The Incidence of Perioperative Adverse Events in Neonates and Infants Undergoing Non Cardiac Surgery with General Anesthesia

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Objective: *To report the incidence of, and to identify the risk factors for, perioperative adverse events in neonates and infants when undergoing general anesthesia.*

Material and Method: *A prospective observational study approved by an institutional ethics committee was conducted at a tertiary care university hospital. The inclusion criteria were neonates and infants who had undergone general anesthesia for non-cardiac surgery. Data on the patients' demographics, their preoperative abnormalities, and the potential risk factors for adverse events were collected. Details of all adverse events occurring from the induction of anesthesia till 24-hours postoperatively were recorded.*

Results: *A total of 130 neonates and infants were recruited for this study. The overall incidence of adverse events was 33.6%. The most common events were insufficient ventilation arising from endotracheal tube leakage (15.4%), followed by multiple-attempt endotracheal intubation (14.6%). Desaturation ranked third, being reported in 11.5% of the population. Bradycardia was the most common cardiovascular event (6.9%), with 50% of the affected patients requiring atropine administration. Cardiac arrest was reported in a neonate with complex heart disease (0.8%). Based on a multivariate logistic analysis, an increased risk for perioperative adverse events was associated with a body weight less than 2,500 grams (OR 3.32, 95% CI 1.17 to 9.45); an American Society of Anesthesiologists (ASA) Physical Status greater or equal to II (OR 25.5, 95% CI 3.35 to 194); cardiovascular comorbidity (OR 3.6, 95% CI 1.59 to 8.14), and respiratory comorbidity (OR 2.2, 95% CI 1.01 to 4.9).*

Conclusion: *Our study confirms that neonates and infants had a high risk of developing perioperative adverse events, with respiratory problems being the most common. A low body weight, an ASA ≥II, and respiratory andcardiovascular comorbidities increased the risk for perioperative adverse events.*

Keywords: *Adverse event, Infants, Neonates, Anesthesia*

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An increasing number of surgical procedures are performed on pediatric patients. The incidence of anesthesia-related morbidity and mortality among these vulnerable patients is higher than that for adults, especially in the cases of neonates and infants[1-3]. The risk increases further for patients with comorbidity and emergency conditions[1-4]. In a study on Thai children, desaturation was determined to be the most common intraoperative problem[3], followed by re-intubation, esophageal intubation, bradycardia, cardiac arrest, drug error and death. Furthermore, the incidence of intra-operative hypoxemia increases at younger ages, with the highest incidence occurring among neonates[5]. Difficulty with airway management is also found in this population[3,4]. Endotracheal tube (ETT) related problems have been reported with a high incidence, with 19 to 75% of neonates having an ETT leakage that may cause insufficient oxygenation while on positive-pressure ventilation[6,7].

As for cardiovascular concerns, bradycardia is a potentially major adverse event that can occur even in non-hypoxic conditions during anesthesia[8]. Neonates' immature cardiac function and cardiac output are highly dependent on their heart rate, and their hemodynamic status can become abruptly worse in the event of bradycardia. The current literature indicates that there is a great variability in the mortality and morbidity rates age group. A literature review by Catre et al showed the incidence of morbidity varies from 0.42% to 30.8%[4], depending on the methodology

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and the definition of adverse event used in each of the reviewed studies. Advances in surgery, monitoring and anesthesia techniques in this decade may influence the nature and incidence of the adverse event. The objectives of this study were to determine the incidence of perioperative adverse events in neonates and infants who had undergone general anesthesia, and to identify the risk factors for those events.

Material and Method

Study design and data collection

After approval by the Institutional Review Board (Si 109/2014), a prospective observational study was conducted at a tertiary care university hospital. The data collection was performed from March 2014 to January 2015. The inclusion criteria were all children aged ≤1year who were undergoing general anesthesia for non-cardiac surgery.

