Original Article

Perioperative and Anesthetic Adverse Events in Thailand (PAAd Thai) Study: An Analysis of Suspected Myocardial Ischemia/Infarction

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Background: Perioperative myocardial ischemia or infarction (PMI) is infrequent but is a life-threatening complication. The pathophysiology is complex, and the diagnosis can be difficult due to asymptomatic presentations.

Objective: To investigate the patient, anesthetic, and surgical characteristics of the suspected PMI incidents, as well as the outcomes, and suggested corrective strategies to avoid the adverse events.

Materials and Methods: The suspected PMI incident reports were extracted from the database of the Perioperative and Anesthetic Adverse Events in Thailand (PAAd Thai) study, conducted between January 1, and December 31, 2015. Surgical patients undergoing anesthesia with suspected PMI reported in 22 hospitals were included. Three anesthesiologists independently reviewed the reports. The patient, anesthetic, and surgical profiles, and other incident details were collected from the standardized report forms. Descriptive statistics were used.

Results: Suspected PMI was reported in 29 non-cardiac surgical patients with the mortality rate of 20.7% (6/29 patients). PMI was confirmed in 24 patients (82.8%). Non-ST-elevation MI (NSTEMI) was the predominant diagnosis of all reports (15/29 patients, 51.7%). Most incidents occurred in the operating room and were asymptomatic at presentation. Patient factor was considered the most common predisposing factor (96.5%), followed by surgery (58.6%), and anesthesia (37.9%). Quality assurance activity was the most recommended corrective strategies.

Conclusion: PMI is not common among non-cardiac surgical patients in Thailand but causes significant mortality. Understanding the pathophysiology and being aware of PMI are important for appropriate perioperative management. Furthermore, early detection, along with multidisciplinary assessment for optimization of the treatment are crucial for prognostic outcomes.

Keywords: Perioperative, Adverse event, Anesthesia, Myocardial, Infarction, Ischemia, Complication

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Myocardial ischemia is one of the leading causes of major perioperative cardiac complications. These include myocardial infarction (MI), heart failure, and arrhythmias, which are all strongly associated with increased perioperative morbidity and mortality[1,2]. Perioperative MI (PMI) increases the risk of 30-day mortality at least five-fold compared with non-surgical patients[1].

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The pathophysiology of PMI can be explained by two different mechanisms[3]. The first is acute coronary syndrome (ACS), which occurs after vulnerable plaque rupture. The second is from imbalance between myocardial oxygen demand and delivery. Therefore, surgical trauma and anesthesia substantially elevate the risk of MI as increased stress, inflammatory process, hypercoagulability, and hypoxia, commonly occur throughout the perioperative period[4,5].

The incidence of PMI in patients undergoing non-cardiac surgery ranges from 0.016% to 1%[1,2,6-8]. Different patient characteristics, types of surgery, study designs, and definitions may cause the large variation[1,9,10]. Risk factors associated with PMI include emergency procedure, increasing age, higher American Society of Anesthesiologists (ASA) physical status and surgical risk group, as well as pre-existing cardiovascular diseases[1]. With the improvement of health care quality, the number of elderly patients with several comorbidities is rising, and hence, increases the risk of PMI and adverse events. However, the recent data on the incidence and impacts of PMI among non-cardiac surgical patients in Thailand are still limited.

In 2015, the multicenter study of the Perioperative Anesthetic Adverse Events in Thailand (PAAd Thai)[11] was endorsed by the Royal college of Anesthesiologists of Thailand (RCAT). The present study was part of the PAAd Thai study aiming to specifically report the incidence, clinical characteristics, management, and outcomes of PMI. Furthermore, the authors also aimed to identify factors contributing to the incidents and minimizing the outcomes, as well as suggested corrective strategies to avoid the adverse events.

Materials and Methods

Twenty-two participating hospitals, which Included eight university and 14 service-based hospitals, were asked to report the critical incidents of interests. The informed consent was exempted after receiving approval from each Institutional Review Board. The data collection was processed between January 1, and December 31, 2015.

