ADVANCES / EDUCATION

Impact of a multifaceted pediatric sedation course: self-directed learning versus a formal continuing medical education course to improve knowledge of sedation guidelines

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ABSTRACT

Background: Procedural sedation guidelines were established for a tertiary care pediatric emergency department (ED). We developed a pediatric procedural sedation course to disseminate these guidelines.

Objective: Our objective was to evaluate the effectiveness of a sedation course in improving physicians' knowledge of pediatric procedural sedation practices and guidelines, relative to individual self-directed learning.

Methods: We recruited emergency staff physicians and fellows as well as fourth-year pediatric residents in a tertiary care pediatric ED to participate in a randomized, controlled, educational intervention. All consenting physicians received pediatric sedation educational material for individual study 2 weeks before a learning assessment. Participants were randomly assigned to one of 2 groups. The self-directed learning group (n = 24) completed a multiple-choice examination without receiving any formal teaching. The study group (n = 24) participated in a 4-hour formal multifaceted sedation course before writing the multiple-choice examination.

Results: The groups did not differ significantly in demographic characteristics or self-perceived knowledge of pediatric sedation. The formal teaching group's median examination score (83.3%; range 75.8%–96.5%) was significantly higher ($p < 0.0001$) than the median examination score of participants in the self-directed study group (73.3%, range 43.5%–86.6%).

Conclusion: The multifaceted sedation course was more effective in improving physician knowledge and understanding of sedation guidelines and practices than unstructured, self-directed learning.

Key words: emergency medicine, pediatrics, sedation, continuing education, guidelines, learning

RÉSUMÉ

Contexte : On a établi des lignes directrices sur la sédation opératoire pour un service d'urgence pédiatrique de soins tertiaires, et un cours à ce sujet pour les diffuser.

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Objectif : Nous voulions déterminer dans quelle mesure un cours sur la sédation, par rapport à l'apprentissage autodirigé individuel, pouvait améliorer chez les médecins la connaissance des méthodes de sédation opératoire en pédiatrie et des lignes directrices en la matière.
Méthodes : Nous avons recruté des médecins et des fellows du personnel de l'urgence, ainsi que des résidents en pédiatrie de quatrième année d'un service d'urgence de soins tertiaires en pédiatrie, pour qu'ils participent à une intervention de formation contrôlée randomisée. Tous les médecins qui ont accepté de participer ont reçu des documents de formation sur la sédation en pédiatrie qu'ils ont étudiés individuellement pendant deux semaines avant qu'on évalue le savoir acquis. Les participants ont été répartis au hasard en deux groupes. Les membres du groupe qui ont appris de façon autodirigée (n = 24) ont répondu à un examen à choix multiples sans recevoir de formation structurée. Ceux du groupe d'étude (n = 24) ont participé à un cours structuré à facettes multiples d'une durée de quatre heures sur la sédation avant de répondre à l'examen à choix multiples.
Résultats : Il n'y avait pas de différence significative entre les membres des deux groupes quant aux caractéristiques démographiques ou à la connaissance autoperçue de la sédation en pédiatrie. Les résultats médians obtenus par le groupe des médecins qui ont suivi le cours structuré (83,3 %; intervalle de 75,8 % à 96,5 %) étaient beaucoup plus élevés (p < 0,0001) que ceux des participants membres du groupe d'étude autodirigée (73,3 %; plage de 43,5 % à 86,6 %).
Conclusion : Le cours à facettes multiples sur la sédation a réussi plus efficacement que l'apprentissage autodirigé non structuré à améliorer la connaissance et la compréhension chez les médecins des pratiques de sédation et des lignes directrices en la matière.

