A Multi-center Thai University-based Surgical Intensive Care Unit Study (THAI-SICU Study): Incidence of Acute Myocardial Infarction and Associated Factors

Waraporn Chau-In MD*[1],
Sarinya Chanthawong MD*[1], Tanyong Pipanmekaporn MD, PhD*[2],
Suneerat Kongsayreepong MD*[3], Kaweesak Chittawatanarat MD, PhD*[4],
Nonthida Rojanapithayakorn MD*[1], the THAI-SICU study group

*[1] *Department of Anesthesiology, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand*
*[2] *Department of Anesthesiology, Faculty of Medicne, Chiang Mai University, Chiang Mai, Thailand*
*[3] *Department of Anesthesiology, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand*
*[4] *Departmento of Surgery, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand*

Introduction: *To describe the incidence, characteristics and outcomes of acute myocardial infarction (AMI) and determine risk factor(s) of AMI in THAI-surgical intensive care unit (SICU).*

Material and Method: *This study was multicenter prospective cohorts study that conducted data from 9 university-affiliated SICUs in Thailand between April 2011 and January 2013. We collected and evaluated data of AMI events. The patients were followed-up for up to 28 days after admitted to the SICUs.*

Results: *The overall incidence of AMI in SICU was 1.4% (66 of 4,652 patients). Non-ST elevated MI was the most common electrocardiography (ECG) presentation (75%). The common clinical sign and symptom of AMI included ECG changes (53%) and elevation of cardiac enzymes (48.5%). Patients with AMI had significantly higher 28-day mortality rate (28.8% versus 13.6%, p<0.001) than those with non-MI. The Acute Physiologic and Chronic Health Evaluation (APACHE) II scores (RR 1.04, 95% CI 1.01-1.07, p = 0.003) and age ≥65 year (RR 2.54, 95% CI 1.36-4.75, p = 0.003) were significant risk factors of AMI.*

Conclusion: *The incidence of AMI in the SICU was uncommon but led to significantly higher mortality rates. The APACHE II score and age ≥65 year were significant predictors of AMI in SICU.*

Keywords: *Acute myocardial infarction, Incidence, Predictors, Outcomes, Surgical intensive care unit.*

J Med Assoc Thai 2016; 99 (Suppl. 6): S74-S82
Full text. e-Journal: *http://www.jmatonline.com*

Acute myocardial infarction (AMI) represents one of the common causes of life-threatening disease. In the last decades, medical advances in management of AMI including the early use of reperfusion strategies by combinations of both coronary stenting and antiplatelet therapy were practiced, but the mortality rates remained high and varied from 13.5% to 28% for patients in the cardiac intensive care units(1). The incidence of AMI or perioperative myocardial infarction (PMI) varied widely depending on the patient population studied and diagnostic criteria used for making diagnoses.

Correspondence to:
Chau-In W, Department of Anesthesiology, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand.
Phone: +66-43-348390, Fax: +66-43-348390 ext. 403
E-mail: chauin4@gmail.com, warcha@kku.ac.th

The adverse events of AMI, such as cardiogenic shock, arrhythmias, heart failure, or acute pulmonary edema, also lead to an increased severity and mortality rate. The occurrence of AMI in critically-ill patient admitted to ICUs with other diagnoses has been reported as independent factors of death[2,3]. In the surgical intensive care unit (SICU), the most common population is the postoperative patient who is associated with this adverse event. Cardiac complications constitute the most common cause of postoperative morbidity and mortality, having an impact on the length of stay and cost of hospitalization[4-6].

Recently in Thailand, a large multicenter observational study, the Thai Anesthesia Incidents Monitoring (Thai AIMS) Study[7], focused on intra-operative events and outcomes for all surgeries. The incidence of PMI among anesthetized patients 24 hours postoperatively was 0.9% but comparative data on AMIs in-SICU in Thailand are not available. In the THAI-SICU study[8], the main objectives were to describe the overall outcomes and incidence of adverse events in university-based SICUs in Thailand. The objectives of this study were (a) to determine the incidence of AMI in SICU, its characteristics, diagnostics, types and outcomes and (b) to ascertain the predictors for the occurrence of AMI in the SICU.

Material and Method

Design and setting

The THAI-SICU study was a multi-center, prospective, cohort observational registry of surgical intensive care unit (SICU) patients. Data were collected from the case record form reports between April 1, 2011 and January 31, 2013 on SICU patients from 9 university-affiliated, tertiary-care hospitals. The Ethic Committee (EC) or Institutional Review Board (IRB) approved the study. Informed consent was waived due to the observational nature of the study. The ClinicalTrials.gov identification number was NCT01354197. This article focuses on the incidences, characteristics, initial therapies, and outcomes of AMI in SICUs and the predictors of AMI in the SICUs.

