Perioperative Pulmonary Aspiration: An Analysis of 28 Reports from the Thai Anesthesia Incident Monitoring Study (Thai AIMS)

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Objective: *To study the patients' characteristics, outcomes, contributory factors, factors minimizing the incidence and suggested corrective strategies for perioperative pulmonary aspiration in Thailand.*

Materiel and Method: *This is a prospective descriptive research design. The relevant data was extracted from the incident reports on aspiration from 51 hospitals across Thailand during the study period between January 1 and June 30, 2007 from the Thai Anesthesia Incident Monitoring Study (Thai AIMS) database. Descriptive statistics was used. Each incident report was reviewed by three senior anesthesiologists. Any disagreement was discussed to achieve a consensus.*

Results: *From 1,996 incident reports, there were 28 reports (1.4%) that met the definition of pulmonary aspiration. Most of the incidents occurred in patients with ASA 1-2 (85.7%), during the official hour (64.3%) and the anesthesiologists were in charge (67.9%). Eleven incidents (39.3%) occurred during induction, seven (25%) during maintenance and seven (25%) during emergence phases. Anesthetic factors played an important role in 26 incidents (92.9%). All the incidents except one (96.4%) were considered human errors and 25 (89.2%) were preventable. Of the incidents caused by human errors, nine (32.1%) were caused by skill-based errors. Thirteen patients (46.4%) had major physiologic changes and 10 (35.7%) of them needed unplanned ICU admission. Ten patients (35.7%) needed prolonged ventilator support and two (7.14%) of them died.*

Conclusion: *The contributing factors that might lead to the incidents were improper decision (75%), lack of experience (53.5%) and lack of knowledge (21.4%). Factors minimizing incident, were vigilance (85.7%), having experienced assistant (50%) and experience in that situation (25%). Suggested preventive strategies were guidelines practice in anesthetic management (67.8%), improvement of supervision (57.1%), additional training (42.8%) and quality assurance activity (28.6%).*

Keywords: *Aspiration, Anesthesia, Incidence, Complication, Multicenter study*

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Perioperative pulmonary aspiration has been known for more than 150 years. Much knowledge of possible risks factors, prevention, and management of pulmonary aspiration has been gained along the time since then[1-3]. These help anesthesia safer than the earlier period. However, the incidences of pulmonary aspiration varied between 1:3,226 and 1:7,130[4-9]. The incident from a closed claims analysis for pulmonary aspiration in anesthesia showed between 1.3-2%[10,11].

Pulmonary aspiration is not a common complication nowadays. Therefore, the study of its pitfalls can be done through case reports, closed claimed reports, incident reports and quality assurance reports. The possible risk factors for pulmonary aspiration include increased gastric content; increase tendency for regurgitation and laryngeal incompetence[1]. Managements during the event have been suggested[12]. Preventive strategies

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include identification of patient at risk, fasting policy, pharmacotherapy and choice of anesthesia.

In 2005, The Royal College of Anesthesiologists of Thailand (RCAT) endorsed a multicenter registry of anesthesia related adverse events among 20 hospitals across Thailand, the Thai Incidents Monitoring Study (THAI Study)[13,14]. The incidence of suspected pulmonary aspiration in perioperative period was 0.9%[14]. In 2007, the RCAT in collaboration with the National Research Council of Thailand and the Thai Joint Commission on Hospital Accreditation used the method of incident reporting to identify and analyze anesthesia related incidents in 51 hospitals, namely the Thai Anesthesia Incidents Monitoring Study (Thai AIMS)[15,16]. Pulmonary aspiration was sporadically occurred during perioperative period in Thailand.

The primary objective of the present study was to determine the frequency, outcomes, contributing factors, and factor minimizing incidents of pulmonary aspiration in a large scale across Thailand.

Materiel and Method

The prospective multi-center study, the Thai Anesthesia Incidents Monitoring Study (Thai AIMS), was conducted by the RCAT between January 1, 2007 and June 30, 2007. All attending anesthesiologists and nurse anesthetists in 51 hospitals ranging from district (community) hospitals to tertiary (regional or university) hospitals across Thailand, were invited to report the critical incidents on an anonymous and voluntary basis[15,16].