Introduction

Over the past decade there has been an increased recognition of the importance of providing safe and effective management of painful procedures in the emergency department (ED). However, children often receive inadequate sedation and pain management due to fear of adverse reactions.[1,2] Many of the drugs used for sedation and analgesia have the potential to cause central nervous system, respiratory and cardiac depression.[3–5] Adverse outcomes from sedation tend to occur because individuals who have the appropriate airway management and resuscitation skills fail to recognize patients who are developing adverse events and intervene in a timely manner.[6] Adequate attention to procedural pain and anxiety will improve quality of care and patient satisfaction by facilitating procedures and minimizing patient suffering. Hoffman and colleagues found that applying a structured model to the practice of pediatric procedural sedation reduced the occurrence of adverse events.[7] Although Canadian pediatric emergency physicians have provided sedation for invasive and noninvasive procedures for several years, there has been no formal training or certification for physicians.

Guidelines for pediatric procedural sedation have been established.[8–15] Although physicians often report good compliance with guidelines, studies have shown relatively poor understanding of or compliance with them.[16–20] Dissemination and implementation of guidelines is more effective when they are locally developed or approved, actively deployed by community-based opinion leaders, have qualities compatible with existing beliefs and values, and can be readily incorporated into current practice.[21–24]

We established pediatric emergency procedural sedation guidelines for a tertiary care pediatric ED based on existing hospital-wide sedation guidelines and published guidelines.[8–15] We then developed an educational intervention to help disseminate and implement these guidelines. The learning needs of our target audience were identified with surveys and focus group discussions. Davis and colleagues demonstrated that multifaceted interventions incorporating 2 or more education strategies more effectively changes physician performance when compared with single interventions. Based on their work, we designed a multi-faceted sedation course.[25–27]

Although many educational programs have shifted toward self-directed learning, formal continuing medical education (CME) activities rely heavily on traditional expert-led teaching.[28] Adult learning principles suggest that self-directed learning is more likely to result in 'deep' learning and the development of critical thinking skills.[29] However, if the knowledge gap is unperceived, then self-directed learning may not be effective. Emergency physicians who are already involved in procedural sedation without specific institutional guidelines may not be aware of potential gaps in their knowledge and may not perceive a need for further education. The purpose of this study was to compare the effectiveness of a formal procedural sedation course with unstructured, self-directed learning

in terms of improvements in physician knowledge of pediatric procedural sedation practices and guidelines.

Methods

Research design

This randomized, post-test, controlled trial was approved by the Hospital for Sick Children Research Ethics Board.

Subjects

Between June and September 2003, we recruited physicians affiliated with the ED at the Hospital for Sick Children to participate in an educational intervention. Full-time and part-time staff emergency physicians as well as physicians with advanced emergency or pediatric training, including pediatric emergency medicine fellows, emergency medicine residents (Royal College of Physicians and Surgeons of Canada, Canadian College of Family Practice) and fourth year pediatric residents, were eligible to participate in the study. Participation was voluntary for all groups. Physicians involved in course development and design, as well as the participants who had not received the study material 2 weeks before the learning assessment, were excluded from the study. All participants completed demographic information questionnaires and provided informed consent.

Interventions

The sedation learning package included detailed learning objectives, a sedation booklet outlining the sedation guidelines, the pharmacology of sedative agents, airway management and complications, as well as a sedation flow sheet, a sedation pocket card and discharge instructions for parents.

The sedation course was developed as a 4-hour, multifaceted teaching program consisting of didactic and small group learning sessions. We used results from focus groups held before the study to develop the intervention and to identify barriers to change. The 2-hour didactic portion encompassed a review of pediatric emergency sedation guidelines, pharmacology of sedative and analgesic agents used in the ED, and a review of potential complications of sedation. The 1.5-hour small group sessions were case-based discussions designed to reinforce and apply the material from the didactic sessions. Enabling methods included the introduction of a procedural sedation record. Members of the Divisions of Pediatric Critical Care, Anesthesiology, and the Drugs and Therapeutics Committee at the Hospital for Sick Children developed a sedation pocket card to reinforce and review lessons. Those attending the course were asked to fill out an evaluation to assess teaching effectiveness and course content.