All adults patients ($\geq$18 years) admitted to SICUs, having experienced an AMI during admission, were eligible for inclusion. Patients whose lengths of stay in the SICU were less than 6 hours were excluded.

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[8]. Patients' data between April, 2011 and January, 2013 were recorded including CRF 1: admission, daily screening and discharge data and CRF 2, adverse events records.

Core data elements from CRF 1 included: demographics, characteristics, admission diagnoses, and outcomes after AMI. From CRF 2, the AMI event, the data collected included: (a) Time of symptoms present, (b) The diagnostic criteria of AMI categorized to ST elevated MI (STEMT) and non-ST elevated MI (NSTEMI), (c) Type of AMI, (d) Initial medical therapy and definite treatment of AMI [conservative, surgery or percutaneous coronary intervention (PCI)], and (e) complications after AMI.

In the present study during the SICU stay, the daily screening CRF was completed. If an AMI incident occurred, the CRF 2 was completed. The diagnostic criteria of AMI were defined by at least 2 of 3 criteria based on the ACC/AHA 2007 guidelines[9] as follows: (1) A positive troponin or peak CK-MB $\geq$4% of an elevated total CK with characteristic rises and falls, (2) new onset or a worsening pattern of characteristic ischemic symptoms (such as chest pain, shortness of breath) lasting longer than 20 minutes, and (3) Electrocardiography (ECG) changes consistent with ischemia including: a) acute ST elevation followed by the appearance of Q wave or loss of R waves, b) new left bundle branch block, c) new persistent T wave inversion for at least 24 hours, d) new ST segment depression that persists for at least 24 hours; ST segment depression ($\geq$0.05 mV) or transient ST elevation, T wave ($\geq$0.3 mV) inversion in $\geq$2 leads, elevated cardiac marker necrosis.

The type of AMI was defined as follows; (1) spontaneous myocardial infarction related to ischemia due to a primary coronary event such as plaque erosion or rupture, fissuring or dissection, (2) myocardial infarction secondary to ischemia due to imbalance between oxygen demand and supply e.g. coronary spasm, anemia, or hypotension, (3) sudden cardiac death with symptoms of ischemia, accompanied by new ST elevation or left bundle branch block (LBBB), or verified coronary thrombus by angiography or autopsy, with death occurring before blood samples could be obtained, (4) 4a myocardial infarction associated with PCI: 4b myocardial infarction associated with verified stent thrombosis, and (5) myocardial infarction associated with coronary artery bypass grafting (CABG)[10].

The risk factors associated with AMI were categorized by using the revised cardiac risk index (RCRI) criteria[9] that included; high risk surgery (thoracic, abdominal, or pelvic vascular; aorta, renal, mesenteric), history of ischemic heart disease, history of congestive heart disease, history of cerebrovascular disease, preoperative treatment with insulin therapy for diabetes and preoperative serum creatinine >2.0 mg/dl.

At discharge from SICU, the discharge CRF was used. Patients were followed-up after admitted in the ICU within 28 days and discharged. Details of all the CRF and data can be obtained at http://thaisicu.crcthailand.com/index.php.

Well-trained residents or critical care nurses who worked in SICUs during the study period, collected all of the case record form 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 MedResNet. External surveyors performed quality control and data monitoring (viz., an independent study site and the Thai Medical School Consortium (MedResNet)).

Outcome measures

The prospectively selected primary outcome measure was incidence of AMI in SICUs; its characteristics, diagnostics, type and outcomes. The secondary outcome measures were predictors of AMI in SICUs.

Statistical analysis

Descriptive numerical and categorical statistics were performed for continuous data with parametric or non-parametric distribution and categorical data, by calculating the respective mean $\pm$ standard deviation (SD) or median and the interquartile range (IQR) and percentage. All data include sex, age, body mass index (BMI), site of operation, history of hypertension, current smoking, revised cardiac risk index criteria and scores, medication used, Acute Physiology and Chronic Health Evaluation (APACHE) II score, duration of surgery, hospital lengths of stay, ICU mortality and 28-day mortality. Risk factors of AMI were determined by risk regression analysis. The significant univariable risk predictors (p<0.20 including: high risk surgery, $\geq$2 factors of RCRI, age >65 years, APACHE II score, ASA $\geq$III, hypertension, smoking, beta-blocker used and statins used)were run through a multivariate risk regression in order to identify independent predictors. The predictor independently associated with occurrence of an AMI was presented as the relative risk (RR) and 95% confidence interval (CI). All the tests were 2-tailed p<0.05 was considered significant. Data were analyzed and exported using the SPSS software for Windows (Version 11.0; STATA Inc, College Station, TX).

