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ORIGINAL RESEARCH

Incidence of and factors associated with perioperative cardiac arrest within 24 hours of anesthesia for emergency surgery

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Purpose: To determine the incidence of and factors associated with perioperative cardiac arrest within 24 hours of receiving anesthesia for emergency surgery.

Patients and methods: This retrospective cohort study was approved by the ethical committee of Maharaj Nakorn Chiang Mai Hospital, Thailand. We reviewed the data of 44,339 patients receiving anesthesia for emergency surgery during the period from January 1, 2003 to March 31, 2011. The data included patient characteristics, surgical procedures, American Society of Anesthesiologists (ASA) physical status classification, anesthesia information, location of anesthesia performed, and outcomes. Data of patients who had received topical anesthesia or monitoring anesthesia care were excluded. Factors associated with cardiac arrest were identified by univariate analyses. Multiple regressions for the risk ratio (RR) and 95% confidence intervals (CI) were used to determine the strength of factors associated with cardiac arrest. A forward stepwise algorithm was chosen at a *P*-value <0.05.

Results: The incidence (within 24 hours) of perioperative cardiac arrest in patients receiving anesthesia for emergency surgery was 163 per 10,000. Factors associated with 24-hour perioperative cardiac arrest in emergency surgery were age of 2 years or younger (RR =1.46, CI =1.03–2.08, *P*=0.036), ASA physical status classification of 3–4 (RR =5.84, CI =4.20–8.12, $P<0.001$) and 5–6 (RR =33.98, CI =23.09–49.98, $P<0.001$), the anatomic site of surgery (upper intra-abdominal, RR =2.67, CI =2.14–3.33, $P<0.001$; intracranial, RR =1.74, CI =1.35–2.25, $P<0.001$; intrathoracic, RR =2.35, CI =1.70–3.24, $P<0.001$; cardiac, RR =3.61, CI =2.60–4.99, $P<0.001$; and major vascular; RR =3.05, CI =2.22–4.18, $P<0.001$), respiratory or cardiovascular comorbidities (RR =1.95, CI =1.60–2.38, $P<0.001$ and RR =1.38, CI =1.11–1.72, *P*=0.004, respectively), and patients in shock prior to receiving anesthesia (RR =2.62, CI =2.07–3.33, $P<0.001$).

Conclusion: The perioperative incidence of cardiac arrest within 24 hours of anesthesia for emergency surgery was high and associated with multiple factors such as young age (≤2 years old), cardiovascular and respiratory comorbidities, increasing ASA physical status classification, preoperative shock, and surgery site. Perioperative care providers, including surgeons, anesthesiologists, and nurses, should be prepared to manage promptly this high risk group of surgical patients.

Keywords: risk factors, retrospective cohort, anesthetic care, perioperative cardiac arrest, emergency surgery

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Introduction

Cardiac arrest in patients after receiving anesthesia for emergency surgery occurs at a rate of more than twice that of elective surgical cases, and also with significantly higher mortality rates.[1–6] Two studies reported that 50%–60% of all episodes of cardiac arrest in surgical patients occurred in patients undergoing emergency surgeries.[2,7] In developing countries the incidence of all perioperative cardiac arrest varies from 2.99–40.4

per 10,000[2,5,8] and increases in emergency surgery with the incidence varying from 6.48–62.1 per 10,000.[2,9,10]

Patients undergoing emergency surgery face unavoidable risks, particularly in an unplanned procedure, due to the limited preoperative anesthetic preparation time. Additionally, other risks include blood loss and multiple injuries to various systems of the body. During emergency situations, providing appropriate patient care prior to entering the operating room can be a challenge.

