Original Article

A collaborative educational intervention on procedural sedation and analgesia across the Pacific

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Aim: Worldwide, health-care providers carry out procedural sedation and analgesia (PSA) in the emergency department. However, training opportunities are limited in many Asian countries, including Japan. We formed an educational group consisting of board-certified emergency physicians in the USA and Japanese physicians and developed a PSA training module. The aims of our study were to demonstrate the effectiveness of training and to describe PSA practice in Japan.

Methods: We undertook a pretest of PSA knowledge questions and a retest immediately after the training intervention. We also carried out a survey and asked about participants' PSA practice. The training module consisted of four didactic hours and three simulation and skills laboratory hours. Results of all pre- and post-intervention knowledge questions were analyzed with McNemar's test, and overall scores were analyzed with a paired *t*-test.

Results: One hundred and forty-four health-care providers including 123 physicians, 16 nurses, two pharmacists, and three medical students participated in the training. A total of 119 (83%) completed both the pre- and post-intervention knowledge questions. Before the training, participants scored an average 66% (63%–69%) on the written knowledge test. After the intervention, participants showed significant improvement on the knowledge test (improvement 17%; 14%–20%). Among participants who answered the practice survey, 121 (88%) have undertaken PSA. Only 14 (12%) participants always or often use a continuous capnography for PSA. Only 32 (26.4%) participants undertook pre-PSA systematic evaluation.

Conclusion: Our educational intervention successfully increased participants' knowledge. Only the minority of health-care providers use capnography routinely for PSA, and pre-PSA evaluation is not commonly carried out.

Key words: Anesthesia, education, procedural sedation and analgesia, safety, simulation

BACKGROUND

PROCEDURAL SEDATION AND analgesia (PSA) is routinely undertaken outside of the operation room by health-care providers for a variety of indications worldwide.[1–3] An increasing number of studies have shown that PSA can be safely carried out in different settings including the emergency department (ED), gastrointestinal endoscopic suites, and cardiac catheterization laboratory.[4–6]

Procedural sedation and analgesia is a complex skill set requiring multiple competencies, including medical knowledge and diagnostic skills, to prevent and rapidly identify adverse events and resuscitation skills. Training opportunities for health-care providers is limited in many Asian countries, including Japan.

Except in gastrointestinal endoscopy and cardiac catheterization suites, the extent to which PSA is practiced in East Asia, including Japan, is largely unknown, particularly in the ED.[7,8] Available evidence suggests that the practice of PSA in both adult and pediatric EDs might differ from the practice of PSA in other countries. For example, a nationwide survey of pediatric EDs in South Korea showed that only two-thirds of pediatric EDs in the country did some type of monitoring when they carried out PSA.[9]

Our group developed a PSA training module and a survey to both meet a need for training in Japan by health-care professionals who carry out PSA and also to explore the practice patterns of PSA in Japan. The objectives of this project were to examine the baseline level of knowledge and to

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determine the effectiveness of training in improving health-care providers' knowledge. We also aimed to document and describe PSA practice patterns in order to improve our training module and develop a PSA practice guideline in Japan in the future.

METHODS

Study design

WE DESIGNED AND evaluated a quasi-experimental educational intervention involving practicing health-care professionals. The University of New Mexico Health Science Center (Albuquerque, NM, USA) approved the study design as an exempt study. The core learning objectives and educational content were developed for post-graduate trainees in the USA based on the American Society of Anesthesiologists guideline.[10] We formed the 'Japan Society of Procedural Sedation and Analgesia', an educational group consisting of physicians who were board-certified in emergency medicine in the USA and several Japanese physicians. The Japanese physicians had a variety of different specialties including anesthesiology, emergency medicine, and internal medicine. The group reviewed the content of the curriculum and modified it to fit with the PSA practice in Japan. The major changes included the modification of the list of pharmacologic options and airway devices reviewed in the training course. For example, etomidate has not been approved in Japan and was not available, so etomidate was taken out of the curriculum. In contrast, thiopental was added to the training because it is widely used for PSA in Japan.

The training module, called the 'sedation course', consists of 4 h of didactics and 3 h of small group sessions. Table 1 shows the overall schedule of the training module. Small group sessions included simulation cases (Fig. 1), a skill session and group discussions of adult and pediatric PSA cases. The local Japanese physicians taught the sessions.