Using computer generated random numbers, participants were randomly allocated to either a self-study or a formal teaching group. All participants received the sedation learning package with clearly defined learning objectives and were asked to study the material. Those assigned to the self-study group (group 1) received no formal teaching, while those in the formal teaching group (group 2) attended a 4-hour, multifaceted sedation course. Prior to the assessment date, participants were unaware of their assigned group. Both groups took the same 30-item, 45-minute, closed-book multiple-choice examination (Figure 1).

Assessment tool: multiple-choice examination

To ensure content validity of the test items, we used a representative collection of items and a "sensible" method of test construction.[30] Test questions corresponding to each objective were composed by course faculty or modified from other published sources on pediatric sedation. There was at least one action item and one concept item question corresponding to each learning objective. The action items corresponded as closely as possible to the practice behaviour that the program was designed to promote. Course faculty members reviewed all the test items. The test was piloted on volunteer, third-year pediatric residents at the tertiary care institution to ensure item difficulty and discrimination. We compared the multiple choice examination scores of the 2 groups.

We conducted a pilot study with the first 9 physicians in each group. We calculated the mean scores and standard deviations (SDs) of the 2 groups to determine the sample size needed to achieve a power of 0.8 with an alpha of 0.05, 2-tailed. Based on this data, only 9 physicians in each group were needed to achieve a statistically significant difference between the 2 groups. However, 24 physicians were enrolled in each group to account for potential dropout and to obtain adequate evaluation of the course.

Data analysis

We calculated mean, median and range of multiple choice exam scores for both groups. We used a Wilcoxon 2-sample test, as opposed to a a *t* test, to compare the exam scores of the 2 groups because the assumption of normality was not verified. We also compared exam scores by subgroup (ED staff physicians compared with trainees), by level of subspecialty training (pediatric emergency medicine subspecialty training compared with other subspe-

cialty training or no subspecialty training) and for years of clinical experience in the ED. We used Cohen's *d* to calculate the effect size.

Results

There were 51 physicians eligible for the study; however, 2 weeks before the assessment, 3 physicians who had agreed to participate had not received their course material and were therefore excluded (see Figure 1). Table 1 shows that there were 24 physicians with similar baseline characteristics in each group. Most were staff emergency physicians (54% in the self-directed group, compared with 62% in the formal teaching group), although a minority had emergency subspecialty training, reflecting the recent emergence of the pediatric emergency medicine subspecialty in Canada. Of participants in both groups, 79% had been in clinical practice for less than 10 years. Both groups indicated that a sedation course would be useful to their practice (100% in the self-directed group, compared with 92% in the formal teaching group) and most participants indicated a need for greater knowledge about pediatric sedation (79% in the self-directed group, compared with 54% in the formal teaching group). Overall, only 8% of participants indicated that self-directed learning was their preferred method of learning.

Table 2 summarizes both groups' examination scores, showing that subjects in the formal teaching group scored significantly higher ($p < 0.0001$). The median and mean examination scores of participants in the self-study group were 73.3% (range 43.5%–86.6%) and 71.1%, SD 11.6, respectively. The median and mean examination scores of participants in the formal teaching group were 83.3% (range 75.8%–96.5%) and 85.5% SD 5.76, respectively. This is shown graphically in Figure 2. An effect size of 0.6 was calculated from Cohen's *d* of 1.52, which indicates that the percentage nonoverlap between the 2 groups was 38.2%.

There were no significant exam score differences between staff emergency physicians and trainees ($p = 0.83$),