Previous studies have revealed many factors, such as age,[5,11] underlying conditions,[1] American Society of Anesthesiologists (ASA) physical status classification,[4,6,10] hemodynamic changes,[12] blood loss,[6] the anatomic site of the surgery,[5,10] and the types and severity of injuries (for example: blunt trauma and vascular injuries)[13,14] associated with cardiac arrest during anesthesia. Recognition of such risk factors may help anesthesia care providers to plan appropriate anesthetic care, including the preparation of resuscitation equipment and medications in order to deal promptly with cardiac arrest. Despite this, few studies have focused on the incidence of and factors associated with perioperative cardiac arrest after anesthesia for an emergency surgery.[2] Emergency surgery is likely to increase as the population grows over the next decade, and one would, therefore, expect to see higher mortality rates.[2,10,15] Hence, it is critical to promptly manage these patients in order to preserve circulation and protect vital organs, particularly the brain and the heart, greatly affecting the outcome of any surgical treatment.[16]

Therefore, this study was conducted to determine the incidence of and factors associated with patients whose cardiac arrest occurred within 24 hours of receiving anesthesia for emergency surgery at Maharaj Nakorn Chiang Mai Hospital, a university-based teaching hospital in northern Thailand.

Patients and methods

After the study was approved by the ethical committee of Maharaj Nakorn Chiang Mai Hospital, Faculty of Medicine, Chiang Mai University; the recorded data of 44,339 patients receiving anesthesia for emergency surgery during the period from January 1, 2003 to March 31, 2011 were reviewed.

We documented data from the time of onset of anesthesia until 24 hours after by using a study record form[17] which was developed and approved for content validity by experienced anesthesiologists. The process of data collection was tested in ten emergency surgery cases for its completeness prior to starting the study.

Data included general patient characteristics such as sex and age, medication use, substance abuse, and comorbidities prior to receiving anesthesia. Additional information included assessment of the patient's initial physical conditions, details of the surgery and administration of anesthesia, ASA physical status classification, anatomic sites of surgery, patient monitoring, anesthetic techniques, airway management, and anesthetic agents used.

Details of the event were documented in the data record form and checked for errors and completeness before being entered into the computerized database. All of the data were obtained by chart review, including the digital hospital database, anesthesiology records, medical records, and electrocardiogram (EKG) examination and laboratory reports. Data extraction from the database for analysis was done by two research assistants who had been trained and tested for standardized data collection techniques by anesthesiologists to ensure the accuracy of the information recorded. The data entry was done by using the double-entry technique for ensuring accuracy. Data from those who had cardiac arrest prior to surgery, received local anesthesia by surgeons, or underwent monitoring anesthesia care were excluded.

Cardiac arrest was defined as a sudden state of circulatory failure due to a loss of cardiac systolic function and specific changes in the cardiac rhythm causing a disturbance of the heart before the occurrence of cardiac arrest; ie, ventricular fibrillation, pulseless ventricular tachycardia, pulseless electrical activity, and asystole.

The statistical analysis was performed using the STATA (StataCorp LP, College Station, TX, USA) statistical package. Descriptive statistics were used to describe patient characteristics, including age, sex, ASA physical status classification, current medications, personal history, and comorbidities. Fisher's exact or chi-square test was used to analyze categorical variables, and the *t*-test or Wilcoxon's rank-sum test was used to analyze the continuous data when appropriate. Factors potentially associated with cardiac arrest were initially determined by using the univariable statistical analysis. Factors associated with cardiac arrest at *P*-values of less than 0.02 were selected for further analysis by a stepwise multivariable generalized linear regression for risk ratio (RR). The multicollinearity of all variables was examined by bivariate correlation matrix. If any factors showed multicollinearity, only one of them was selected to further multivariate analysis. A *P*-value of less than 0.05 was considered as statistically significant. The RR and 95% confidence interval (CI) were used to determine the strength of association between each factor and the cardiac arrest.

Results

During the 9-year period, the first episode of cardiac arrest within 24 hours of anesthesia occurred in 721 cases out of