The research team members identified patients aged less than 1 year who were scheduled for either elective or emergency surgery under general anesthesia before surgery. The data collected included age, gender, American society of anesthesiologist status (ASA) Physical Status, type of surgery, the techniques of anesthesia and airway management, perioperative complications, intraoperative management and the outcomes. The research team observed and recorded all adverse events from the induction time until 24 hours postoperatively. All perioperative adverse events were documented.

Details of a wide range of possible preoperative risk factors for adverse events during anesthesia were recorded. The factors included preterm status, postconceptional age, body weight, previous intubation, previous anesthesia and surgery, and a preoperative comorbidity (such as abnormal airway, cardiovascular disease, respiratory disease, neurological disease, risk of full stomach, and congenital syndrome).

The adverse events were divided into airway, respiratory, cardiovascular and miscellaneous (such as allergy, dosage and drug mistake). A definition of each adverse event and risk factors were defined in Table 1[1,3,5,8-10]. Cardiovascular events were defined using the following Pediatric Advanced Life Support: 2010 American Heart Association Guidelines[10].

Statistical analysis

The sample size was calculated based on endotracheal tube-related problems. Insufficient oxygenation and ventilation arising from endotracheal tube leakage is one of the most common events, and an incidence of 19% to 75% has been reported among neonates who were on mechanical ventilation[6,7]. A 20% incidence of adverse events was selected for sample size calculation purposes. To obtain a 95% confidence interval of 7%, a sample of at least 126 cases was required.

To report the incidence of adverse events and characteristics of the population, descriptive statistics were used,and data were presented as mean ± standard deviation, frequencies and percentages. The potential relationship to an adverse event during anesthesia was explored for each categorized variable by means of a univariate analysis. The statistical significances were estimated by the *p*-value of a Chi-square testand the 95% confidence interval. Data were presented as percent or 95% CI, as appropriate. A $p<0.05$ was considered to indicate a statistically significant difference.

Variables with a $p<0.2$ in the univariate analysis were included in a subsequent, multiple logistic regression model to examine the risk factors for the adverse events. The crude odds ratio, the adjusted odds ratio and the 95% CI were reported to consider the strength of the association between the possible predisposing conditions and the adverse events. All statistical analyses were conducted using PASW Statistics for Windows, Version 18.0 Chicago: SPSS, Inc.

Results

During the one-year period of this study, 130 infants were eligible.Their demographic data, underlying medical problems, and related surgical and anesthesia characteristics are at Table 2. Forty-one cases (26.4%) were transferred to the Intensive Care Unit (ICU), with the remainder receiving intubation and ventilator support.

The overall incidence of adverse events during anesthesia in this population was 33.6% (Table 3). The most common events were endotracheal tube-related problems such as insufficient ventilation resulting from ETT leakage (15.4%), multiple-attempt intubation (14.6%), and cardiovascular adverse events (13.1%). Bradycardia was found in 6.9% of this population, and 50% of those required atropine for management. Desaturation resulting from various causes occurred in 12.3% of the population.

Difficult intubation was found in 5 infants (3.8%). Two of them were suspected to have a difficult intubation as a result of their underlying disease and