The details of specific perioperative adverse events during anesthesia and 24 hours after surgery were recorded in the standardized incident report forms by the attending anesthetic practitioners on an anonymous basis. All critical incidents of the first 2,000 incident reports were reviewed by the site manager of each hospital before conveying to the data management unit.

In the present study, all incident reports of suspected PMI were extracted from the database of the PAAd Thai study and assessed by three independent anesthesiologists. If any discrepancies were encountered, a consensus would be obtained after a thorough discussion. Demographic data, medical history, surgical characteristics, anesthetic profiles, and details of the suspected PMI events were identified. These details included the timing and location upon presentation, clinical manifestations, cardiac biomarkers, medications, and interventions.

Suspected PMI was adjudicated based on clinical information from the incident reports, including perioperative signs and symptoms of ischemia (e.g., chest pain, shortness of breath, hypotension, tachycardia, or hypoxemia), electrocardiogram (ECG) changes, cardiac biomarkers (e.g., troponin), echocardiography, and coronary angiography, if performed. The cardiac risk of surgery was classified into three groups, low-, intermediate-, and high-risk groups, according to the risk of myocardial infarction (MI) among different surgeries[1]. Based on the ECG and biomarker findings, PMI events were categorized into three groups, ST-elevation MI (STEMI), non-ST-elevation MI (NSTEMI), and unstable angina. The outcome at 24 hours and seven days after the occurrence of PMI were recorded. The perspectives of the attending anesthetic personnel on the potential factors for contributing the incidents and minimizing the outcomes, as well as suggested corrective strategies were also collected. Descriptive statistics were used to summarize data. Continuous data were presented as median with interquartile range and categorical variables as frequency with percentage.

Results

On the report of the PAAd Thai database between January 1, and December 31, 2015, there were 333,219 anesthetics performed in the participating hospitals. Among these, 34 critical incidents of suspected PMI were enrolled. However, five patients were excluded on account of unrelated diagnoses. As a result, there were 29 patients included in the final analysis.

Among 29 suspected PMI incidents, the diagnosis of PMI was confirmed in 24 patients (82.8%). NSTEMI and STEMI were confirmed in 15 patients (51.7%) and eight patients (27.6%), respectively. The remaining one patient was diagnosed of unstable angina. Demographic data and baseline characteristics are shown in Table 1. Most patients were female (17 patients, 58.6%) and categorized as ASA physical status III (18 patients, 62.1%). The overall median age was 69 years (ranged from 31 to 93 years). The most common comorbidity was hypertension in 11 patients (37.9%), followed by coronary artery disease in nine patients (31.0%), and sepsis in seven patients (24.1%). General surgery and neurosurgery were the two most common subspecialties and accounted for 55.1% of all suspected PMI incidents. Additional subspecialties not presented in Table 1 were thoracic, colorectal, obstetric surgery, and ophthalmic surgery. The suspected PMI incident was reported in one patient (3.4%) among each of the last-mentioned subspecialties. Massive bleeding occurred in four patients (13.8%), all diagnosed of NSTEMI. The operations included craniotomy for tumor removal, open abdominal aortic aneurysm