44,339 emergency surgical patients (163:10,000). Their ages ranged from 2 months to 78 years. The vast majority of them received general anesthesia (97.5%) and were intubated (92.1%). More than half of them were male (69.6%), and had an ASA physical status classification of 3 or higher (92.6%). Table 1 compares the preoperative comorbidities, anatomic sites of surgery, and history of drug administration and substance abuse in those with and without cardiac arrest. Patients in the two groups were statistically different in many characteristic variables, as outlined in Table 1. Details of medications, including anesthetic agents, are shown in Table 2. There was no significant difference between the two groups regarding the mean duration of anesthesia (126.3±95.1 minutes versus 120.6±104.2 minutes). The surgery was discontinued in 65 patients (0.14%) due to uncontrollable bleeding and/or unavailability of blood components. Some patients experienced electrocardioversion or cardiac arrest during surgery. The incidence of cardiac arrest in patients undergoing surgery during the evening or at night was two times higher than in those undergoing surgery during the daytime (74.1% versus 25.9%). Using the univariate analysis, variables with a P-value of less than 0.02 were male sex (RR =1.48, CI =1.26–1.73, $P<0.001$), aged 2 years or younger (RR =1.86, CI =1.32–1.92, $P<0.001$) or older than 65 years (RR =2.47, CI =2.00–3.04, $P<0.001$), having an ASA physical status classification of 3–4 ($P<0.001$) and 5–6 ($P<0.001$), anatomic sites of surgery (upper intra-abdomen, intracranial, intrathoracic, cardiac, and major vascular, each $P<0.001$), patient comorbidities (respiratory, cardiovascular, and hematology, each $P<0.001$; endocrine, $P=0.002$), current NSAID medications such as aspirin (RR =4.62, CI =2.61–8.17, $P<0.001$), general anesthesia techniques and requiring endotracheal intubation (RR =8.49, CI =5.32–13.55, $P<0.001$), and hemodynamic instability or patients in shock prior to receiving anesthesia (RR =23.23, CI =20.07–26.87, $P<0.001$) (Tables 1 and 2). Additionally, statistically significant anesthetic medications as shown in Table 2.

From the multivariate analyses, the statistically significant factors associated with cardiac arrest were age of 2 years or younger (RR =1.46, CI =1.03–2.08, $P=0.036$), ASA physical status of 3–4 (RR =5.84, CI =4.20–8.12, $P<0.001$) and 5–6 (RR =33.98, CI =23.09–49.98, $P<0.001$), anatomic sites of surgery (upper intra-abdominal, RR =2.67, CI =2.14–3.33, $P<0.001$; intracranial, RR =1.74, CI =1.35–2.25, $P<0.001$; intrathoracic, RR =2.35, CI =1.70–3.24, $P<0.001$; cardiac, RR =3.61, CI =2.60–4.99, $P<0.001$; and major vascular; RR =3.05, CI =2.22–4.18, $P<0.001$), respiratory (RR =1.95, CI =1.60–2.38, $P<0.001$) or cardiovascular comorbidities (RR =1.38, CI =1.11–1.72, $P=0.004$), and patients with shock before receiving anesthesia (RR =2.62, CI =2.07–3.33, $P<0.001$) (Table 3).

Discussion

Over the past decade, there has been growing interest in determining risk factors for cardiac arrest in patients who receive anesthesia for surgery in order to develop practice guidelines aimed at reducing mortality rates.[1,3,5,6,11] However, most studies have focused on patients undergoing elective surgery, even though emergency surgery patients were occasionally included.[1,3–6,8,14] Patients undergoing elective surgery usually have an anesthesia presurgical plan completed in advance, but emergency surgery patients do not. In addition, previous studies involving emergency patients did not focus on many of the risk factors which contribute to cardiac arrest. Also, there are differences in ethnic groups across studies with limited sample size or merely being case reports.[4,10,15,18] Moreover, there is a lack of good data regarding the role of specific risk factors associated with cardiac arrest in patients receiving anesthesia for emergency surgery, which has been shown to lead to higher mortality rates than in patients undergoing elective surgery.

In the review of our data, the cardiac arrest rate in the first 24 hours after receiving anesthesia for emergency surgery was 163 per 10,000 cases, compared to an overall rate of 8.5 per 10,000 cases. Differences in study design and patient demographic data, however, may have affected the results. Studies in Thailand reported a range from 8.2 to 96.4 per 10,000 cases,[5,10,12,19–21] and in Nigeria and Pakistan cardiac arrest rates ranged from 0.64 to 60 per 10,000 cases.[2,9,11,22] A review of the relevant studies over the past decade in both developed and developing countries revealed that cardiac arrest rates tended to decrease over time in developed countries, but not in developing countries.[23–28] For example, a study in Switzerland found anesthesia-related cardiac arrest had been low during the past decade[3] and in Japan over the past 5 years the cardiac arrest rate had been decreasing from 5.79 to 4.24 per 10,000 patients.[24] However, those studies included all patients, whether undergoing either elective or emergency surgery.