Table 1. Overall schedule of the procedural sedation and anesthesia (PSA) training module developed for Japanese health-care professionals

08:30–09:00	Welcome and registration
09:00–09:15	Introduction and foundations for PSA
09:15–10:00	Monitoring
10:00–10:10	Break
10:10–11:15	Sedation pharmacology
11:15–11:25	Break
11:25–12:10	Complication management and post-sedation management
12:10–12:15	Break
12:15–12:45	PSA for pediatric and geriatric patients
12:45–13:35	Break
13:35–13:50	Orientation on small group sessions
13:50–16:40	Rotate through stations: (30 min each station with 5-min break between each station)
	Station 1: Airway skills
	Station 2: Pediatric case simulation
	Station 3: Adult case simulation
	Station 4: Pediatric case discussion
	Station 5: Adult case discussion
16:40–16:50	Break
16:50–17:10	Post-training knowledge written test and survey
Summary and questions	

Setting and selection of participants

We carried out a pretest of PSA knowledge questions and a retest immediately after the training intervention. Each module had approximately 20 participants. The total study population was 144 health-care providers including physicians, nurses, pharmacists, and medical students in Japan. Both assessments consisted of 10 written knowledge questions. The group members, who each had at least 10 years of PSA practice and teaching experience, created the written knowledge questions. Each question was categorized as one of five topics: complications, pharmacology, sedation depth, *nil per os* guidelines, and special populations including pediatrics and geriatrics. Pre- and post-intervention knowledge questions were identical.

In Japan, 2 years of transitional year training is mandatory after graduating from medical school. New graduates rotate through primary care and selected specialties during their training. After successful completion of the transitional year training, residents choose their specialties. Procedural sedation and analgesia is typically carried out by either an anesthesiologist or a non-anesthesiologist who is trained in pediatrics, emergency medicine, gastroenterology, cardiology, surgery, or orthopedics. Indications for PSA include joint dislocation and fracture reduction, incision and drainage, cardioversion, gastrointestinal endoscopy, and diagnostic studies in pediatric patients. A nurse often administers medications under direction of a physician and monitors the patient while the physician is undertaking the procedure.

A pre-course survey was administered to collect information about participants' current PSA practice (before taking the training course), including the use of a monitoring device such as continuous capnography during PSA, undertaking systematic evaluation, and obtaining written consent

before PSA. We also undertook a post-course practice survey of physician participants who took one of the recent courses. The post-course survey was carried out after the course ended and included a question about continuous capnography use in the future.

Statistical analysis

Results of each pre- and post-intervention knowledge question were analyzed with McNemar's test, and overall scores were analyzed with a paired *t*-test. *P*-values <0.05 were considered significant. We used SAS statistical software (version 9.3; The SAS Institute, Cary, NC, USA) and the R statistical language[11] for analysis.

Fig. 1. Pediatric simulation of procedural sedation and analgesia. Participants in the training module for Japanese health-care professionals are learning skills to rapidly identify adverse events and undertake resuscitation.

RESULTS

ONE HUNDRED AND forty-four health-care professionals including 123 physicians, 16 nurses, two pharmacists, and three medical students participated in the training. A total of 119 (83%) completed both the pre- and post-intervention knowledge questions and 137 (95%) completed the practice survey; most participants 112 (78%) were men. The length of clinical experience after graduating medical school and specialty of the physicians varied. The median years of experience was four (interquartile range, 2–10). Among physicians who participated in the training, 42 (34.1%) were still in their mandatory transitional year training. Figure 2 shows specialties for the rest of the physicians. The most common specialty was emergency medicine (N = 38, 26.3%), followed by general internal medicine (N = 25, 18.1%).

Before the training, participants overall scored average 66% (63%–69%) on the written knowledge test. After the intervention, participants showed statistically significant improvement in seven out of 10 written knowledge questions and the overall average score significantly improved by 17% (14%–20%; Table 2, Fig. 3).

Figure 4 summarizes the practice survey results. Among participants who answered the survey (n = 137/144, 95.1%), 121 (88.3%) participants have performed PSA. The majority of them (n = 113, 93.4%) always use pulse oximetry for PSA with 6 (5.0%) often using pulse oximetry