Table 1. Definitions of perioperative adverse events

Adverse events	Definition
Difficult ventilation	Inadequate chest movement, absence of adequate breath sounds, signs of a severe airway obstruction, gastric air entry or dilatation, inadequate exhaled carbon dioxide, and hemody namics change with hypoxia or hypercarbia.
Bronchospasm	An increase in respiratory effort, especially expiration, associated with hypercapnia and oxygen desaturation; wheeze on auscultation; and increase in airway peak pressure.
Laryngospasm	Glottic closure due to a reflex constriction of the laryngeal muscles, resulting in a complete or partial closure of the airway; associated with muscle rigidity of the abdominal or chest wall, bradycardia and oxygen desaturation; requires deepening of anesthesia or succinyl choline administration.
Desaturation	Either a sustained decrease in oxygen saturation of $\leq$90%, or a sustained decrease in oxygen saturation of $\geq$5% from the baseline level for more than one minute
Apnea	A cessation of breathing movements and/or airflow for >15–20 seconds; it may be accom panied by oxygen desaturation and bradycardia.
Endobronchial intubation:	Unintentional or unrecognized intubation to the right or left main bronchus.
Pulmonary aspiration	The inhalation of material into the airway below the level of the true vocal cords.
Difficult intubation	Required > three attempts for intubation, in the presence or absence of tracheal pathology.
Multiple attempts for endotracheal tube intubation	Required laryngoscope and intubation >1 time during anesthesia.
Endotracheal tube leakage	A leak around the tube at a peak less than an inflation pressure of 15 cm H_2O; causes insufficient ventilation without management.
Endotracheal tube dislodgement:	Unintentional dislodgement of the endotracheal tube.
Esophageal intubation	Unintentional or unrecognized intubation to the esophagus
Bradycardia	Defined as bradycardia causing inadequate blood circulation. Neonates: heart rate <100/min. Infants and children: heart rate <60/min.
Tachycardia	Defined as a heart rate greater than the upper limit of the normal heart rate for the age. Normal heart rates: Newborns to age 3 months: 85-205 bpm awake; 80-160 bpm asleep. Children aged 3 months to 2 years: 100-190 bpm awake; 75-160 bpm asleep.
Arrhythmias:	Variations from the sinus rhythm.
Hypotension	A mean arterial pressure decrease greater than 20% from the baseline

airway condition, while the others had unanticipated difficult airways. Laryngospasm happened in 4 infants (3%), and it most commonly occurred during the induction period. Bronchospasm was found in 2 infants, whose clinical condition improved after bronchodilator administration. One infant had respiratory acidosis caused by a malfunction of the heat and moisture exchange filter.

Postoperative adverse eventswere found in 4.6% of the patients (Table 3). Cardiac arrest occurred in one neonate (the post-conceptual age at birth was 38 weeks). The patient had a complex heart disease and underwent an exploratory laparotomy for NEC. The intraoperative adverse events were desaturation as well as a severe metabolic acidosis with unstable hemodynamics that required a high dose of inotrope. This baby was expired 6 hours after transfer to the pediatric ICU. Other events were related to respiratory causes.

The risk associated with each adverse event was analyzed via the univariable analysis (Table 4). The variables that were significantly associated (p<0.05) with an increased risk of adverse event were a body weight less than 2,500 grams, a coexisting respiratory orcardiovascular disease, ASA >1 and multiple preoperative abnormalities. The odds ratio for ASA >I had a 25.5-fold (95% CI 3.35 to 194, p<0.01) increased risk for perioperative adverse events. The odds ratio for a body weight <2,500 grams also showed a 3.3-fold increased risk for the events (95% CI 1.17 to 9.45, p = 0.02). Furthermore, coexisting respiratory, cardio vascular and multiple preoperative abnormalities

Table 2. Demographic data, details of surgery and airway devices

Characteristics	Total (n = 130)
Age (month)	3.75±3.81
Gender: male/female	69/61 (53.1/46.9)
Neonate	55 (42.3)
History of preterm	37 (28.5)
Body weight <2,500 g	17 (13.1)
Type of surgery	
Eye, ENT, head & neck surgery	25 (19.2)
Thoracic surgery	7 (5.4)
Abdominal surgery	52 (40)
Urological surgery	31 (23.8)
Others	15 (11.6)
ASA classification	
ASA I	33 (25.4)
ASA II	59 (45.4)
ASA >III	38 (29.2)
Emergency surgery	19 (14.6)
Pre-existing conditions	
Abnormal airway	13 (10)
Respiratory system	36 (27.7)
Cardiovascular system	34 (26.2)
Neurogenic	13 (10)
Sepsis	6 (4.6)
Full stomach	44 (33.8)
Others	11 (8.4)
Airway device	
Endotracheal tube	111 (85.4)
Face mask	8 (6.2)
Supraglottic airway	11 (8.5)

