kause J, Smith G, Prytherch D, Parr M, Flabouris A, Hillman K. A comparison of antecedents to cardiac arrests, deaths and emergency intensive care admissions in Australia and New Zealand, and the United Kingdom—the ACADEMIA study. Resuscitation 2004; 62: 275-82.
15. Guimaraes HP, Resque AP, Costa MPF, Machado FR, Hasegawa E, Abib ACV, et al. Cardiac arrest in ICU: the Ultstein method results in general

intensive care. Critical Care 2001; 5: P13.
16. Nunnally ME, O'Connor MF, Kordylewski H, Westlake B, Dutton RP. The incidence and risk factors for perioperative cardiac arrest observed in the national anesthesia clinical outcomes registry. Anesth Analg 2015; 120: 364-70.
17. Kazaure HS, Roman SA, Rosenthal RA, Sosa JA. Cardiac arrest among surgical patients: an analysis of incidence, patient characteristics, and outcomes in ACS-NSQIP. JAMA Surg 2013; 148: 14-21.
18. Siriphuwanun V, Punjasawadwong Y, Lapisatepun W, Charuluxananan S, Uerpairojkit K. Incidence of and factors associated with perioperative cardiac arrest within 24 hours of anesthesia for emergency surgery. Risk Manag Healthc Policy 2014; 7: 155-62.
19. Chen YC, Lin MC, Lin YC, Chang HW, Huang CC, Tsai YH. ICU discharge APACHE II scores help to predict post-ICU death. Chang Gung Med J 2007; 30: 142-50.
20. Ratanarat R, Thanakittiwirun M, Vilaichone W, Thongyoo S, Permpikul C. Prediction of mortality by using the standard scoring systems in a medical intensive care unit in Thailand. J Med Assoc Thai 2005; 88: 949-55.
21. Donnino MW, Salciccioli JD, Dejam A, Giberson T, Giberson B, Cristia C, et al. APACHE II scoring to predict outcome in post-cardiac arrest. Resuscitation 2013; 84: 651-6.
22. Chang SH, Huang CH, Shih CL, Lee CC, Chang WT, Chen YT, et al. Who survives cardiac arrest in the intensive care units? J Crit Care 2009; 24: 408-14.
23. Nadkarni VM, Larkin GL, Peberdy MA, Carey SM, Kaye W, Mancini ME, et al. First documented rhythm and clinical outcome from in-hospital cardiac arrest among children and adults. JAMA 2006; 295: 50-7.
24. Efendijev I, Nurmi J, Castren M, Skrifvars MB. Incidence and outcome from adult cardiac arrest occurring in the intensive care unit: a systematic review of the literature. Resuscitation 2014; 85: 472-9.
25. Kronick SL, Kurz MC, Lin S, Edelson DP, Berg RA, Billi JE, et al. Part 4: Systems of Care and Continuous Quality Improvement: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2015; 132: S397-413.

# *อุบัติการณ์ภาวะหัวใจหยุดเต้นและปัจจัยที่เกี่ยวข้องในการศึกษาแบบสหสถาบันที่หออภิบาลผู้ป่วยหนักทางศัลยกรรมในโรงพยาบาลมหาวิทยาลัยในประเทศไทย*

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***วัตถุประสงค์:*** *มีการจัดตั้งกลุ่มวิจัย THAI-SICU ขึ้นเพื่อศึกษาข้อมูลพื้นฐานและภาวะแทรกซ้อนในกลุ่มผู้ป่วยที่เข้ารับการรักษาในหออภิบาลผู้ป่วยหนักทางศัลยกรรมในประเทศไทยวัตถุประสงค์เพื่อพรรณนาถึงอุบัติการณ์ ปัจจัยที่เกี่ยวข้องและผล หลังการเกิดภาวะหัวใจหยุดเต้นในผู้ป่วยที่ได้รับการดูแลในหออภิบาลผู้ป่วยหนักทางศัลยกรรมในโรงพยาบาลมหาวิทยาลัยในประเทศไทย*