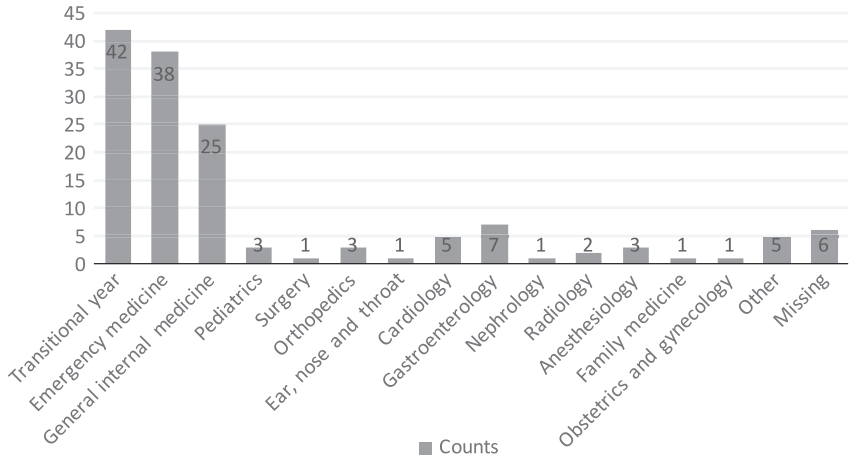

Fig. 2. Specialties of health-care professionals who participated in a procedural sedation and analgesia training module developed for Japan.

and 2 (1.7%) sometimes using pulse oximetry. Only a small number of participants (n = 8, 6.6%) always use capnography for PSA with 6 (5.0%) often using capnography and 33 (27.3%) sometimes using capnography. Almost two-thirds (n = 74, 61.2%) have never used capnography for PSA. A total of 57 (47.1%) participants reported obtaining written informed consent before PSA. Only 32 (26.4%) participants reported performing systematic evaluation before PSA.

Figure 5 compared pre-course and post-course practice survey results focusing on capnography use. The post-course survey was distributed to physicians who took one of the recent courses, and 19 out of 20 (95%) participants responded to the survey. A total of 17 (89.5%) participants stated that they would always or often use capnography for PSA, and two (10.5%) participants stated that they would sometime use capnography. No participant stated that he or she would never use capnography. Seventeen out of 20 (85%) participants completed both the pre-course practice survey and post-course practice survey, and the difference was statistically significant ($P < 0.001$).

DISCUSSION

PROCEDURAL SEDATION AND analgesia is a fundamental part of clinical practice in many specialties and facilitates a number of invasive and uncomfortable procedures. Training programs including simulations on PSA have been described in published works, particularly for post-graduate training.[12,13] However, most of these trainings occurred in North America and limited evidence exists on the implementation of PSA training outside of North America, where available resources and clinical training opportunities are different. To our knowledge, our study is the first to describe, in English, a PSA training program in Japan and showed the effectiveness of the training on clinical knowledge improvement on PSA.

Our results showed that health-care professionals who participated in the training in Japan had somewhat limited baseline knowledge on PSA. Our educational intervention successfully increased participants' overall knowledge about PSA, and we saw statistically significant improvement in most of the questions except for the questions on pediatrics, complications, and sedation depth.

Table 2. List of pre- and post-intervention written knowledge test questions and results with regard to a procedural sedation and analgesia training module developed for Japan (n = 119)

	Question	Category	Pre-test†	Post-test†	*P*-value
1	When do complications most often occur during procedural sedation?	Complication	54.1	86.4	<0.0001
2	Which of the following is most important when deciding dosing intervals in order to prevent 'dose stacking'?	Pharmacology	46.7	98.4	<0.0001
3	For elective procedures, the NPO guidelines state that, at a minimum, an adult patient must have which of the following?	NPO guideline	71.1	92.8	<0.0001
4	A 22-year-old patient who has been given fentanyl and midazolam for sedation during a laceration repair begins to vomit during the procedure. What is the appropriate sequence in management?	Complication	92.6	92.0	0.7539
5	Which level of sedation best describes this patient: 24-year-old male with purposeful response only to painful stimulation, sonorous respirations at a rate of 12?	Sedation depth	68.9	80.0	0.1325
6	Which agent can cause laryngospasm as a side-effect?	Pharmacology	71.1	96.8	<0.0001
7	Propofol is contraindicated in which of the conditions?	Pharmacology	79.3	96.8	<0.0001
8	What is most important in the following statements regarding PSA in elderly patients?	Special population: Geriatrics	84.3	96.0	0.0043
9	Which of the following best describe pulmonary physiology in pediatric patients?	Special population: Pediatrics	63.0	77.6	0.0009
10	Which of the following best describe the pediatric airway?	Special population: Pediatrics	26.7	22.6	0.2295

†Percent correctly answered.
NPO, *nil per os*.