Data presented as n (%)
ASA = American society of anesthesiologist PhysicalStatus classification; ENT = Ear nose throat

Table 3. Perioperative adverse events

Events	Total (n = 130)
Intraoperative	
Airway and respiratory events	
Desaturation	15 (11.5)
Difficult intubation	5 (3.8)
Esophageal intubation	3 (2.3)
Insufficient ventilation from endotracheal tube leakage:need change of endotracheal tube	20 (15.4): 11 (8.5)
Difficult ventilate	2 (1.5)
ETT dislodgement and obstruction	4 (3.1)
Laryngospasm	4 (3.1)
Bronchospasm	2 (1.5)
Multiple endotracheal tube	19 (14.6)
Equipment	1 (0.8)
Cardiovascular events	
Bradycardia	9 (6.9)
Tachycardia	2 (1.5)
Arrhythmias	3 (2.3)
Hypotension	3 (2.3)
Others	
Heat and moisture exchange filter malfunction	1 (0.8)
Postoperative	
Respiratory events	
Apnea and irregular breathing	2 (1.5)
Atelectasis	1 (0.8)
Bronchospasm and secretion	1 (0.8)
ETT dislodgement	1 (0.8)
Cardiac arrest	1 (0.8)

Data presented as n (%)

were found to increase the risk of an adverse event, with odds ratios of 3.6, 2.2 and 3.5, respectively. Although emergency surgery had a high risk of 1.95 to fold (95% CI 0.85 to 5.87, $p = 0.25$), it was not statistically significant. A multivariate logistic analysis was performed after a univariable analysis (Table 4). The table represents a model including neonate, history of prematurity, ASA physical status, a body weight less than 2,500 grams, emergency surgery, previous intubation and preoperative comorbidity to evaluate the risk factors for the adverse events.

Discussion

This prospective observational study describes the incidence, nature and risk factors of the adverse events experienced during perioperative period by neonates and infants who had undergone general anesthesia. The overall incidence of adverse events during anesthesia performed at the tertiary medical center was 34%. The most common events arose from endotracheal tube and respiratory causes. The highest incidence was insufficient ventilation caused by endotracheal tube leakage (15.4%).

At our institute, an uncuffed tube is utilized in this age group due to the unavailability of cuffed endotracheal tubes.ETT leakage can create the need for an additional laryngoscopy, cause unreliable ventilation, require a high-inspired gas flow, or may cause pulmonary aspiration[11-13]. Khine et al found that the rate of reintubation required with uncuffed tubes is 30% among children younger than 2 years[12]. We reported 50% of the cases required the ETT to be

Table 4. Factors associated with perioperative events

Factors	Adverse events		Crude OR (95%CI)	Adjusted OR (95%CI)	*p*-value
	Yes (n = 59)	No (n = 71)			
Age group					
Infant	24 (18.4)	51 (39.2)	1	-	0.60
Neonate	20 (15.4)	35 (27.0)	1.21 (0.58, 2.53)	-	-
History at birth					
Term infant	29 (22.3)	64 (49.2)	1	-	0.31
Prematurity	15 (11.5)	22 (17.0)	1.50 (0.68, 3.31)	-	-
Body weight					
>2,500 g	34 (26.2)	79 (60.8)	1	1	-
<2,500 g	10 (7.6)	7 (5.4)	3.32 (1.17, 9.45)	4.49 (1.24, 16.25)	0.02
Type of surgery					
Elective	35 (27.0)	76 (58.5)	1	-	0.18
Emergency	9 (6.9)	10 (7.6)	1.95 (0.73, 5.24)	-	-
Full stomach					
No	25 (19.2)	61 (46.9)	1	-	-
Yes	19 (14.7)	25 (19.2)	1.85 (0.87, 3.95)	-	0.11
ASA classification					
I	1 (0.8)	54 (41.5)	1	1	>0.01
>I	43 (33.1)	32 (24.6)	25.48 (3.35, 194.0)	22.78 (2.79,185.96)	
Previous ETT					
No	28 (21.5)	21 (16.2)	1	-	0.15
Yes	16 (12.3)	65 (50.0)	1.77 (0.80, 3.89)	-	-
Normal airway					
Yes	39 (30.0)	78 (60.0)	1	-	0.71
No	5 (3.8)	8 (6.2)	1.25 (0.38, 4.08)	-	-
Sepsis					
No	42 (32.3)	82 (63.1)	1	-	0.98
Yes	2 (1.5)	4 (3.1)	0.98 (0.17, 5.55)	-	-
Normal neurological condition					
Yes	39 (30.0)	78 (60.0)	1	-	0.14
No	5 (3.8)	8 (6.2)	1.25 (0.38, 4.07)	-	-
Normal cardiovascular system					
Yes	25 (19.2)	71 (54.6)	1	1	>0.01
No	19 (14.7)	15 (11.5)	3.60 (1.59, 8.14)	2.15 (0.84, 5.49)	-
Normal respiratory system					
Yes	27 (20.8)	67 (51.5)	1	1	0.046
No	17 (13.1)	19 (14.6)	2.22 (1.00, 4.90)	0.91 (0.36, 2.35)	-
Multiple organ abnormality					
No	27 (20.8)	73 (56.1)	1	-	0.03
Yes	17 (13.1)	13 (10)	3.53 (1.52, 8.24)	-	-