Results

During the study period, the 6,548 patients admitted to SICUs and 4,652 were included into the study. Sixty-six patients were diagnosed AMI and the incidence of AMI in SICU was 1.4%. Patient characteristics of patients with AMI and non-AMI are presented in Table 1. Patients with AMI were significantly older (72.7$\pm$11.1 years versus 61.6$\pm$17.3, p<0.001), had higher percentage of hypertension (72.7% versus 48.4%, p<0.001), and higher percentage of RCRI >2 factors (9.1% versus 2.8%, p = 0.001) than those with non-AMI. Patients with AMI also had significantly higher APACHE II score (13 (10-8.5) versus 10 (7-15), p = 0.033), required longer length of ICU stay (4 (3-9) days versus 2 (1-4) days, p<0.001), and had higher ICU mortality (22.8% versus 9.4%, p = 0.001) and higher 28-day mortality (28.8% versus 13.6%, p<0.001) than those with non-AMI. Among RCRI criteria, patients with AMI required significantly insulin therapy, had higher percentage of history of ischemic heart disease, higher percentage of history of cerebrovascular disease, and higher percentage of history of congestive heart failure than those with non-AMI.

Diagnosis, treatment and complications of AMI are described in Table 2. AMI commonly occurred within 24 hours after ICU admission (56%). Non-ST elevated MI (NSTEMI) was accounted for 75% of ECG presentation during AMI and ST depression on ECG was common. The initial signs and symptoms before AMI were ECG changes (74.5%), elevated of cardiac enzymes (68.1%) and chest pain (36.1%). Type II (59.1%) and I (6.1%) were the two most common types of AMI.

Majority of AMI patients received conservative treatment (60%). The univariable and multivariable risk regression analysis of AMI are presented in the Table 3. Age $\geq$65 year, hypertension, APACHE II score, RCRI $\geq$2 factors, and using statins were significant risk factors of AMI in univariable risk regression analysis. However, after adjustment the variables associated with AMI, age $\geq$65 year (RR 2.54, 95% CI 1.36-4.75, p = 0.003) and APACHE II score (RR 1.04, 95% CI 1.01-1.07, p = 0.003) were the two significant predictors of AMI in SICU.

Discussion

The overall incidence of AMI at 9 university-based surgical ICUs in Thailand was 1.4%. Approximately 72.7% of AMI patient had a statistically significant history of hypertension. Most AMIs were male gender and occurred during the postoperative period after abdominal surgery. A previous study, reported that the incidence of PMI varied between 1.4 and 38%[11]. The study by Go[12], reported approximately 15 million Americans over 20 years of age have coronary heart disease (CHD) in which the prevalence for myocardial infarction (MI) is 2.9%. The prevalence of AMI is higher for men than for women and increases with age, corresponding with the present study. The large study by Yeh, et al[13] identified patients 30 years of age or older in a large community-based population