The present study was approved by all institutional ethical review boards, with no additional written informed consent required. The specific anesthesia adverse events detected during anesthesia and during the 24 hour postoperative period were reported by filling out a standardized incident reporting form as soon as possible after the occurrence of adverse events. These included pulmonary aspiration, suspected pulmonary embolism, esophageal intubation, endo-bronchial intubation, oxygen desaturation, re-intubation, difficult intubation, failed intubation, total spinal anesthesia, awareness, cerebral-vascular accident, convulsion, nerve injuries, transfusion mismatch, suspected myocardial infarction/ischemia, cardiac arrest, death, suspected malignant hyperthermia, anaphylaxis, drug error, equipment malfunction, and cardiac arrhythmia requiring treatment. The surgical profile, anesthesia profiles and a narrative of incidents were also recorded. Details of the Thai AIMS Study methodology have been described. All forms were sent to the data management unit at Chulalongkorn University.

Each critical incident of perioperative pulmonary aspiration was reviewed by three anesthesiologists. Discrepancies among the three members were resolved by discussion. The descriptive statistics in term of frequency and percentage were used for data analysis with SPSS for Windows, version 12.0.

Results

During the six months period, there were 1996 incidents reported to the Thai AIMS. There were 32 incidents of suspected pulmonary aspiration. After reviewing all the reports, four records were excluded because they did not meet the criteria. This made the incidence of perioperative pulmonary aspiration to be 1.4% of the total incidents. There were more male (75%) than female (25%) (Table 1). Twenty-four incidents (85.7%) occurred in patients with ASA 1-2. Twenty-one incidents (75%) occurred in patients aged between 2-64 years old (Table 1). Most of the incidents (64.3%) occurred during the official hours in which none of them was operated on an emergency basis. The rest of the incidents (35.7%) were emergency cases and were operated during non-official hour. Twenty-six patients were from the in-patient department. Only one patient was scheduled on an ambulatory basis and was admitted after the event. The other patient was from home and planned to be admitted after having his esophageal stent changed. Nine (32.1%) and five

Table 1. Demographic data of perioperative pulmonary aspiration (n = 28)

	n	%
Sex		
Male	21	75
Female	7	25
ASA Physical status		
1:1E	6:3	21.4:10.7
2:2E	10:5	35.7:17.9
3	2	7.1
4E	2	7.1
5	0	0
Age group (years)		
0-1	3	10.7
2-14	6	21.4
15-64	15	53.6
> 64	4	14.3

incidents (17.9%) occurred in patients that underwent general surgery and orthopedics procedures respectively (Fig. 1).

The anesthetic choices were general anesthesia with endotracheal tube (57.1%), laryngeal mask airway (17.9%) and total intravenous anesthesia with oxygen supplementation (Table 2). For all the incidents that occurred in patients with laryngeal mask airway, at the time of incidents, the patients were taken care by the nurse anesthetist. Nineteen incidents (67.9%) occurred in the presence of the anesthesiologists. Another one and eight (28.6%) incidents occurred in the presence of the anesthesiology trainee and nurses anesthetists respectively. Twenty-five incidents (89.3%) occurred in the operating theater. More than half of the incidents occurred during induction and emergence (Fig. 2). Diagnosis of the events was made before the monitoring alarm in 21 cases (75%). Monitoring equipment helped to diagnose the other seven cases (25%). All of them were warned by pulse oximeter. After the events, the operation was cancelled in one case.

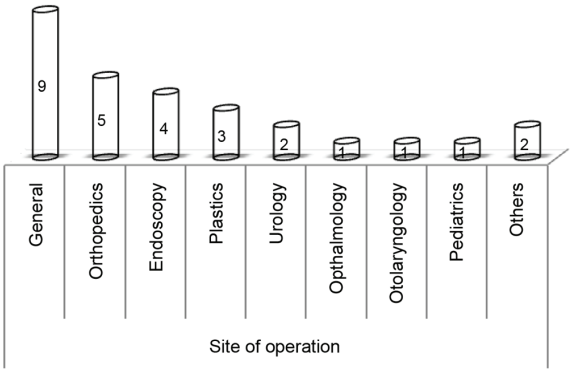

Fig. 1 Site of operation of patients with pulmonary aspiration (n = 28)