Table 1. Demographic data and baseline characteristics

Characteristics	All patients (n=29, 100%); n (%)	NSTEMI (n=15, 51.7%); n (%)	STEMI (n=8, 27.6%); n (%)
Demographics			
Age (year); median (IQR)	69 (16.5)	74 (11)	65.5 (22)
Sex: male	12 (41.4)	5 (33.3)	6 (75.0)
ASA physical status			
I	2 (6.9)	0 (0.0)	1 (12.5)
II	6 (20.7)	4 (26.7)	1 (12.5)
III	18 (62.1)	10 (66.6)	5 (62.5)
IV	3 (10.3)	1 (6.7)	1 (12.5)
Comorbidity			
Hypertension	11 (37.9)	7 (46.7)	2 (25.0)
Coronary artery disease	9 (31.0)	3 (20.0)	4 (50.0)
Sepsis/septic shock	7 (24.1)	2 (13.3)	4 (50.0)
Diabetes mellitus	6 (20.7)	2 (13.3)	3 (37.5)
Chronic kidney disease	5 (17.2)	3 (20.0)	2 (25.0)
Congestive heart failure	2 (6.9)	0 (0.0)	1 (12.5)
Valvular heart disease	2 (6.9)	1 (6.7)	1 (12.5)
Respiratory tract disease/smoking	2 (6.9)	0 (0.0)	1 (12.5)
Prior stoke/TIA	1 (3.4)	1 (6.7)	0 (0.0)
Surgical specialty			
General surgery	11 (37.9)	6 (40.0)	4 (25.0)
Neurosurgery	5 (17.2)	4 (26.7)	0 (0.0)
Orthopedics	3 (10.3)	1 (6.7)	1 (12.5)
Otolaryngology	3 (10.3)	1 (6.7)	2 (25.0)
Urosurgery	3 (10.3)	2 (13.3)	0 (0.0)
Others	4 (13.8)	1 (6.7)	1 (12.5)
Procedural cardiac risk			
Low risk*	5 (17.2)	1 (6.7)	2 (25.0)
Medium risk§	21 (72.4)	12 (80.0)	5 (62.5)
High risk¶	3 (10.3)	2 (13.3)	1 (12.5)
Emergency surgery	7 (24.1)	3 (20.0)	2 (25.0)
Significant bleeding	4 (13.8)	4 (26.7)	0 (0.0)
General anesthesia	24 (82.8)	13 (86.7)	7 (87.5)

ASA=American Society of Anesthesiologists; STEMI=ST elevation myocardial infarction; NSTEMI=non-ST elevation myocardial infarction; TIA=transient ischemic attack; IQR=interquartile range

* Endocrine, otorhinolaryngology, ophthalmic, dental, breast, gynecologic surgery; § Gastrointestinal, neuro, urologic, orthopedic, dermatologic surgery; ¶ Vascular, noncardiac, thoracic surgery

repair, femorofemoral bypass, and open nephrectomy.

Sixteen (55.2%) of the suspected PMI incidents occurred in the operating room which included two patients (6.9%) during the time of pre-induction, seven patients (24.1%) during induction, and seven patients (24.1%) during maintenance. Surgery was cancelled in eight patients (27.6%) after the incident. All cancelled cases were elective and 75% of these occurred during pre-induction and induction phase. Hypotension was the most common clinical manifestation through the onset of the incidents with 14 patients (48.3%), followed by arrhythmia with 10 patients (34.5%). Sudden cardiac arrest at the time of presentation was found in four patients (13.8%). The most frequent abnormal finding on the ECG was ST-segment depression in 15 patients (51.7%). However, more patients diagnosed of STEMI underwent percutaneous coronary intervention (37.5% versus