Table 1. Patients' demographic data of AMI vs. Non-AMI groups in SICU

Variables	AMI (n = 66)	Non-AMI (n = 4,586)	*p*-value
Sex, n (%)	66 (1.4)	4,586 (98.6)	
Male	38 (57.6)	2,691 (58.7)	0.875
Female	28 (42.4)	1,895 (41.3)	
Age, years (mean ± SD)	72.7±11.1	61.6±17.3	<0.001
<65	15 (22.7)	2,419 (52.7)	
≥65	51 (77.3)	2,167 (47.3)	
BMI, kg/m^2 (mean ± SD)	23.0±5.6	22.4±4.4	0.393
ASA classification; n (%)			0.044
I	1 (2.4)	234 (6.6)	
II	7 (17.1)	1,124 (31.9)	
III	23 (56.1)	1,725 (49.0)	
IV	10 (24.4)	388 (11.0)	
V	0 (0.0)	48 (1.4)	
VI	0 (0.0)	3 (0.1)	
Emergency surgery, n (%)	15 (22.7)	1,133 (24.7)	0.711
Site of operation, n (%)			
Lower abdomen	13 (19.7)	1,269 (27.7)	0.150
Upper abdomen	10 (15.2)	1,291 (28.2)	0.019
Extremities	6 (9.1)	379 (8.3)	0.809
Thoracic	3 (4.6)	185 (4.0)	0.834
Maxillofacial	3 (4.6)	77 (1.7)	0.075
Perineal/anus	3 (4.6)	54 (1.2)	0.014
Peripheral vascular	2 (3.0)	143 (3.1)	0.967
Head and neck	2 (3.0)	323 (7.0)	0.204
Spine	1 (1.5)	147 (3.2)	0.437
Hypertension, n (%)	48 (72.7)	2,220 (48.4)	<0.001
Current smoking, n (%)	5 (7.6)	561 (13.0)	0.149
RCRI criteria, n (%)			
Insulin therapy for diabetes mellitus	21 (31.8)	997 (21.7)	0.049
History of ischemic heart disease	19 (28.8)	441 (9.62)	<0.010
High risk surgery	10 (15.2)	1,033 (22.5)	0.154
History of cerebrovascular disease	10 (15.2)	266 (5.8)	0.001
Preoperative serum creatinine >2.0 mg/dl	5 (7.6)	694 (15.5)	0.516
History of congestive heart disease	5 (7.6)	102 (2.9)	0.004
RCRI, n (%)			0.001
0	22 (33.3)	2,252 (49.1)	
1	24 (36.4)	1,658 (36.2)	
2	14 (21.2)	549 (12.0)	
3	6 (9.1)	109 (2.4)	
≥4	0 (0.0)	18 (0.4)	
Medication used, n (%)			
Statin	23 (34.9)	836 (18.2)	0.001
Beta-blocker	21 (31.8)	854 (18.6)	0.006
ACEI or ARBs	18 (27.3)	642 (14.0)	0.002
Calcium channel blocker	17 (25.8)	782 (17.05)	0.063
APACHE II score, median (IQR)	10 (7-15)	13 (10-18.5)	0.033
Duration of surgery, minutes, median (IQR)	240 (150-350)	172.5 (95-302)	0.022
ICU lengths of stay, days, median (IQR)	2 (1-4)	4 (3-9)	<0.001
Hospital lengths of stay, days, median (IQR)	4 (2-11)	9 (5-13)	0.001
ICU mortality, n (%)	15 (22.8)	432 (9.4)	0.001
28-day mortality, n (%)	19 (28.8)	623 (13.6)	<0.001

AMI = Acute myocardial infarction; ASA = American Society of Anesthesiologists; ICU = Intensive care unit; RCRI = Revised cardiac risk index; ACEI = Angiotensin-converting enzyme inhibitors; ARBs = angiotensin-receptor blockers; APACHE = Acute physiology and chronic health evaluation; IQR = Interquartile range

Table 2. Diagnosis, treatment and complications of AMI in SICU (Total n = 66)

Variables	Number	Percent
Onset after admission in ICU, hours, median (IQR)	24 (24-48)	
Onset after admission in ICU		
$\leq$24 hours	37	56.1
24-72 hours	22	33.3
>72 hours	7	10.6
Diagnosis (n = 66)		
STEMI	11	25.0
NSTEMI		
ECG change: ST depression	22	33.3
ECG change: inverted T	10	15.1
No change ECG	4	6.1
Not defined	19	20.5
First symptom for diagnosis (n = 66)		
ECG change	35	53.0
Elevated cardiac enzyme	32	48.5
Chest pain	17	25.7
Major arrhythmias	16	24.2
Hemodynamic instability	12	18.2
Not defined	19	28.8
Type of MI (n = 66)		
Type I	4	6.1
Type II	39	59.1
Type III	2	3.0
Type IV	1	1.5
Not defined	20	30.3
Treatment (n = 66)		
Conservative	40	60.6
Surgery	4	6.1
PCI	4	6.1
Not defined	18	27.2
Initial medical therapy in 24 hour (n = 66)		
Antiplatelet	27	40.9
Anticoagulant	15	22.7
Morphine	9	13.6
Statin	7	10.6
Nitroglycerine intravenous	4	6.1
ACEI/ARB	3	4.5
Beta-blocker	3	4.5
Not defined	19	28.8
Complication after AMI, n (%)		
Heart failure	14	21.2
Cardiogenic shock	13	19.7
Major arrhythmias	13	19.7
Emboli	1	1.5

AMI = Acute myocardial infarction; ICU = Intensive care unit; IQR = Interquartile range; ECG = electrocardiogram; STEMI = ST elevated myocardial ischemia; NSTEMI = Non-ST elevated myocardial ischemia; PCI = Percutaneous coronary intervention; ACEI = angiotensin-converting-enzyme inhibitor; ARBs = Angiotensin II receptor blockers

who were hospitalized for an MI incident. The incidence of MI was 0.24% with NSTEMI at 66.9% most prevalent. Most common was in the male gender and co-existing diseases were hypertension, dyslipidemia and diabetes mellitus.