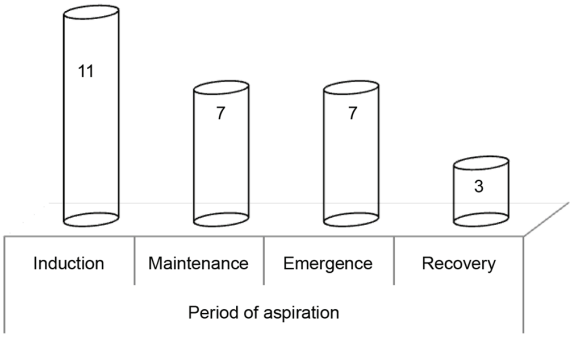

Fig. 2 Period of aspiration (n = 28)

Table 2. Anesthetic techniques of choice during the incident (n = 28)

Technique	n	%
GA (endotracheal tube)	16	57.1
GA (laryngeal mask airway)	5	17.9
GA (total intravenous anesthesia)	4	14.3
GA (under mask)	3	10.7

GA = general anesthesia

Table 3. Factors that may relate to pulmonary aspiration

	n	%
Patient factors		
Full stomach	9	32.1
Esophageal stricture	1	3.6
Surgical factors		
Misdiagnosis	1	3.6
Anesthesia factors		
Inappropriate technique	8	28.6
Inappropriate anesthetic management	4	14.3
Inappropriate airway management	3	10.7
Anesthetic drug	3	10.7
Residual anesthetic drug	2	7.1
Improper LMA intubation	1	3.6
Esophageal intubation	1	3.6
Equipment failure	1	3.6
Inexperienced	1	3.6
System factors		
No supervisor	1	3.6

* Data are not mutually exclusive
LMA = laryngeal mask airway

Factors related to incidents of pulmonary aspiration are shown in Table 3. Twenty-five incidents (89.3%) were considered to be caused by human error, which nine (32.1%), nine (32.1%) and 12 (42.9%) incidents were from ruled-based, knowledge-based, and from skilled-based errors respectively. Only three incidents (10.7%) were considered unpreventable. One of them occurred in a training hospital by the trainee. Another incident was done by a nurse anesthetist. The last incident was due to the patient factor.

Immediate outcomes after the events were major physiologic changes (46.4%), unplanned ICU admission (35.7%) and minor physiologic changes (10.7%) (Table 4). For long-term outcomes, 10 patients (35.7%) needed prolonged ventilator support while eight patients (25%) had complete recovery (Table 4).

Table 4. Outcomes after pulmonary aspiration

Outcomes	Immediate outcome	Long term outcome
Major physiologic change	13 (46.4%)	
Unplanned ICU admission	10 (35.7%)	
Minor physiologic change	3 (10.7%)	
Complete recovery	2 (7.1%)	8 (28.6%)
Unplanned hospital admission	1 (3.6%)	
Prolonged emergence/ apnea	1 (3.6%)	
Prolonged ventilatory support		10 (35.7%)
Prolonged hospital stay after event		2 (7.1%)
Death		2 (7.1%)

* Data are not mutually exclusive

Two patients died after the events, which made the mortality rate in the present study to be 7.14%. These two incidents occurred in the endoscopic suit in the same university hospital. They were both 72-year-old male patients. One patient was diagnosed with carcinoma of the sigmoid colon with sign and symptom of gut obstruction. He was scheduled for sigmoidoscopy. The other patient was scheduled for colonic stent. Total intravenous anesthesia (TIVA) was given to both patient. Aspiration occurred during emergence and in the post anesthesia care unit. They were intubated and ventilated in the ICU. The causes of death were sepsis and respiratory failure.

Considering factors that contribute to pulmonary aspiration, anesthetic-related factor alone played a role in 17 incidents (60.7%). Combined anesthetic- and patient-related factor were considered in eight incidents (28.6%). Only one incident was found in each of the other group *i.e.* patient factor, combined patient- with surgical-related factors and combined anesthetic- and systematic- related factors (Fig. 3). The details of factors related to incidents are shown in Table 3. Considering factors that may relate to pulmonary aspiration, full stomach were responsible for nine cases. One incident was considered to be caused by systematic factor because the nurse anesthetist did not consult the anesthesiologist. The patient was 18 months old undergoing emergency incision and drainage of perianal abscess under general anesthesia with mask. He was NPO for 8 hours. The patient was aspirated during emergence.

The frequent contributing factors that might lead to the incidents were improper decision (75%), lack of experienced (53.3%) and lack of knowledge (21.4%) (Table 5). For factors minimizing incident, the important factors were vigilance (85.7%), having experienced assistants (50%) and experience in that situation (25%). Having guideline practice in anesthetic management was the most common suggestive corrective strategy (67.8%). The others were improved supervision (57.1%), additional training (42.8%) and quality assurance activity (28.6%).