***วัสดุและวิธีการ:*** *การศึกษานี้เป็นการศึกษาแบบสหสถาบันไปข้างหน้าเก็บข้อมูลผู้ป่วยที่เข้ารับการรักษาในหออภิบาลผู้ป่วยหนักทางศัลยกรรมในโรงพยาบาลมหาวิทยาลัย 9 แห่งในประเทศไทย ในช่วงระยะเวลาตั้งแต่ เดือนเมษายน พ.ศ. 2554 ถึง เดือนมกราคม พ.ศ. 2556 โดยใช้แบบฟอร์มเก็บข้อมูล 2 ชุด ได้แก่ ฟอร์ม 1 ข้อมูลพื้นฐานทั่วไปและฟอร์ม 2 ข้อมูลของการเกิดภาวะหัวใจหยุดเต้น รวบรวมข้อมูลอุบัติการณ์ ปัจจัยที่เกี่ยวข้องและผลหลังการเกิดภาวะ หัวใจหยุดเต้นในผู้ป่วยเพื่อรายงาน*

***ผลการศึกษา:*** *ผู้ป่วยทั้งหมด 4,652 คน พบอุบัติการณ์การเกิดภาวะหัวใจหยุดเต้นจำนวน 226 ราย (ร้อยละ 4.9) ค่าคะแนน APACHE II ในวันที่เข้ารักษาวันแรกเฉลี่ยเท่ากับ 24.1 ลักษณะของคลื่นไฟฟ้าหัวใจก่อนเกิดภาวะหัวใจหยุดเต้นที่พบมากที่สุด ได้แก่ asystole (ร้อยละ 35.4) รองลงมาได้แก่ bradycardia (ร้อยละ 22.6) และ pulseless electrical activity (ร้อยละ 14.6) สาเหตุหลักของการเกิดภาวะหัวใจหยุดเต้น คือ สาเหตุจากสภาพผู้ป่วยที่แย่อยู่เดิม (ร้อยละ 51.3) โดยส่วนใหญ่ผู้ป่วยมักจะมีเหตุการณ์ผิดปกตินำมาก่อน (ร้อยละ 73.9) ซึ่งเหตุการณ์ที่พบบ่อย คือ ความดันโลหิตต่ำ ความผิดปกติทางเมตาบอลิซึม และภาวะช็อคจากการติดเชื้อในกระแสเลือด ผลจากการช่วยกู้ชีพพบว่าผู้ป่วยร้อยละ 23.5 มีระบบไหลเวียนโลหิตกลับคืน ผู้ป่วยที่เกิดภาวะหัวใจหยุดเต้นมีอัตราการเสียชีวิตในโรงพยาบาลเท่ากับร้อยละ 91.6 ซึ่งสูงกว่าผู้ป่วยที่ไม่เกิดภาวะนี้อย่างมีนัยสำคัญทางสถิติ ($p<0.001$) เมื่อวิเคราะห์ทางสถิติพบว่าปัจจัยที่มีความสัมพันธ์กับการเกิดภาวะหัวใจหยุดเต้น ได้แก่ ค่าคะแนน APACHE II ที่เพิ่มขึ้น (OR 1.15, 95% CI 1.11-1.19, $p<0.001$) ค่าคะแนน SOFA ที่เพิ่มขึ้น (OR 1.12, 95%CI 1.03-1.20, $p = 0.005$) และผู้ป่วยที่มี ASA physical status ≥3 (OR 2.32, 95% CI 1.33-4.04, $p = 0.003$)*

***สรุป:*** *อุบัติการณ์การเกิดภาวะหัวใจหยุดเต้นในผู้ป่วยที่เข้ารับการรักษาในหออภิบาลผู้ป่วยหนักทางศัลยกรรม ในโรงพยาบาลมหาวิทยาลัยในประเทศไทยพบได้น้อย ลักษณะคลื่นไฟฟ้าหัวใจที่พบบ่อยก่อนเกิดภาวะหัวใจหยุดเต้นเป็นแบบ nonshockable และมักจะมีเหตุการณ์ผิดปกติของร่างกายนำมาก่อน ปัจจัยที่มีความสัมพันธ์กับการเกิดภาวะหัวใจหยุดเต้นได้แก่ ค่าคะแนน APACHE II ค่าคะแนน SOFA ที่สูงขึ้น และผู้ป่วยที่มี ASA physical status ≥3*