The present study had a higher AMI incidence

Table 3. The univariable and multivariable risk regression analysis of variables associate with AMI in SICU

Variable	Univariable analysis			Multivariable analysis		
	RR	95% CI	*p*-value	RR	95% CI	*p*-value
Age ≥65 years	3.76	2.10-6.77	<0.001	2.54	1.36-4.75	0.003
Male gender	0.96	0.59-1.55	0.857			
ASA ≥III	1.12	0.69-1.80	0.650			
Smoker	1.30	0.79-2.13	0.301			
Hypertension	2.80	1.63-4.80	<0.001	1.63	0.86-3.09	0.137
≥2 Factors of RCRI	3.39	1.49-7.72	0.004	1.46	0.59-3.65	0.410
β-blocker used	2.01	3.42-5.92	<0.001	1.16	0.66-2.06	0.606
Statin used	2.36	1.43-3.90	0.001	1.51	0.89-2.56	0.125
APACHE II score	1.04	1.02-1.07	0.002	1.04	1.01-1.07	0.003
High-risk surgery	0.81	0.44-1.48	0.494			

AMI = Acute myocardial infarction; ASA = American Society of Anesthesiologists; SICU = Surgical intensive care unit; RCRI = Revised cardiac risk index; APACHE = Acute Physiology and Chronic Health Evaluation; RR = relative risk; 95% CI = 95% confidence interval

than the incidence from the THAI-AIMS study (0.9%)[6], because of different patients' conditions. Most of the PMI occurred in that study was elective cases (84%) and orthopedic procedures (55.6%). New ST-T segment change was detected in 92% of these patients. Most patients in SICUs were postoperative patients where cardiac complications constituted the most common cause of postoperative morbidity and mortality, having an impact on the length and cost of hospitalization[6]. The present study had a lower incidence of AMI than the incidence reported by Chaiyamano and Tungsubutra[14], in a similar target group. Chaiyamano and Tungsubutra[14] showed the incidence of PMI in the general SICU patients, with intermediate to high risk after operations of major elective non-cardiac surgeries was 17.6%. Only 26% had ST segment deviation compatible with MI; most had ST depression. Less than one-fifth had angina. PMIs were complicated with heart failure (17.3%) and experienced cardiogenic shock (4.3%). PMIs were associated with a longer length of stay in ICU and prolonged mechanical ventilator use after surgery, but were not associated with in-hospital mortality[14]. Only high APACHE II scores and prolongation of duration of intra-operative hypotension were independent predictors of PMI.

AMIs has unique manifestations in individual patients, can occur at any time of the day especially in the first day after surgery. In the ICU, the diagnosis of AMI is challenging for many reasons. Symptoms in critically ill patients or postoperative patients may be masked by sedative or analgesic medications, endotracheal intubation or coma. For these reasons, the incidence of AMI in the SICU may be below the actual incidences. Cardiac troponin is a sensitive and specific measure of myocardial necrosis; it is the preferred biomarker for use in the diagnosis of AMI in this setting[15].

Six primary risk factors have been identified with the development of artherosclerotic coronary artery disease and MI: hyperlipidemia, diabetes mellitus, hypertension, smoking, male gender, and a family history of atherosclerotic arterial disease. The presence of any risk factors is associated with doubling the relative risk of developing artherosclerotic coronary artery disease[16]. In the present study, approximately 72.7% of AMI patients had a history of hypertension that was statistically significant. Previous studies[4-11] found that high blood pressure was consistently associated with an increased risk of MI. This risk is associated with systolic and diastolic hypertension. In this present study, smoking was not shown to be an associated risk of AMI even though in another study[17] it was an increased risk because certain components of tobacco and tobacco combustion gases were known to damage blood vessel wall and formation of artherosclerosis.

Having two or more points on the RCRI scale increased the probability of an AMI event by RR 3.39 (95% CI 1.49-7.72) times (Table 3). In a different analysis, Lee et al estimated the risk of a major cardiac event (MCE) at 2.4% in patients with two risk factors[18]. In the present study the RCRI scores were mainly due to preoperative treatment with insulin therapy for diabetes, 31.8%, a history of ischemic heart disease, 28.8%, and high risk surgery equal to that of cerebrovascular disease, 15.2% (Table 1).