Our pretest results showed that there was a potential deficit in knowledge on pediatric PSA, and we saw no significant improvement in a question on pediatrics. This might be due to the structure of our training course. We also had somewhat limited time to teach some of the key materials about PSA. For instance, only 1.5 h of the 7-h program was spent on lectures and simulations exclusively addressing pediatric PSA. Because our course participants had a variety of clinical backgrounds and many of them do not see pediatric patients on a daily basis, it might be necessary to modify our training curriculum to address differences in participants' clinical backgrounds and to place more emphasis on pediatric PSA.

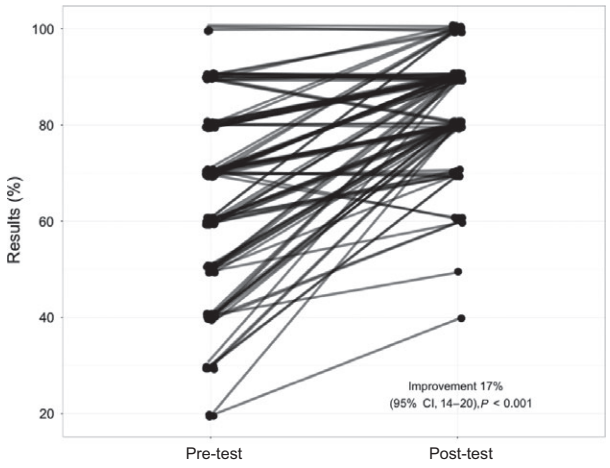

Fig. 3. Overall scores among participants of a procedural sedation and analgesia training module developed for Japan, before and after the intervention (n = 119).

Participants also scored particularly low in pharmacology questions in the pretest. Only 47% of participants correctly answered the question regarding medication dosing interval. This might indicate that there is a potential deficit in pharmacologic knowledge. In Japan, residents rarely receive pharmacology education regarding PSA during the first 2 years of transitional year training after graduating from medical school or during specialty training, except for training in pediatrics and anesthesiology.[14,15]

This knowledge gap might be affecting PSA practice in Japan. Analgesics with a long time to peak effect, such as meperidine, are still widely used for PSA in Japan.[16] Although there is ongoing debate over what the ideal medications for PSA are, experts generally agree that ideal pharmacological characteristics of medications for PSA should include rapid onset of action and short time to peak effect.[17] Because health-care providers with a variety of specialty backgrounds currently practice PSA in Japan, stakeholders might need to consider including PSA on the list of competencies and provide some training opportunities during their specialty training.

Effective training on PSA is important for patient safety. Multiple studies have described PSA training programs in sub-Saharan Africa, where health-care resources are extremely limited. Bisanzo *et al.*[18] described the delivery of PSA training to nurses in Uganda and showed that 191 PSA cases were safely carried out by six nurses who participated in the training. Another project of teaching and implementing a simplified protocol and checklist for ketamine for PSA has

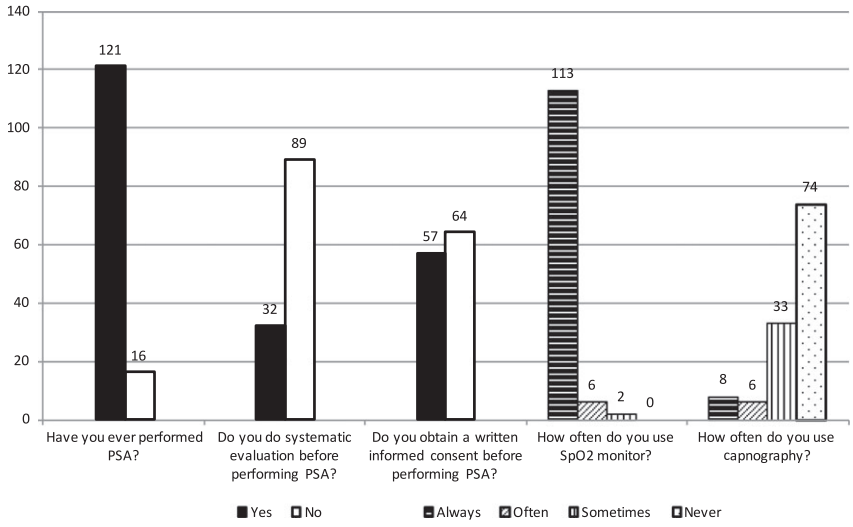

Fig. 4. Results of procedural sedation and analgesia practice survey (n = 137).