The relatively high rate of cardiac arrest in our study may have resulted from many factors, such as the patient's poor condition prior to emergency surgery, the presence of severe injuries, significant blood loss, and the lack of preparation time in advance of the emergency surgery. In addition, some patients with shock had to be urgently transferred from the

Table 1 Baseline characteristics of patients receiving anesthesia for emergency surgery (univariable analysis)

Characteristic	Perioperative cardiac arrest		Univariable RR	95% CI	*P*-value
	Yes (n=721) n (%)	No (n=43,618) n (%)			
Sex					
Female	219 (30.4)	17,172 (39.4)	1.00		
Male	**502 (69.6)**	26,446 (60.6)	1.48	1.26–1.73	<0.001
Age (years)					
≤2	**41 (5.8)**	2,020 (4.7)	1.86	1.32–2.61	<0.001
3–12	27 (3.8)	2,364 (5.4)	1.07	0.70–1.58	0.792
13–34	176 (25.0)	16,283 (37.3)	1.00		
35–64	**284 (40.4)**	16,440 (37.7)	1.59	1.32–1.92	<0.001
≥65	**176 (25.0)**	6,498 (14.9)	2.47	2.00–3.04	<0.001
Mean ± SD	45.1±23.4	38.6±21.7	1.02	1.02–1.03	<0.001
ASA physical status classification					
1–2	53 (7.4)	29,292 (67.2)	1.00		
3–4	**389 (53.9)**	14,049 (32.2)	14.91	11.19–19.87	<0.001
5–6	**279 (38.7)**	277 (0.6)	227.84	207.13–372.67	<0.001
BMI (kg/m^2) mean ± SD, n=12,622	22.6±4.2	22.3±4.9	1.00	0.99–1.000	0.849
Anatomic site of surgery					
Lower intra-abdominal	52 (7.2)	11,979 (27.5)	0.21	0.16–0.27	<0.001
Upper intra-abdominal	**264 (36.6)**	4,917 (11.3)	4.36	3.75–5.08	<0.001
Intracranial	**138 (19.1)**	6,576 (15.1)	1.33	1.10–1.59	0.003
Intrathoracic	**57 (7.9)**	998 (2.3)	5.82	4.47–7.57	<0.001
Cardiac	**60 (8.3)**	621 (1.4)	20.38	14.06–29.55	<0.001
ENT	32 (4.4)	5,842 (13.4)	0.30	0.21–0.43	<0.001
Major vascular	**61 (8.5)**	897 (2.1)	4.18	3.22–5.44	<0.001
Extremities	46 (6.4)	11,710 (26.9)	0.91	0.14–0.25	<0.001
Preoperative comorbidity[a]					
Respiratory	**542 (75.2)**	10,536 (24.2)	9.09	7.68–10.76	<0.001
Cardiovascular	**489 (67.8)**	8,975 (20.6)	7.76	6.64–9.08	<0.001
Neuromuscular	**243 (33.7)**	5,379 (12.3)	3.50	3.00–4.09	<0.001
Hematological	**378 (52.4)**	9,488 (21.7)	3.85	3.33–4.46	<0.001
Endocrine	102 (14.2)	4,608 (10.6)	1.39	1.12–1.70	0.002
Current medication					
Antihypertensive	4 (0.5)	625 (1.4)	0.39	0.15–1.04	0.054
Hypoglycemic drug	2 (0.3)	243 (0.6)	0.50	0.12–2.01	0.315
Steroids (within 1 year)	6 (0.8)	208 (0.5)	1.73	0.77–3.86	0.167
Anticoagulant (within 7 days)	4 (0.5)	137 (0.3)	1.75	0.65–4.67	0.297
NSAID such as aspirin	**12 (1.7)**	150 (0.3)	4.62	2.61–8.17	<0.001
Personal history					
Smoking ≥10 pack-years	20 (2.8)	1,694 (3.9)	0.71	0.45–1.10	0.125
Alcoholic	15 (2.1)	1,780 (4.1)	0.50	0.30–0.83	0.007
Allergy history	1 (0.1)	853 (2.0)	0.07	0.01–0.50	<0.001
Anesthesia techniques					
Non-GA	18 (2.5)	7,899 (18.1)	1.00		
GA/GA (TIVA)	**703 (97.5)**	35,719 (81.9)	8.49	5.32–13.55	<0.001
Airway management					
On endotracheal tube	**664 (92.1)**	34,398 (78.9)	3.08	2.35–4.03	<0.001
Tracheostomy	6 (0.8)	1,077 (2.6)	0.32	0.15–0.72	0.006
Double lumen tube	16 (2.2)	433 (1.1)	2.17	1.31–3.52	0.005
Bronchoscope	4 (0.6)	125 (0.3)	1.85	0.69–4.94	0.173
Other	78 (10.8)	7,793 (17.9)	0.56	0.44–0.71	<0.001
Hemodynamic status					
Shock/impending shock	**341 (47.3)**	1,308 (3.0)	23.23	20.07–26.87	<0.001