Discussion

In this present study, 28 incidents on pulmonary aspiration from the total 1,996 incidents (1.4%) were reported during the 6-month period. This was a higher incidence than that of the Thai Anesthesia Incidents Study (THAI study), which had only 32 incidents from the total 163,403 cases (0.019%) during a 12-month period[8]. These may be because more general and community hospitals joined in the present study. Most of the anesthesia services in those hospitals were given by the nurse anesthetists

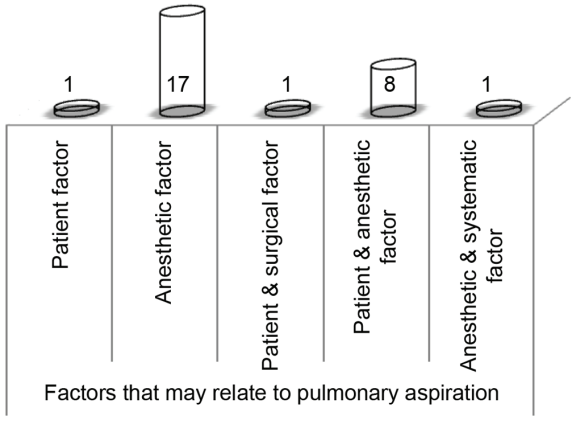

Fig. 3 Distribution of factors that may relate to pulmonary aspiration (n = 28)

Table 5. Contributory factors factors minimizing incidents and suggestive corrective strategies for pulmonary aspiration (n = 28)

	n	%
Contributory factors		
Improper decision	21	75.0
Lack of experience	15	53.5
Lack of knowledge	6	21.4
Haste (hurry)	4	14.3
Communication failure	1	3.6
Emergency	1	3.6
Inadequate preoperative evolution	1	3.6
Others	1	3.6
Factor minimizing incident		
Vigilance	24	85.7
Experienced assistant	14	50.0
Past experienced	7	25.0
Consultation	3	10.7
Equipment maintenance	1	3.6
Following guidelines	1	3.6
Others	1	3.6
Suggested corrective strategies		
Guideline practice	19	67.8
Improved supervision	16	57.1
Additional training	12	42.8
Quality assurance activity (M-M)	8	28.6
Equipment maintenance	1	3.6
Others	1	3.6

because of shortage of anesthesiologists in Thailand. The other reason for the lower incidence of the authors' previous study was that there might be a hawthorn effect during that study. However, the presented incidents were lower than the other incidents and closed claim studies were 2.7-4%[10,17,18]. In one closed claim in the United State analyzed by the Certified Registered Nurse Anesthetist (CRNA), they found nine cases (15.5%) out of 58 claims that were determined to be CRNA-related of aspiration[19]. In fact, the number of pulmonary aspiration in the closed claim study might not represent the real incidence because the majority of the outcomes were not so bad.

We found that most of the incidents occurred in elective surgery and during official hours. The result was the same as the other studies[8,20]. Cheney et al[18] reported that 45% of the cases occurred during emergency surgery. However, Warner MA et al[9] demonstrated that the incident of pulmonary aspiration was higher in emergency than elective surgery (1:895 vs. 1:3,886). Emergency surgery was the highest predisposing factor (15.8%) for pulmonary aspiration in the AIM study[17].

Obstetric patient has been identified to be high risk for pulmonary aspiration especially when there was undergone general anesthesia. From ASA closed claims in 1996, the incidence of aspiration increased from 1% in parturient receiving regional anesthesia group to 14% in those receiving general anesthesia[21]. In 2003, the data was re-analyzed with more data included. The results demonstrated that the number of aspiration in the obstetric claims was 3% compared to 2% in the non-obstetric claims[22]. The possible explanation is more regional anesthesia was used in this group of patients. Cheney et al[18] reported 29% of aspiration occurred in parturient. Therefore, it was surprising that in the present study, there was no obstetric patient. This might be from being under-reported because nurse anesthetists in Thailand cannot perform regional anesthesia. They are legally approved to provide general anesthesia when there is no anesthesiologist available. Therefore, the authors believe that aspiration pneumonitis is still a problem in obstetric anesthesia in Thailand. However, Warner et al [9] found no aspiration in parturient undergoing elective and emergency cesarean section under general anesthesia. There was also no aspiration in the obstetric surgery in the study of Neelakanta G et al[5].