Data presented as n (%)
ASA = American society of anesthesiologist Physical Status classification; ETT = endotracheal tube

changed, while the remainder were managed by other, conservative management measures, such as gauze packing oran increased gas flow. Selecting the correct size of an uncuffed ETT is difficult in spite of the availability of numerous formulae. Frequently, the chosen tube does not fit properly, leading to a large air leak and necessitating a tube change. Changing an ETT can cause many consequences, such as

cardiovascular effects during laryngoscopy, desaturation, aspiration, and an increased incidence of post-intubation croup. An ultrasound measurement of the subglottic diameter in order to try to choose the proper-sized ETT also shows little correlation if children are aged less than 12 months. This means that the risk of having an inappropriate size and the need to perform an ETT change remains[14]. A cuffed endotracheal tube may be warranted to avoid the need to change the ETT in those cases where a change may prove to be deleterious.

A high incidence of multiple endotracheal intubation attempts (14.6%) was also found in this population, and they stemmed from various causes. The most common was an inappropriate tube size, followed by difficulty in airway management (unable to achieve successful intubation on the first attempt, difficult intubation, and esophageal intubation). Unexpected difficult intubation was found in 3 cases (2.3%) who had unremarkable histories. The first case was a 3-month old, male, premature infant (post-conceptual age = 49 weeks) who underwent laser treatment for retinopathy of prematurity. The second was an 8-month old, male infant with Coffin-Siris syndrome who underwent a herniotomy. The last was a 3-month old, male infant with a history of prematurity scheduled for loop ileostomy closure. All three required multiple intubation attempts, and the last needed a video laryngoscope to achieve a successful intubation. Bradycardia occurred during the intubation of one of them. A potential difficult airway may result from patients' syndromes or airway abnormalities. A study on unanticipated difficult airway in children by Valois-Gomez et al found the incidence of difficult bag mask ventilation was 6.6%, compared with 1.2% in our study[15]. The study by Valois-Gomez et al also determined that, apart from DBMV, the incidence of difficult intubation was 1.2% and independent from difficult ventilation[15].

The incidence of laryngospasm in the current study was not very high relative to other conditions. That result may be due to the concern given to that particular event and the consequential preparations made for the complication. All incidents of laryngospasm were managed with no further consequences. Desaturation in this population was reported as 11.5% of the cases, compared with 1.15% from a previous study[1]. Differences in the two studies' populations and their definitions of desaturation may have caused the variance.