(*Continued*)

Table 1 (*Continued*)

Characteristic	Perioperative cardiac arrest		Univariable RR	95% CI	*P*-value
	Yes (n=721) n (%)	No (n=43,618) n (%)			
Time of surgery					
Working hours	185 (25.9)	15,761 (36.1)	1.00		
Nonworking hours	530 (74.1)	27,849 (63.9)	1.61	1.36–1.90	<0.001
Anesthesia duration time, mean ± SD	126.3±95.1	120.6±104.2	0.99	0.99–1.00	0.487

Notes: [a]One patient had more than one comorbidity. Data in bold indicates univariate logistic factors related with perioperative cardiac arrest.
Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; CI, confidence interval; ENT, ear nose throat; GA, general anesthesia; NSAID, nonsteroidal anti-inflammatory drug; RR, risk ratio; SD, standard deviation; TIVA, total intravenous anesthesia.

emergency room to the operating room in order to provide emergency surgery. Hence, they required immediate attention and excellent cooperation among the interdisciplinary team for proper surgical management. The factors associated with cardiac arrest in our study will be discussed below.

Multivariable regression analysis of the patient characteristics shows that factors significantly associated with perioperative cardiac arrest are higher ASA classification, anatomic site of surgery (upper intra-abdominal, thoracic, intracranial, cardiac or major vascular), younger age (≤2 years), preoperative comorbidities (respiratory and cardiovascular), and the presence of shock prior to anesthesia.

Age was found to be a statistically significant factor associated with cardiac arrest in patients who were 2 years old or younger. The incidence of cardiac arrest in these younger patients was almost double that of those in the middle-age range. The finding is consistent with the result from a previous study at our center[29] as well as other studies reporting that pediatric patients are at a higher risk for cardiac arrest and higher morbidity in the peri- and postoperative periods in traumatic cases. It was also reported that pediatric patients with high ASA physical status classification suffering from injury before receiving anesthesia had a higher cardiac arrest and comorbidity rate.[1–3,11,18,30] Several factors may explain

Table 2 Anesthetic agents used in the patients for emergency surgery (univariable analysis)