Table 2. Details of suspected PMI incidents

Characteristics	All patients (n=29, 100%); n (%)	NSTEMI(n=15, 51.7%); n (%)	STEMI(n=8, 27.6%); n (%)
Time of presentation			
Pre-induction	2 (6.9)	1 (6.7)	0 (0.0)
Induction	7 (24.1)	3 (20.0)	1 (12.5)
Maintenance	7 (24.1)	5 (33.3)	0 (0.0)
Recovery	7 (24.1)	3 (20.0)	4 (50.0)
Post-recovery	6 (20.7)	3 (20.0)	3 (37.5)
Location, n (%)			
Operating room	16 (55.2)	9 (60.0)	1 (12.5)
Recovery room	4 (13.8)	3 (20.0)	1 (12.5)
Intensive care unit	5 (17.2)	1 (6.7)	4 (62.5)
Ward	4 (13.8)	2 (13.3)	2 (25.0)
Clinical presentation			
Chest/arm/epigastric/jaw pain	2 (6.9)	0 (0.0)	2 (25.0)
Hypertension	8 (27.6)	5 (33.3)	1 (12.5)
Hypotension	14 (48.3)	9 (60.0)	4 (50.0)
Tachycardia	6 (20.7)	2 (13.3)	3 (37.5)
Arrhythmia	10 (34.5)	7 (46.7)	2 (25.0)
Dyspnea	6 (20.7)	2 (13.3)	3 (37.5)
Hypoxemia	7 (24.1)	4 (26.7)	2 (25.0)
Pulmonary edema	3 (10.3)	1 (6.7)	2 (25.0)
Cardiac arrest	4 (13.8)	2 (13.3)	1 (12.5)
Characteristics of ECG			
Q waves	3 (10.3)	1 (6.7)	2 (25.0)
T-wave inversion	4 (13.8)	2 (13.3)	1 (12.5)
ST-segment depression	15 (51.7)	11 (73.3)	N/A
ST-segment elevation	10 (34.5)	N/A	8 (100)
Other ischemic changes	10 (34.5)	8 (53.3)	1 (12.5)
Management			
Cancellation of surgery	8 (27.6)	5 (33.3)	1 (12.5)
Inotrope/vasopressor	19 (65.5)	12 (80.0)	6 (75.0)
IABP	4 (13.8)	2 (13.3)	2 (25.0)
Anti-platelet/anti-thrombin	9 (31.0)	5 (33.3)	3 (37.5)
PCI/stent	5 (17.2)	2 (13.3)	3 (37.5)
CABG	2 (6.9)	1 (6.7)	1 (12.5)

STEMI=ST elevation myocardial infarction; NSTEMI=non-ST elevation myocardial infarction; ECG=electrocardiogram; IABP=Intra-aortic balloon pump; PCI=percutaneous coronary intervention; CABG=coronary artery bypass grafting surgery

13.3%) and coronary artery bypass grafting surgery (12.5% versus 6.7%), compared with NSTEMI. The recorded management and details of suspected PMI incidents are described in Table 2.

Following the incidents, the overall 24-hour and 7-day mortality rates were 10.3% and 20.7%. The mortality rates at both times for patients diagnosed of STEMI were higher than those diagnosed of NSTEMI (12.5% versus 6.75 and 25% versus 20%, respectively). Apart from these, major physiologic changes, including cardiovascular changes (e.g., cardiogenic shock and arrhythmia) and respiratory changes (e.g., pulmonary edema and hypoxia requiring intubation), were also reported in 72.4% and 20.7% of all patients, respectively. Complete recovery was found in 12 patients (14.4%) with the higher rate among the NSTEMI group than the STEMI group (40.0% versus 25.0%). The adverse outcomes

Table 3. Immediate and long-term outcomes

Adverse outcomes	All patients (n=29, 100%); n (%)	NSTEMI (n=15, 51.7%); n (%)	STEMI (n=8, 27.6%); n (%)
Within 24 hours			
Unplanned ICU admission	7 (24.1)	5 (33.3)	1 (12.5)
Acute kidney injury	4 (13.8)	2 (13.3)	2 (13.3)
Major respiratory changes	6 (20.7)	3 (20.0)	3 (37.5)
Major cardiovascular changes	21 (72.4)	12 (80.0)	8 (100)
Cardiac arrest	6 (20.7)	4 (26.7)	1 (12.5)
Death	3 (10.3)	1 (6.7)	1 (12.5)
At 7th day after incident			
Complete recovery	12 (14.4)	6 (40.0)	2 (25.0)
Prolonged ventilatory support	5 (17.2)	2 (13.3)	3 (37.5)
Prolonged hospitalization >7 days	10 (34.5)	5 (33.3)	4 (50.0)
ESRD	1 (3.4)	1 (6.7)	0 (0.0)
Disabled	1 (3.4)	0 (0.0)	1 (12.5)
Death	6 (20.7)	3 (20.0)	2 (25.0)
Missing data	1 (3.4)	1 (6.7)	0 (0.0)

STEMI=ST elevation myocardial infarction; NSTEMI=non-ST elevation myocardial infarction; ICU=intensive care unit; ESRD=end-stage renal disease

resulted from suspected PMI are shown in Table 3.