As for the cardiovascular aspects, bradycardia was one of the most common events[3]. It was found in 9 infants (6.9%), and 3.1% required atropine administration. The incidence in this age group was higher than those found in two previous Thai studies[3,8]. The bradycardia events were primarily attributed toreflex bradycardia caused by hypoxia and direct laryngoscopy[8,15]. Anesthetic factors and surgical manipulations were other causes of bradycardia. In one Thai study, the incidence of non-hypoxic bradycardia was 2.4%, and the events mostly related to anesthesia[8]. No cardiac arrests occurred during anesthesia. One cardiac arrest was reported in a neonate who had a complex heart disease and was under going an exploratory laparotomy for NEC with severe sepsis. This baby was expired 6 hours after transfer to the pediatric ICU.

The adverse event incidents mostly occurred during anesthesia rather than in the post-anesthesia care unit, which is different from the reports of a Thai study and of a French survey[1,3]. In the present study, 26.4% of the population remained intubated and were transferred to the ICU, which may have changed the nature and the incidence of the postoperative events. Most of the incidents in this study were also related to respiratory causes. Two of those cases involved apnea and irregular breathing in ex-premature babies who had a post conceptual age of less than 60 weeks. Another case had a history of bronchopulmonary dysplasia.

Adverse events were higher in many aspects in this prospective study, which reported both minor and major morbidities. In particular, we reported the incidence of endotracheal tube leakage and the requirement for multiple intubation attempts in newborns and infants during anesthesia, neither of which had been reported in other studies. In addition, our institute is a tertiary care university hospital; two previous studies also reported that there was a higher incidence in a tertiary care setting than in a primary or secondary care hospital[1,3]. Furthermore, there has been mention of an underestimation of the true rate of minor complication arising from underreporting by anesthesiologists[1,4].

We did not find any incidents of nausea, vomiting, emergence agitation or medication error in this study. The incidence of nausea, vomiting and emergence agitation is generally low in this age group[1,3,4]. Medication errors were reported as 1/405 in one survey, but none were found in our study[17]. The absence of any errors may be explained by the drug concentration protocol employed by, and the close supervision of all trainees at, the institute. The

subjects may also have been too small for the complications of nausea, vomiting, emergence agitation or medication error to be detected.

Moving on to the risk factors related to adverse events, age under 1 year, an ASA >I, coexisting diseases and emergency surgery have been correlated with adverse incidents[1,3,4]. In our study, a univariate analysis demonstrated that the risks associated with adverse events were a body weight <2,500 grams, an AS>I, coexisting cardiovascular and respiratory diseases, and multiple preoperative abnormalities. Emergency surgery, however, was not shown as a risk factor in our study. This study may have had too low a statistical power to detect the association between the emergency condition, a history of prematurity, previous intubation, a full stomach condition, and other preoperative abnormalities and the perioperative adverse events. In addition, by using a multiple logistic regression model, we demonstrated that the adjusted odds of a body weight <2,500 grams and an ASA >I were associated with adverse events. Other factors, such as respiratory and cardiovascular diseases,were not identified as risks in our study.

One limitation of the study was the use of uncuffed endotracheal tubes, which was different from previous studies,while another limitation was that a quarter of the patients remain intubated, which may have affected the incidence and character of the events. Moreover, the time set for follow-up of the patients was 24 hours; we would therefore not have detected any further consequences, such as airway edema or post-extubation croup.

Conclusion

Neonates and infants and those with associated disease are at increased risk of morbidity. The airway, the endotracheal tube and the cardiovascular system should be managed precisely to avoid perioperative adverse outcomes. The risk of adverse events was associated with a low body weight, coexisting diseases, and an ASA physical status ≥II.

What is already known on this tropic?

Pediatric patients are at risk of perioperative events. Neonates and infants face added risks arising from their anatomy, the immaturity of their physiology, and developmental limitations that affect the pharmacokinetics of most drugs.

What this study adds?

Few studies focusing on this group have been published. This study shows the incidence, nature and risk factors of the adverse events. Knowing this may influence the monitoring and prevention strategies for these events.

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Potential conflicts of interest

None.