Characteristic	Perioperative cardiac arrest		Univariable RR	95% CI	*P*-value
	Yes, n (%)	No, n (%)			
Pentothal	124 (17.2)	23,146 (53.1)	0.19	0.16–0.23	<0.001
Propofol	60 (8.3)	7,313 (16.8)	0.46	0.35–0.59	<0.001
Ketamine	**107 (14.9)**	1,287 (2.9)	5.37	4.38–6.60	<0.001
Etomidate	79 (11.0)	3,255 (7.5)	1.52	1.19–1.91	0.001
Midazolam	**412 (57.2)**	8,654 (19.8)	5.20	4.49–6.03	<0.001
Diazepam	17 (2.4)	851 (1.9)	1.21	0.75–1.96	0.431
Nitrous oxide	90 (12.5)	22,284 (51.1)	0.14	0.11–0.17	<0.001
Halothane	4 (0.6)	4,728 (10.8)	0.05	0.02–0.12	<0.001
Isoflurane	175 (24.3)	16,874 (38.7)	0.51	0.43–0.61	<0.001
Sevoflurane	204 (28.3)	12,925 (29.6)	0.94	0.79–1.11	0.449
Desflurane	5 (0.7)	151 (0.4)	1.98	0.82–4.77	0.118
Succinylcholine	51 (7.1)	15,531 (35.6)	0.14	0.11–0.186	<0.001
Pancuronium	**191 (26.5)**	9,107 (20.9)	1.36	1.15–1.60	<0.001
Atracurium	47 (6.5)	6,188 (14.2)	0.43	0.32–0.57	<0.001
Cisatracurium	**152 (21.1)**	5,291 (12.2)	1.91	1.59–2.28	<0.001
Vecuronium	197 (27.4)	11,222 (25.8)	0.08	0.92–1.27	0.330
Rocuronium	20 (2.8)	1,642 (3.8)	0.73	0.47–1.14	0.165
Lidocaine	10 (1.4)	2,930 (6.7)	0.19	0.11–0.37	<0.001
Bupivacaine	8 (1.1)	5,442 (12.5)	0.08	0.04–0.16	<0.001
Levobupivacaine	38 (5.3)	19,140 (43.9)	0.07	0.05–0.10	<0.001
Morphine	18 (2.5)	7,804 (17.9)	0.12	0.07–0.19	<0.001
Fentanyl	**548 (76.1)**	28,521 (65.4)	1.67	1.41–1.98	<0.001
Pethidine	1 (0.1)	308 (0.7)	0.19	0.03–1.41	0.586

Notes: Data in bold indicates univariate logistic factors related with perioperative cardiac arrest.
Abbreviations: CI, confidence interval; RR, risk ratio.

Table 3 Factors associated with perioperative cardiac arrest within 24 hours of anesthesia for an emergency surgery (multivariable regression analysis)

Factor	Multivariable RR	95% CI	*P*-value
Age (years)			
≤2	1.46	1.03–2.08	0.036
3–12	1.48	0.98–2.24	0.063
13–34	1.00		
35–64	1.08	0.89–1.30	0.448
≥65	1.09	0.87–1.35	0.475
ASA physical status classification			
1–2	1.00		
3–4	5.84	4.20–8.12	<0.001
5–6	33.98	23.09–49.98	<0.001
Anatomic sites of surgery			
Upper intra-abdominal surgery	2.67	2.14–3.33	<0.001
Intracranial surgery	1.74	1.35–2.25	<0.001
Intrathoracic surgery	2.35	1.70–3.24	<0.001
Cardiac surgery	3.61	2.60–4.99	<0.001
Major vascular surgery	3.05	2.22–4.18	<0.001
Other risk factors			
Preoperative respiratory comorbidity	1.95	1.60–2.38	<0.001
Preoperative cardiovascular comorbidity	1.38	1.11–1.72	0.004
Shock before receiving anesthesia	2.62	2.07–3.33	<0.001

Abbreviations: CI, confidence interval; RR, risk ratio; ASA, American Society of Anesthesiologists.

this increased risk of cardiac arrest in pediatric patients, including severe comorbidities of the cardiovascular and/or respiratory systems, restrictions on drug administration, increased sensitivity to oxygen desaturation, sensitivity in the airways, difficult airway management, and increased sensitivity to changes in the circulatory and/or respiratory systems. This correlates with previous studies[1,31] as well as a study in Thailand which reported that children with respiratory disease and high ASA physical status classifications were at higher risk of cardiac arrest in the perioperative period.[29] Significantly, in our study, most of the pediatric emergency cases involved cardiac surgery during the evening or night hours.