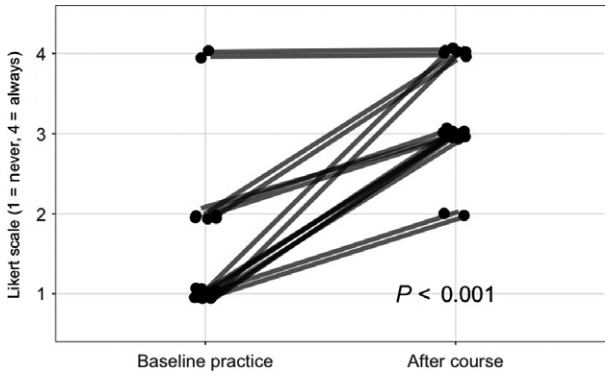

Fig. 5. Comparison of pre-course (baseline) and post-course practice survey results among participants of a procedural sedation and analgesia training module developed for Japan, focusing on capnography use for procedural sedation and analgesia (n = 17). A four-point Likert scale (4 = always, 1 = never) was used.

been described by Schwartz *et al.*[19] Our approach was different from these projects in that we recruited local Japanese physicians to develop and deliver the training sessions. In Japan, there are established specialty training programs for anesthesiology that involve simulation training.[20] However, a severe shortage of anesthesiologists has been a significant issue, even in university hospitals.[21] Our approach might be effective in some countries where there are similar problems, and the resource is available but constrained.

Our survey results showed that most health-care providers who participated in the training routinely use pulse oximetry but only a minority of participants use capnography routinely. A nationwide survey on emergency airway management in Japan found that a quantitative capnometry is available to confirm endotracheal tube placement. Interestingly, the same study showed only 47.8% of the EDs routinely use capnometry for this purpose.[22] This might indicate that the lack of familiarity with a capnometry device, not availability, is the main reason of not using capnometry in airway management and in PSA, as shown in our study.

The benefit of routine use of capnometry for PSA is still controversial.[2] The clinical policy on PSA published by the American College of Emergency Physicians states that capnography may be used as an adjunct to pulse oximetry as a level B recommendation (i.e. for patient care that may identify a particular strategy or range of strategies that reflect moderate clinical certainty).[2] Because the majority of adult patients in Japan are geriatric patients,[23] who are considered as high-risk patients, physicians might need to be more familiar with capnography and should consider using it when it is indicated.

Although we found limited routine use of capnography for PSA in Japan, our post-course survey successfully showed that participants were more eager to use continuous capnography for PSA after the training course. This is most likely because we introduced the idea of using capnography monitors for PSA and presented evidence to support the roles of capnography monitors during the course. This indicates the growing need for educational opportunities to promote the use of capnography during PSA, which might improve the safety of PSA practice in Japan.

We also found that the majority of health-care professionals who answered the survey did not undertake pre-PSA systematic evaluation or obtain written informed consent. This could be the result of the lack of PSA education and also the lack of recognition of the value of pre-PSA systematic risk evaluation. Airway assessment, which is a key component of pre-PSA evaluation, has been widely carried out for emergency airway management in Japanese EDs.[24] This suggests that Japanese physicians might already have a skill set to carry out pre-PSA evaluation but just do not routinely apply their skills for PSA. Although there is not enough evidence to support that pre-PSA evaluation improves outcomes, experts strongly agreed that pre-PSA evaluation would improve patient satisfaction and decrease the likelihood of adverse events.[10] This should be emphasized in future PSA training in Japan.

LIMITATIONS

OUR STUDY HAS several limitations. We surveyed health-care professionals who selectively participated in our PSA training. Those who participated in the training might be different from other health-care professionals in Japan. Although the participants had a wide range of length of experience and different backgrounds, our results might not be generalizable. Further study with a large sample size should be conducted to have a better understanding of the current PSA practice in Japan.

Due to the limitation of available resources, we evaluated improvement of knowledge on PSA but we did not evaluate improvement of skills. However, as discussed above, each skill required for safe PSA practice, particularly airway assessment and management skills, might not be new to many Japanese physicians. Perhaps what is more important would be a practice change that recognizes the value of pre-PSA systematic evaluation and the use of appropriate monitoring devices. Although we successfully showed that participants were more eager to use continuous capnography for PSA after the intervention, future studies focusing on actual practice change should be undertaken at a larger scale.

CONCLUSION

WE DEVELOPED, IMPLEMENTED, and tested successful PSA training in Asia using a collaborative model of US and Japanese physicians. The educational intervention showed significant improvement in PSA clinical knowledge.

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DISCLOSURE

Approval of the research protocol: The University of New Mexico Health Science Center approved the study design as an exempt study with waiver of informed consent.
Informed consent: As above.
Registry and the registration no. of the study/trial: N/A.
Animal studies: N/A.
Conflict of interest: None.

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