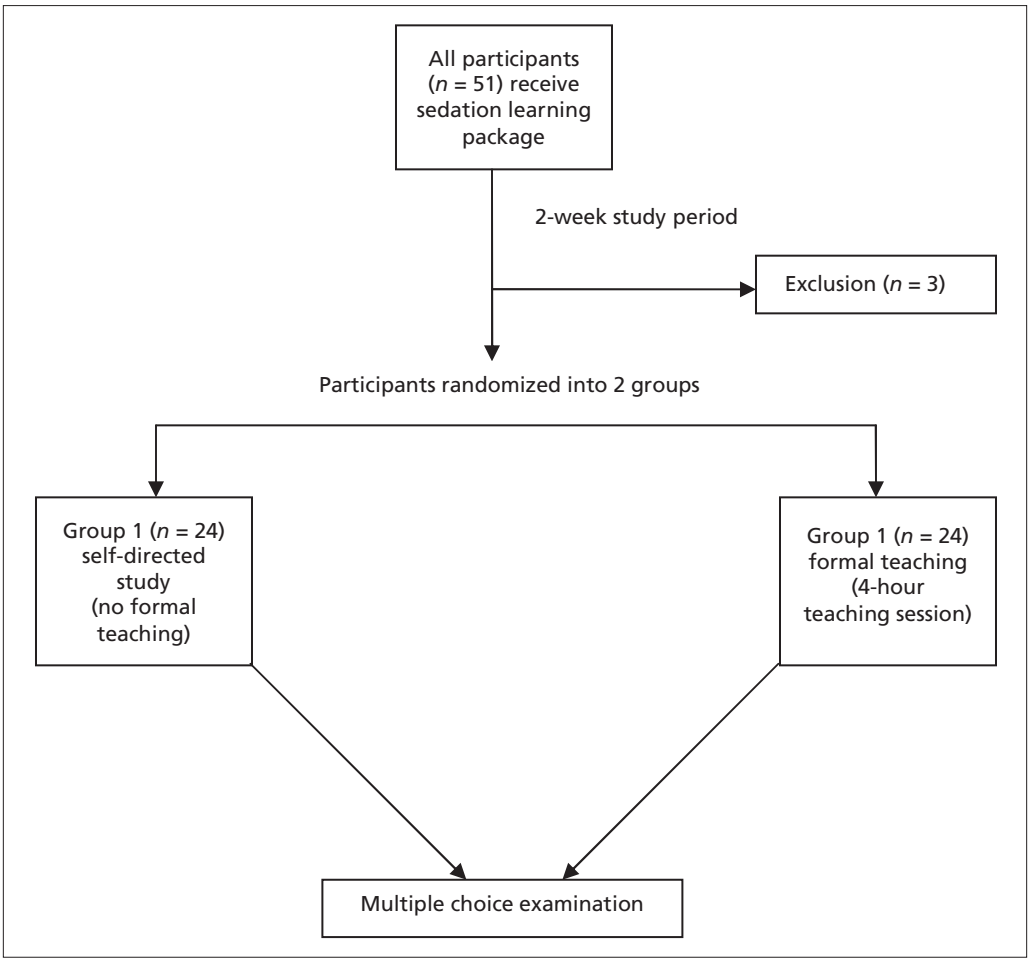

Fig. 1. Participant flow diagram.

between physicians with emergency medicine subspecialty training and no subspecialty training or other subspecialty training, or based on years of experience in the ED (see Table 3). There was no significant difference in examination scores based on sex.

Discussion

This study suggests that a multifaceted sedation course was more effective at improving physicians' knowledge of pediatric sedation guidelines and practices than self-directed learning. The success of this sedation program was based on several factors:

- to ensure compatibility with the learning needs of the target audience, prior to the study we completed a careful needs assessment;
- the learning objectives were clearly outlined at the beginning of the course;
- the sedation course was developed using evidence-based educational strategies and was based on adult learning principles;
- the multifaceted intervention applied predisposing methods (including didactic lectures and small group case-

Table 1. Participant demographic data.