According to the perspectives of the attending anesthesia personnel and site managers of each hospital, the patient factor was the main predisposing factor of suspected PMI incidents (28 patients, 96.6%). Of these, advanced age (older than 65 years) was most frequently identified. The surgical factor (e.g., prolonged operation, significant hemorrhage, emergency procedure, and high-risk surgery) was second (17 patients, 58.6%). The anesthetic factor was considered in 11 patients (37.9%). Administration of anesthetic drugs with myocardial depressant effects, as well as incomplete preoperative evaluation and preparation were the primary reasons. The systemic factor was found in five patients (17.2%). Ineffective interdepartmental consultation, lack of communication, and lack of resource (e.g., intensive care unit) were mentioned. Factors contributing to the incidents and minimizing the outcomes as well as suggested corrective strategies are described in Table 4.

Discussion

The present study is part of the large multicenter incident reporting study of the PAAd Thai. It demonstrated the incidence of suspected PMI of adult patients undergoing non-cardiac surgery at 0.01%[11]. Approximately half of all incidents occurred in the operating room and were diagnosed of NSTEMI. The most common clinical and ischemic ECG presentations were hypotension and ST-segment depression, respectively. One fourth of all patients underwent coronary revascularization procedures. Permanent disability and fatal outcomes accounted for almost 30% of all suspected PMI patients.

Previous studies reported the incidence of suspected PMI in non-cardiac surgical patients ranging from 0.016% to 1%[1,2,6-8]. The wide difference might result from variation of patient characteristics, types of surgery, study designs, and definitions of PMI[1,9,10]. In the present study, PMI was suspected if there were ECG changes consistent with MI (e.g., new Q waves, ST-segment elevation, or depression), along with clinical presentation of myocardial ischemia (e.g., chest pain or hypotension), increased cardiac biomarkers, or strong evidence from echocardiography or coronary angiogram, and postoperative cardiologist notes indicating a diagnosis of PMI. Recently, in 2018, an international expert consensus panel recommended a new universal definition and classification of MI[12]. Although, this novel consensus definition does not precisely direct to the diagnosis of PMI, it is rather consistent with the authors' proposed definition. However, the reported incidents in the present study might be underestimated as PMI are often clinically silent. Therefore, the diagnosis was less likely to be recognized as routine ECG and cardiac biomarker surveillance was lacking. Apart from that, there was a major difference in identification of patients with PMI, leading to higher

Table 4. Predisposing factors, contributing factors, factors minimizing outcomes and suggested corrective strategies (n=29)

	n (%)
Predisposing factors	
Patient	28 (96.5)
Surgery	17 (58.6)
Anesthesia	14 (48.3)
System	5 (17.2)
Contributing factors	
Inadequate preanesthetic preparation	12 (41.4)
Inadequate preanesthetic evaluation	11 (37.9)
Inexperience	10 (34.5)
Inappropriate decision	8 (27.6)
Emergency condition	6 (20.7)
Inadequate knowledge	4 (13.8)
Communication defect	4 (13.8)
Lack of monitor/equipment	1 (3.4)
Haste	1 (3.4)
Factors minimizing outcomes	
Vigilance	20 (70.0)
Having experience	12 (41.4)
Effective consultation system	12 (41.4)
Experienced assistant	6 (20.7)
Effective communication	5 (17.2)
Compliance with practice guidelines	4 (13.8)
Compliance with surgical safety checklists	2 (6.9)
Improvement of training	1 (3.4)
Diagnostic monitor (e.g., TEE)	1 (3.4)
Suggested corrective strategies	
Quality assurance activity	13 (44.8)
Improvement of communication	10 (34.5)
Compliance with practice guidelines	9 (31.0)
Improvement of supervision	5 (17.2)
Additional training	5 (17.2)
Compliance with surgical safety checklists	1 (3.4)

TEE=transesophageal echocardiography

incidence being detected. Some former studies[1,6,15] included patients diagnosed of PMI until 30 days or more postoperatively, whereas the present study definition limited the time of occurrence within 24 hours after the surgery. Furthermore, another explanation could be that the incidences of coronary artery disease, which is a substantial risk factor for PMI, are higher among populations in western countries[13]. However, the incidence of PMI in China[7] (0.016%) was comparable and supported the results of the present study.