Treatment for a myocardial infarction in ICU patients should be initiated early and individualized and geared towards the identified underlying causes. The goals of therapy in AMI are the expedient restoration of normal coronary blood flow and the maximum salvage of functional myocardium[19]. Acute coronary syndrome therapies, including beta-blockades and antiplatelet therapy should be given cautiously in critically ill patients with AMI depending on hemodynamic stability, renal function, and hepatic function. Other treatment options are PCI and surgical revascularization. The present study instituted common initial medical therapy that included antiplatelet and anticoagulant therapies, morphine and statin administration. A majority of patients (85.1%) had conservative treatment. Only 8% had PCI or surgery for treatment of the AMI that was slightly different from other studies.

Early use of beta blockers in AMI has been shown to reduce the incidence of ventricular arrhythmias, reduce the use of other anti-arrhythmic medications, decrease chest pain symptoms, and decrease sudden cardiac death and early and late re-infarction[20-23]. The lack of evidence for the effectiveness of beta-blocker therapy in significantly reducing AMI events in this study may be related to the small number of patients given this medication (21 cases).

The AMI patients had significantly longer ICU and hospital lengths of stay than non-AMI patients ($p \leq 0.001$). The respective mortality rates after AMI at ICU discharge and 28-days post discharge were 22.8% and 28.8% with a significantly higher mortality rate than non-AMI patients ($p \leq 0.001$). The non-AMI patients had a longer-term higher survival outcome.

Limitations

Data integrity and validation issues at multiple sites were complicated. In order to mitigate source bias, a rigorous abstractor certification process was employed, that consisted of uniform data collection, consistent definitions, a scientific advisory board re-abstraction process, and a large sample size. Data re-abstraction results served to verify the integrity of the data. Secondly, differences at each site made the data difficult to interpret. Finally, the number of surviving patients was too few to assess neurological outcomes after AMIs.

Conclusion

In this large, multicenter THAI-SICU registry, AMI in the SICU was uncommon. NSTEMI were most common. Most AMIs were diagnosed by ECG changes and elevation of cardiac enzymes. The AMI patients had significantly longer ICU, longer hospital lengths of stay and higher overall mortality rate than non-AMI patients. Only age $\geq$65 year and APACHE II scores remained significant predictors for AMI in the SICU. Identification of potential risk factors of AMI helps medical personnel find any preventive strategy to minimize incidence and severity of this condition.

What is already known on this topic?

In Thailand, the data on AMI in SICU are not available. Most recent studies in other countries were done in medical intensive care unit and perioperative period.

What this study adds?

The study showed the incidence, main causes, outcomes and the significant predictors of AMI in SICU in Thailand. Identification of potential risk factors of AMI helps medical personnel find any preventive strategy to minimize incidence and severity of this condition.

Acknowledgements

The study 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 Thai Medical Schools Consortium (MedResNet). The publication was supported by Medical Association of Thailand (Prasert Prasarttong-osoth research fund).

The THAI-STUDY listed these participants

Suneerat Kongsayreepong, Onuma Chaiwat (Siriraj Hospital, Mahidol University, Bangkok), Kaweesak Chittawatanarat, Tanyong Pipanmekaporn (Chiang Mai University, Chiang Mai) Sunthiiti Morakul (Ramathibodi Hospital, Bangkok), Thammasak Thawitsri, Somrat Charuluxananan (King Chulalongkorn Memorial Hospital, Bangkok), Petch Wacharasint, Pusit Fuengfoo (Phramongkutklao Hospital, Bangkok), Sunisa Chatmongkolchart, Osaree Akaraborworn (Prince of Songkla University, Songkhla), Chompunoot

Pathonsamit, Sujaree Poopipatpab (Navamindradhiraj University, Vajira Hospital, Bangkok), Sarinya Chanthawong, Waraporn Chau-In (Khon Kaen University, Khon Kaen), Chaiyapruk Kusumaphanyo, Phakapan Buppha (Srinakharinwirot University).

Potential conflicts of interest

None.