In the present study, there was no aspiration reported in patients receiving regional anesthesia. This was consistent with the closed claim report in 1991[18] in which 95% of the cases were under general anesthesia. However, the other details were not in common. In the present study, most incidents (39.3%) occurred during induction, which was the same as the report from France[23]. However, Cheney et al[19] reported that the incidence occurred mostly during maintenance with mask (41%).

In the present study, 17.9% of the incidents occurred in cases that received laryngeal mask airway (LMA). In the AIM study (8), 20.3% of the airway in use at the time that pulmonary aspiration occurred was LMA, which was a little higher than the present study. Does LMA increase the risk of pulmonary aspiration is still a debate. Recently Bernardini A et al[24] reported incidences of pulmonary aspiration in patients who underwent general anesthesia with LMA or endotracheal tube. The incidences of pulmonary aspiration in patients receiving LMA vs. tracheal intubation for elective and unplanned surgery were 1:17,349 vs. 1:13,819 and 1:933 vs. 1:489 respectively. These may help to confirm the safety use of LMA in

a selected case. However, this was not a randomized controlled trial. Therefore, selection bias might decrease the level of the evidence since LMA is not widely used in Thailand. This may be the reason for the lower incidents of aspiration when compared with endotracheal tube technique. Besides that with the lower rate of usage that leads to limited-skill.

Even if the anesthetic of choice in the endoscope suites is total intravenous anesthesia (TIVA) with propofol and short acting narcotic, there may be a certain group of patients who are at risk of aspiration. As shown in the present study, five incidents occurred during endoscopic procedures and three of them were from the same university hospital. All except one received TIVA. The other received general anesthesia with endotracheal tube. Two of these patients died after the events, which were the only death in the present report. The authors also found another two case-report of unrecognized aspiration pneumonitis during colonoscopy and endoscopic retrograde cholangiopancreatoscopy from this hospital[25].

The mortality rate in this study (7.1%) was nearly the same rate as the study of Sakai T el al (7.7%)[6]. However, the result from the previous THAI study was 15.6%[8], which was still higher than from the other studies, which was 4-5.9%[9,17]. The mortality rate in the study of Cheney was 44.6%. They also had two cases of death that occurred during colonoscopy. Larson et al[19] reported seven deaths (77.8%) after the events. All except one case had a risk factor of aspiration. The inappropriate anesthetic managements described in this study were no rapid sequence induction, no Sellick maneuver and no endotracheal tube of at-risk patient, etc.

In a study of the cause of death related to anesthesia in France[26], there were 83 deaths related to aspiration from the 131 deaths that related to respiratory complication. They did not demonstrate death in obstetric patients but two deaths occurred during colonoscopy[23]. All patients involved were elderly, in a critical condition (ASA $\geq$ 3) and often underwent urgent abdominal surgery. Analysis of practice patterns disclosed significant deviations from recommendations.

Common factors related to incidents were inexperience, lack of vigilance, inadequate pre-anesthetic evaluation, inappropriate decision, emergency condition, haste, inadequate supervision, and ineffective communication. Suggested corrective strategies were quality assurance activity, clinical practice guideline, improvement of supervision, additional training, improvement of communication and an increase in personnel.

Most of the incidents in the present study were from human factors. In this study, two out of three patients that underwent general anesthesia with mask were 9 years old and 18 months old. Both of them were emergency cases. The NPO times were eight hours and uncertain. They still used general anesthesia with mask, which is not considered a proper choice. These were different from the other studies that the incidents were contributed to the patient with preoperative factor for aspiration[5,19].

The four common suggested corrective strategies in the previous THAI study and in the present study were the same. They were guidelines practice, improved supervision, additional training and quality assurance activity. This could confirm that in situation of Thailand with the shortage of anesthesiologists and some of the anesthesia was given by nurse anesthetists who had 1 year training in anesthesia need to be improved. The Royal College of Anesthesiologists of Thailand (RCAT) should provide more continuing medication education on perioperative pulmonary aspiration.

Conclusion

Pulmonary aspiration can occurred at any time during the perioperative period. The common contributing factors were improper decision and lack of experience. Factor minimizing incidents were vigilance and having experienced assistants. Suggested preventive strategies guidelines practice, improvement of supervision, additional training and quality assurance activity.