Factors related to the PMI included emergency procedure, increasing age, higher ASA physical status and surgical risk group, as well as pre-existing cardiovascular disease[1]. The median age of PMI patients in the present study was 69 years (31 to 93 years), which is older when compared with the previous report in Thailand of ten years ago(8), and was comparable with the more recent studies[7,14,15]. This might be because of an increase in life expectancy from improved health care in Thailand. PMI were also found in patients with higher ASA physical status in the present study (27.6% in ASA I & II versus 72.4% in ASA III & IV). In terms of comorbidities associated with the occurrence of suspected PMI, the present study results revealed high proportions of patients with hypertension, coronary artery disease, and diabetes mellitus as well. In addition, patient factor was considered the most common predisposing factor of PMI, compared to surgical, anesthetic, or systematic cause, which was similar to the previous report[14].

Recently, the preoperative cardiac risk assessment of patients undergoing non-cardiac surgery has been used to inform patients risks and guide decisions. The clinical risk indices, for example, the Revised Cardiac Risk Index (RCRI)[9] and the National Surgical Quality Improvement Program risk index for Myocardial infarction and Cardiac Arrest (NSQIP MICA)[16] are commonly accepted for the prediction of cardiac events. Nevertheless, these clinical models classify surgery into broad categories so the true risk contributed by any one procedure might be inadequately estimated. In addition, Liu et al[10] demonstrated that grouping operations led to inaccurate estimation of perioperative cardiac risk of individual operations. Therefore, the present study categorized the risk of PMI into low and medium risk group, based on the previous study by Hallqvist et al[1] according to the odds ratio of MI after different surgeries. The authors found the reports of PMI were mostly among the medium risk group as this population accounted for most patients in the PAAd Thai study[11].

Early detection of PMI in the setting of risk factors is crucial on timely diagnosis and treatment. However, most PMIs are asymptomatic due to anesthesia, analgesia, sedation, and even delirium. A previous study reported chest pain and other symptoms of 6% to 34.7%[3], which are quite concordant with the present study findings on chest pain (7%) and dyspnea (20%). The new ECG findings in PMI are primary ST-segment depression rather than ST-segment elevation, and non-Q-wave rather than Q-wave[3]. This depicts that Type 2 PMI, which is caused by mismatch between oxygen demand and supply, is more common than Type 1 PMI, which is caused by atherosclerotic plaque rupture. The authors demonstrated that ST-segment depression was found in more than 50%, and Q waves in 10% of all cases, supporting the results from the last-mentioned study. The imbalance of oxygen demand-supply during perioperative period might result from several reasons. Surgical trauma, anesthesia, intubation and extubation, pain, fasting, hypothermia, and bleeding can cause extreme stress[4]. As a result, increased stress hormone leads to elevation of blood pressure and heart rate, increasing the oxygen demand. Furthermore, triggers, such as, anemia, anesthesia, and analgesia can also decrease oxygen supply and, thereby, result in myocardial ischemia. These terms are consistent with the present study findings as stress-induced PMI was considered in most patients (almost 80%). The precipitating factors of PMI, such as anesthesia (induction or intubation, or emergence), hypotension (from bleeding or myocardial depressants), sepsis, and administration of local anesthetics with adrenaline were all shown in the present study. In addition, systemic inflammatory response increases cytokines (e.g., tumor necrosis factor-α, interleukin (IL)-1, IL-6, and C reactive protein)[4], which may take part in the beginning of coronary artery plaque rupture and acute thrombosis. This is also demonstrated in the present study as 50% of patients diagnosed of STEMI were precipitated by sepsis.