References

1. Lesage A, Ramakers M, Daubin C, Verrier V, Beynier D, Charbonneau P, et al. Complicated acute myocardial infarction requiring mechanical ventilation in the intensive care unit: prognostic factors of clinical outcome in a series of 157 patients. Crit Care Med 2004; 32: 100-5.
2. Guest TM, Ramanathan AV, Tuteur PG, Schechtman KB, Ladenson JH, Jaffe AS. Myocardial injury in critically ill patients. A frequently unrecognized complication. JAMA 1995; 273: 1945-9.
3. Kollef MH, Ladenson JH, Eisenberg PR. Clinically recognized cardiac dysfunction: an independent determinant of mortality among critically ill patients. Is there a role for serial measurement of cardiac troponin I? Chest 1997; 111: 1340-7.
4. Sprung J, Abdelmalak B, Gottlieb A, Mayhew C, Hammel J, Levy PJ, et al. Analysis of risk factors for myocardial infarction and cardiac mortality after major vascular surgery. Anesthesiology 2000; 93: 129-40.
5. Kertai MD, Klein J, van Urk H, Bax JJ, Poldermans D. Cardiac complications after elective major vascular surgery. Acta Anaesthesiol Scand 2003; 47: 643-54.
6. Landesberg G, Beattie WS, Mosseri M, Jaffe AS, Alpert JS. Perioperative myocardial infarction. Circulation 2009; 119: 2936-44.
7. Ngamprasertwong P, Kositanurit I, Yokanit P, Wattanavinit R, Atichat S, Lapisatepun W. The Thai anesthesia incident monitoring study (Thai AIMS): an analysis of perioperative myocardial ischemia/infarction. J Med Assoc Thai 2008; 91: 1698-705.
8. 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.
9. 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: 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). Circulation 2007; 116: e418-99.
10. Thygesen K, Alpert JS, White HD. Universal definition of myocardial infarction. Eur Heart J 2007; 28: 2525-38.
11. Priebe HJ. Triggers of perioperative myocardial ischaemia and infarction. Br J Anaesth 2004; 93: 9-20.
12. Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Borden WB, et al. Executive summary: heart disease and stroke statistics—2013 update: a report from the American Heart Association. Circulation 2013; 127: 143-52.
13. Yeh RW, Sidney S, Chandra M, Sorel M, Selby JV, Go AS. Population trends in the incidence and outcomes of acute myocardial infarction. N Engl J Med 2010; 362: 2155-65.
14. Chaiyamano C, Tungsubutra W. Characteristic of perioperative myocardial infarction after major noncardiac surgery in general surgical ICU, Siriraj Hospital. Thai Heart J 2006; 19: 39-45.
15. Lim W, Qushmaq I, Cook DJ, Crowther MA, Heels-Ansdell D, Devereaux PJ. Elevated troponin and myocardial infarction in the intensive care unit: a prospective study. Crit Care 2005; 9: R636-44.
16. Cotran RS Kumar V, Robbins SL. Robbins pathologic basis of disease. 5th ed. Philadelphia: WB Saunders; 1994.
17. Hung J, Lam JY, Lacoste L, Letchacovski G. Cigarette smoking acutely increases platelet thrombus formation in patients with coronary artery disease taking aspirin. Circulation 1995; 92: 2432-6.
18. Lee TH, Marcantonio ER, Mangione CM, Thomas EJ, Polanczyk CA, Cook EF, et al. Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. Circulation 1999; 100: 1043-9.
19. Anderson JL, Adams CD, Antman EM, Bridges CR, Califf RM, Casey DE, Jr., et al. ACC/AHA 2007 guidelines for the management of patients with unstable angina/non-ST-Elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee

to Revise the 2002 Guidelines for the Management of Patients With Unstable Angina/Non-ST-Elevation Myocardial Infarction). J Am Coll Cardiol 2007; 50: e1-157.

20. Brooke BS. Perioperative beta-blockers for vascular surgery patients. J Vasc Surg 2010; 51: 515-9.
21. Fleisher LA, Beckman JA, Brown KA, Calkins H, Chaikof EL, Fleischmann KE, et al. 2009 ACCF/AHA focused update on perioperative beta blockade incorporated into the ACC/AHA 2007 guidelines on perioperative cardiovascular evaluation and care for noncardiac surgery. J Am Coll Cardiol 2009; 54: e13-118.
22. Yang H. Further reflections on recent updates to perioperative beta-blocker guidelines. Can J Anaesth 2010; 57: 712-3.
23. Adibi P. POISE trial quality control. Lancet 2008; 372: 1147.