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การศึกษาอุบัติการณ์และปัจจัยเสี่ยงของภาวะแทรกซ้อนที่เกิดขึ้นในเด็กแรกเกิดและทารกที่ได้รับการระงับความรู้สึกแบบทั่วตัว

สหัสา หมั่นดี, ธนพร จิตต์ภักดี, ธารินี บัวสุข, นัยนา อรุณพฤกษากุล

วัตถุประสงค์: เพื่อรายงานอุบัติการณ์และภาวะแทรกซ้อนที่เกิดขึ้น รวมถึงปัจจัยเสี่ยงที่มีความสัมพันธ์กับภาวะแทรกซ้อนที่เกิดขึ้นในเด็กอายุน้อยกว่า 1 ปีที่มารับการระงับความรู้สึกแบบทั่วตัว

วัสดุและวิธีการ: เป็นการศึกษาเชิงสังเกตไปข้างหน้า ในผู้ป่วยเด็กแรกเกิดที่มีอายุน้อยกว่า 1 ปี โดยทำการศึกษาในโรงเรียนแพทย์ ซึ่งเป็นสถานพยาบาลระดับตติยภูมิ เกณฑ์การเข้าร่วมในการวิจัย ได้แก่ ผู้ป่วยเด็กที่อายุน้อยกว่า 1 ปีที่ได้รับระงับความรู้สึกแบบทั่วตัว ยกเว้นในผู้ป่วยที่ได้รับการผ่าตัดหัวใจ ข้อมูลจำเพาะของผู้ป่วย การผ่าตัดโรคประจำและความผิดปกติก่อนผ่าตัด ภาวะแทรกซ้อนที่เกิดขึ้นตั้งแต่เริ่มระงับความรู้สึกจนถึง 24 ชั่วโมงหลังผ่าตัดได้รับการบันทึกไว้

ผลการศึกษา: มีประชากรในการศึกษานี้ทั้งสิ้น 130 คน พบอุบัติการณ์ของการเกิดภาวะแทรกซ้อนในระหว่างและหลังการระงับความรู้สึก 24 ชั่วโมงทั้งสิ้นร้อยละ 33.6 โดยมีสาเหตุส่วนใหญ่เกี่ยวข้องกับระบบทางเดินหายใจ โดยพบอุบัติการณ์ของท่อหายใจขนาดเล็กและไม่สามารถใช้ในการช่วยหายใจได้เพียงพอร้อยละ 15.4 การใส่ท่อหายใจหลายครั้งร้อยละ 14.6 ภาวะออกซิเจนในเลือดต่ำร้อยละ 11.5 ภาวะหัวใจเต้นช้ากว่าปกติร้อยละ 6.9 โดยร้อยละ 50 ต้องได้รับยาอะโทรปีนภาวะหัวใจหยุดเต้นพบในผู้ป่วยเด็กที่มีโรคหัวใจแบบซับซ้อน 1 ราย การวิเคราะห์ความเสี่ยงที่สัมพันธ์กับภาวะแทรกซ้อน พบว่ามีความสัมพันธ์กับน้ำหนักตัวน้อยกว่า 2,500 กรัม (OR 3.32, 95% CI 1.17 ถึง 9.45), ASA ≥II (OR 25.5, 95% CI 3.35 ถึง 194) มีความผิดปกติของระบบหัวใจและหลอดเลือด (OR 3.6, 95% CI 1.59 ถึง 8.14) และระบบทางหายใจ (OR 2.2, 95% CI 1.01 ถึง 4.9)

สรุป: จากผลการศึกษาพบว่าในผู้ป่วยเด็กอายุน้อยกว่า 1 ปี มีความเสี่ยงในการเกิดภาวะแทรกซ้อน โดยเฉพาะอย่างยิ่งระบบทางหายใจโดยความเสี่ยงสัมพันธ์กับผู้ป่วยที่มีน้ำหนักน้อยมี ASA ≥II มีโรคในระบบหัวใจและหลอดเลือดและทางหายใจมาก่อน