Potential conflicts of interest

None.

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ภาวะสำลักเข้าปอด: ผลการวิเคราะห์ผู้ป่วย 28 ราย จากโครงการเฝ้าระวังภาวะแทรกซ้อนทางวิสัญญีโดยการรายงานอุบัติการณ์ในประเทศไทย (Thai AIMS)

ศิริลักษณ์ กล้าณรงค์, ศิริลักษณ์ สุขสมปอง, ธนู หินทอง, วราภรณ์ เชื้ออินทร์, ประสาทนีย์ จันทร, เทวารักษ์ วีระวัฒกานนท์

วัตถุประสงค์: *เพื่อศึกษาข้อมูลลักษณะผู้ป่วย ผลลัพธ์ ปัจจัยนำปัจจัยลด และปัจจัยป้องกันเชิงระบบสำหรับภาวะสำลักเข้าปอดในผู้ป่วยที่ได้รับการให้ยาระงับความรู้สึกในประเทศไทย*

วิธีการศึกษา: *เป็นการศึกษาแบบพรรณนาชนิดเก็บข้อมูลไปข้างหน้าจากฐานข้อมูลโครงการศึกษาภาวะแทรกซ้อนทางวิสัญญีในประเทศไทยโดยการรายงานอุบัติการณ์ (Thai AIMS) ซึ่งเก็บข้อมูลจากโรงพยาบาล 51 แห่ง ในช่วงระยะเวลา 6 เดือน ระหว่างวันที่ 1 มกราคม ถึง 30 มิถุนายน พ.ศ. 2550 รายงานอุบัติการณ์ การสำลักเข้าปอดได้รับการทบทวนและวิเคราะห์โดยวิสัญญีแพทย์อาวุโส 3 ท่าน หากมีข้อเห็นแย้งจะมีการอภิปรายจนได้ฉันทามติร่วมกัน วิเคราะห์โดยใช้สถิติแบบพรรณนา*

ผลการศึกษา: *จากฐานข้อมูล 1,996 รายงาน อุบัติการณ์พบรายงานของการเกิดภาวะสำลักเข้าปอด 28 ราย (1.4%) ซึ่งพบในผู้ป่วย ASA 1-2 (85.7%) ระหว่างเวลาราชการ (64.3%) และอยู่ในระหว่างที่มีวิสัญญีปฏิบัติงานอยู่ด้วย (67.9%) โดยเกิดในช่วงนำสลบ 11 ราย (39.3%) ช่วงระหว่างการให้ยาระงับความรู้สึก 7 ราย (25%) และในช่วงฟื้น 7 ราย (25%) ตามลำดับ 26 ราย (92.9%) ของอุบัติการณ์วิเคราะห์ได้ว่าเป็นปัจจัยทางวิสัญญี โดย 27 ราย (96.4%) และ 25 ราย (89.2%) เกิดจากปัจจัยมนุษย์ และอาจป้องกันได้ 9 ราย (32.1%) เกิดจากความพลั้งเผลอสำหรับผลที่เกิดจากผู้ป่วยได้แก่ ความผิดปกติทางสรีรวิทยาอย่างมาก 13 ราย (46.4%) เข้าหออภิบาลผู้ป่วยหนัก 10 ราย (35.7%) ใส่ท่อหายใจเป็นเวลานาน 10 ราย (35.7%) และเสียชีวิต 2 ราย (7.14%)*

สรุป: *ปัจจัยนำสู่ภาวะสำลักเข้าปอดได้แก่ การตัดสินใจไม่เหมาะสม (75%) ขาดประสบการณ์ (53.5%) ขาดความรู้ (21.4%) ปัจจัยลดอุบัติการณ์ได้แก่ ความรอบคอบระแวดระวัง (85.7%) มีผู้ช่วยที่มีประสบการณ์ (50%) เคยมีประสบการณ์นั้นมาก่อน (25%) แนวทางป้องกันเชิงระบบที่แนะนำได้แก่ การปฏิบัติตามแนวทางเวชปฏิบัติ (67.8%) การปรับปรุงการให้คำปรึกษาหรือการเป็นพี่เลี้ยง (57.1%) การฝึกอบรมเพิ่มเติม (42.8%) และกิจกรรมประกันคุณภาพ (28.6%)*