อุบัติการณ์ภาวะกล้ามเนื้อหัวใจขาดเลือดและปัจจัยที่เกี่ยวข้อง: การศึกษาแบบสหสถาบันที่หออภิบาลผู้ป่วยหนักทางศัลยกรรมในโรงพยาบาลมหาวิทยาลัยในประเทศไทย

วราภรณ์ เชื้ออินทร์, ศรินญา จันทะวงศ์, ตันหยง พิมานเมฆาภรณ์, สุณีรัตน์ คงเสรีพงศ์, กวีศักดิ์ จิตตวัฒนรัตน์, นนทิดา โรจนพิทยากร

วัตถุประสงค์: *กลุ่มวิจัย THAI-SICU จัดตั้งขึ้นเพื่อศึกษาข้อมูลพื้นฐานและภาวะแทรกซ้อนในกลุ่มผู้ป่วยที่เข้ารับการรักษาในหออภิบาลผู้ป่วยหนักทางศัลยกรรมในประเทศไทย วัตถุประสงค์ของการศึกษานี้เพื่อศึกษาอุบัติการณ์ ปัจจัยที่เกี่ยวข้อง การรักษาเริ่มต้นและผลหลังการเกิดภาวะกล้ามเนื้อหัวใจขาดเลือดในผู้ป่วยกลุ่มนี้*

วัสดุและวิธีการ: *เป็นการศึกษาแบบสหสถาบันแบบเก็บข้อมูลไปข้างหน้า โดยเก็บข้อมูลผู้ป่วยที่เข้ารับการรักษาในหออภิบาลผู้ป่วยหนักทางศัลยกรรมในโรงพยาบาลมหาวิทยาลัย 9 แห่งในประเทศไทย ในช่วงระยะเวลาตั้งแต่ เดือนเมษายน พ.ศ. 2554 ถึง เดือนมกราคม พ.ศ. 2556 โดยเก็บข้อมูลของการเกิดภาวะกล้ามเนื้อหัวใจขาดเลือด โดยเริ่มเก็บข้อมูลเมื่อผู้ป่วยเข้ารับการรักษาในหออภิบาลผู้ป่วยหนักทางศัลยกรรมจนถึง 28 วัน หลังเข้ารับการรักษา*

ผลการศึกษา: *ผู้ป่วยทั้งหมด 4,652 คน พบอุบัติการณ์การเกิดภาวะหัวใจหยุดเต้นจำนวน 66 ราย (ร้อยละ 1.4) โดยส่วนใหญ่ลักษณะของคลื่นไฟฟ้าหัวใจที่พบเป็นแบบ non-ST elevated MI (NSTEMI) ถึงร้อยละ 75 ลักษณะอาการแสดงของภาวะกล้ามเนื้อหัวใจขาดเลือดได้แก่ มีการเปลี่ยนแปลงลักษณะของคลื่นไฟฟ้าหัวใจ (ร้อยละ 53) และมีการเพิ่มขึ้นของค่า cardiac enzyme (ร้อยละ 48.5) ผู้ป่วยที่เกิดภาวะกล้ามเนื้อหัวใจขาดเลือด พบว่าอัตราตาย ณ 28 วัน หลังเข้ารับการรักษาในหออภิบาลผู้ป่วยหนักสูงกว่าผู้ป่วยที่ไม่เกิดภาวะนี้ (ร้อยละ 28.8 เทียบกับร้อยละ 13.6, $p = 0.001$) เมื่อนำปัจจัยที่น่าจะมีความสัมพันธ์กับภาวะกล้ามเนื้อหัวใจขาดเลือดมาวิเคราะห์ทางสถิติ พบว่าปัจจัยที่มีความสัมพันธ์เป็นตัวชี้นำต่อการเกิดภาวะนี้ ได้แก่ ค่าคะแนน Acute Physiologic and Chronic Health Evaluation (APACHE) II (RR 1.04, 95%CI 1.01-1.07, $p = 0.003$) และผู้ป่วยที่มีอายุ ≥ 65 ปี (RR 2.54, 95% CI 1.36-4.75, $p = 0.003$)*

สรุป: *อุบัติการณ์การเกิดภาวะกล้ามเนื้อหัวใจขาดเลือดในผู้ป่วยที่เข้ารับการรักษาในหออภิบาลผู้ป่วยหนักทางศัลยกรรม ในโรงพยาบาลมหาวิทยาลัยในประเทศไทยพบได้น้อยแต่มีอัตราตายสูงปัจจัยที่มีความสัมพันธ์เป็นตัวชี้นำต่อการเกิดภาวะนี้ ได้แก่ ค่าคะแนน APACHE II และผู้ป่วยที่มีอายุ ≥ 65 ปี*