Patients experiencing PMI are at high risk for mortality. A recent study from Sweden[1] reported a 30-day mortality of 26%. Another cohort study from Canada[2] also demonstrated 19% of patients with PMI experienced in-hospital death at 30 days after the surgery. These findings are quite congruent with the long-term mortality rate of 20% in the present study. However, Zhou et al. report the higher mortality rate of 75% in patients aged more than 45 years undergoing non-cardiac surgery in China[7]. Their explanations were that general wards were mainly the locations of the PMI onset, where ECG monitoring were not available. According to the present study findings, more than 85% of suspected PMI patients were identified in the operating room or PACU or ICU, and therefore, may result in earlier diagnosis and management. Factors associated with failure to rescue in myocardial infarction after non-cardiac surgery included age more than 85 years old, underweight body mass index, ASA class IV or V, sepsis, and undergoing emergency surgery and high-risk procedures[2]. Although the median age of patients who died in the present study was 75 years. It is still 10 years older than the median age of overall patients.

In the present study, the methods that participating hospitals reported the PMI incidents were similar to the story telling of organizational practice and experience in adverse events. Therefore, lessons can be learnt that several contributing factors can be modified to lessen the occurrence of the incidence. Inadequate preanesthetic evaluation and preparation, inappropriate decision or lack of knowledge or monitor or communication are useful examples. For instance, one patient was administered an inappropriately high dosage of adrenaline mixed with local anesthetics due to lack of medical knowledge. Another example was that there were no communications from the surgical team when inferior vena cava injury occurred, resulting in delayed fluid resuscitation. According to the perspectives of attending personnel, to improve the future outcome when PMI occurs, it is essential to always be vigilant to make an early diagnosis and prompt treatment. Apart from that, having the help from experienced staff and effective consultations between specialists might play an important role. All patients experienced PMI potentially fulfill the criteria for diagnostic coronary angiography unless contraindicated [e.g., patients with underlying diseases related with poor survival or low likelihood of acute coronary syndrome (ACS)][17]. Additionally, certain patients may benefit from coronary interventions, but a careful decision needs to be made regarding the risks from bleeding and benefits from revascularization. Although, quality assurance activity is the most suggested corrective strategy, other beneficial management include improvement of communication, compliance with practice guidelines (e.g., ACC or AHA guidelines for preoperative risk assessment[18]), and improvement of supervision, especially in high-risk patients.

There are some limitations in the present study since the data were collected from a large database. Firstly, the incident reports were written by the attending personnel on an anonymous basis. Therefore, it was difficult to always retrieve complete data. Secondly, reporting bias is possible and may influence the true incidence of PMI. Thirdly, the PMI incidence might also be underestimated due to lack of routine ECG monitoring and serum cardiac markers, which could identify the clinically silent events. Nevertheless, to minimize these problems, several meetings and workshops were set up to clarify the definitions and the reporting system to all participating hospitals.

Conclusion

The incidence of suspected PMI among non-cardiac surgical patients in Thailand is not common, however, clinically silent patients might be undetected. The mortality rate is high, up to 20%. Being aware and understanding the pathophysiology of PMI is essential for anesthesia providers to better identify patients at risks and precipitating factors, and thereby, decrease the incidence of PMI. Other suggested strategies for the prevention of PMI, as well as minimizing the outcomes include compliance with practice guidelines and effective multidisciplinary management.

What is already known on this topic?

PMI is infrequent but may lead to permanent complication and lethal outcomes. Several predisposing factors play an important in the development of PMI, but patient factor is still considered the most common cause. Improvement of preoperative evaluation and preparation, along with early diagnosis and prompt management could be helpful to reduce morbidity and mortality.

What this study adds?

The median age of patients with suspected PMI in Thailand has increased from 65 in 2005 to 69 years in 2015. Fatal outcomes occurred in relatively older patients. Most of the reports were considered Type II PMI. Thus, anesthesia personnel need to increase their awareness and aim to optimize the balance of oxygen demand and supply. PMI can be challenging to diagnose as most patients are asymptomatic, leading to underestimation of the true incidence. Therefore, postoperative ECG and cardiac biomarkers monitoring in patients with high risk factors should be implemented to avoid missing the events that may affect the prognosis.

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Conflicts of interest

The authors declare no conflict of interest.

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