The multivariate analysis in this study failed to demonstrate a statistically significant association between the age group of older than 65 years and cardiac arrest despite a significant association in the univariate analysis. From our data set, we found that there were relatively more patients in the reference group (older children and young adults) with pre-existing severe conditions prior to surgery (41.2% versus 23.6%) or having major surgeries such as cardiac surgery (55.6% versus 4.6%), upper abdominal surgery (43.2% versus 35.8%), and intracranial surgery (31.3% versus 10.8%). These factors could be confounding or interactive factors in the analyses. Hence, the result is not consistent with the result from previous studies which reports older age increased cardiac arrest risk.[5,12]

ASA physical status classification is another significant factor in our study. We found that an ASA physical status classification of 3 or higher was associated with increased risk of cardiac arrest. Patients with a higher ASA physical status classification were shown to be five to 34 times more likely to suffer cardiac arrest in previous studies.[1,3,6,14] A 10-year study at a US teaching hospital showed that ASA physical status classification of 5 increased the risk of cardiac arrest by more than 300 times.[7] This is consistent with results from four studies in a university hospital in Thailand[4,5,10,32] and also in results from studies in other developing countries.[11,33] Furthermore, in a systematic review of perioperative anesthesia in both developed and developing countries, patient ASA physical status classification was a significant factor linked to increased mortality rates over time.[26–28] This has been shown in pediatric populations as well.[31]

Blood loss can lead to variation in assigning ASA physical status classification, especially in emergency patients, where trauma has resulted in injury to the abdomen, brain, heart, and/or musculoskeletal systems. Such cases involve high blood loss prior to hospital arrival, possibly unknown to the surgery and anesthesia teams. Many studies have shown that traumatic cases with high morbidity also involve blood loss.[3,18,30] In one study, the highest cardiac arrest rates occurred in cases involving intraoperative transfusion, traumatic cases, poor ASA physical status classification, and emergency surgery.[3,6,15] A study in Japan revealed that excessive surgical bleeding resulted in higher frequencies of cardiac arrest.[23] In studies in critical care patients in Pakistan and Thailand, the presence of shock was a major factor associated with cardiac arrest.[12,22] We found an increased relative risk of 2.62 for cardiac arrest in patients with shock prior to anesthesia, which would most likely be associated with excessive blood loss.

Respiratory and/or cardiovascular comorbidities were associated with cardiac arrest in our study. It is clear that a number of our cardiac arrest patients were in shock before receiving anesthesia (47.3%), which is one known factor that doubles the incidence of cardiac arrest.[23]

Our study also identified that the anatomic site of surgery was a risk factor for cardiac arrest. Surgeries involving upper intra-abdominal, intracranial, intrathoracic, cardiac, and major vascular areas were significantly associated with cardiac arrest. This is consistent with study results which reports vascular surgery associated with a higher mortality rate, intra-abdominal surgery as a significant factor in cardiac arrest, intrathoracic surgery leading to higher mortality rates, and intracranial surgery as a significant factor in cardiac arrest.[5,10,15,34] Studies from Australia and Thailand found that patients undergoing major vascular surgery had up to a threefold increase in cardiac arrest.[4,15] Furthermore, the anatomic site of surgery and special techniques used during surgery, such as cardiopulmonary bypass and hypotensive technique, were also contributing factors to the occurrence of cardiac arrest in our results.

Our study has some limitations. The process of retrospective data collection may leave out some variables due to error in reviewing the medical records as well as mistakes in recording the data in the computer database. Thus, the analysis could not possibly be adjusted for these unknown factors. Even though practitioners developed guidelines to identify the risk factors associated with cardiac arrest in patients undergoing emergency surgery, it is probably not very practical to use them. Also, since it involves one single institution, and the incidence of cardiac arrest in this study is much higher than in the rest of the published data, it is not really representative of the entire patient population. However, despite the difficulties in using retrospective study results, our study did have certain strengths due to the fact that all of our patients were followed up for 24 hours after anesthesia was administered. The information was verified for accuracy by both anesthesiologists and nurse anesthetists. Additionally, our study confirms the need for further expanded research, including cardiac arrest in the intensive care unit, the emergency department, recovery room, and patient wards.

Conclusion

The perioperative incidence of cardiac arrest within 24 hours of anesthesia for emergency surgery is high and is associated with multiple factors, such as young age (≤2 years old), cardiovascular and respiratory comorbidities, increasing ASA physical status classification, preoperative shock, and certain surgical sites, including the abdomen, major vascular system, brain, and heart. Perioperative care providers, including surgeons, anesthesiologists, and nurses, should be prepared to manage promptly this high-risk group of surgical patients.

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Disclosure

The authors report no conflicts of interest in this work.

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