Characteristic	Group 1 (self-study) (*n* = 24)	Group 2 (formal teaching) (*n* = 24)
	n (%)	*n* (%)
Status		
Full-time physician	7 (29)	7 (29)
Part-time physician	2 (25)	8 (33)
Fellow	6 (25)	6 (25)
EM residents	5 (21)	3 (13)
Sex		
Male	13 (54)	11 (46)
Female	11 (46)	13 (54)
Subspecialty training		
EM	10 (42)	7 (29)
Other	5 (21)	7 (29)
None	9 (38)	10 (42)
Years in practice		
<10	19 (79)	19 (79)
≥10	5 (21)	5 (21)
Years in EM practice		
<2	16 (67)	8 (33)
2–5	5 (21)	10 (42)
5–10	0 (0)	3 (13)
>10	3 (13)	3 (13)
Sedation course useful?		
Yes	24 (100)	22 (92)
No	0 (0)	2 (8)
Self-assessed sedation knowledge		
Very good	5 (21)	9 (38)
Needs improvement	19 (79)	13 (54)
Unanswered	0 (0)	2 (8)
Preferred education		
Self-study	2 (8)	9 (38)
Online course	2 (8)	7 (29)
Formal CME	13 (54)	2 (8)
Self-study or CME	3 (13)	8 (33)
Unanswered	4 (17)	5 (21)

CME = continuing medical education; EM = emergency medicine

Table 2. Examination scores by study group.*

Group	Median score (range)	Mean score (SD)
Group 1, self-study (*n* = 24)	73.3% (43.5–86.6)	71.1% (11.6)
Group 2, formal teaching (*n* = 24)	83.3% (75.8–96.5)	85.5% (5.76)

*$p < 0.0001$ (Wilcoxon 2-sample test)
SD = standard deviation

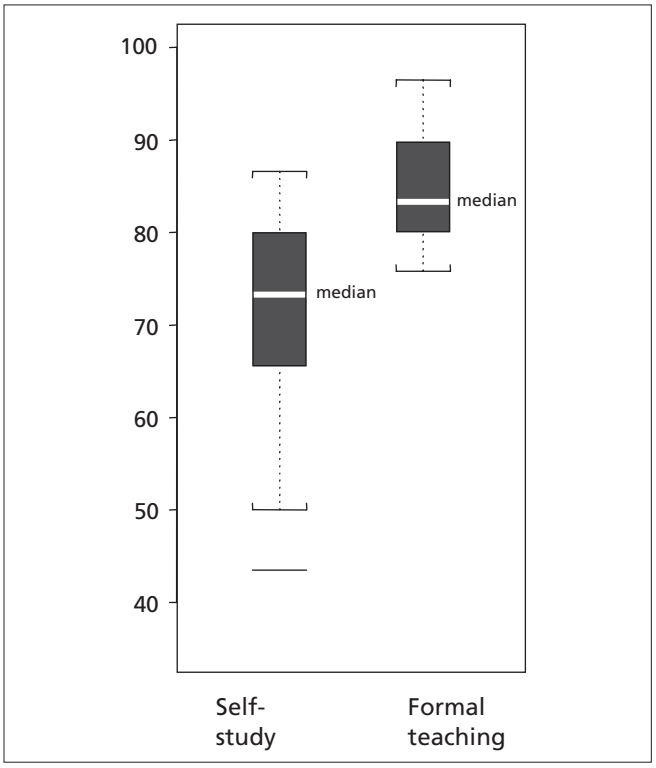

Fig. 2. Multiple choice examination scores of self-directed and formal teaching groups.

based discussions), enabling methods (a sedation flow record) and reinforcing methods (a sedation pocket card for easy reference);
- course material was carefully prepared to ensure it was practical and relevant to the learning needs of the target audience;
- to ensure that practitioners had confidence in the recommendations, we consulted local opinion leaders about guideline development and dissemination processes;
- prior to the study, we used surveys and focus groups to identify increased knowledge of sedation practices and guidelines as important and relevant to the target audience; and
- an active approach to guideline dissemination (i.e., development of a sedation course) ensured that the practitioners had the equipment and skills needed to implement the guidelines.

Physician learning strategies

Increasingly, physicians are being asked to demonstrate clinical competence. Multiple-choice examinations are commonly used as measures of competence for high-risk clinical scenario. Procedural sedation in the ED is considered a high-risk procedure because it has the potential to result in serious adverse events. Courses, such as the Pediatric Life Support Course (PALS) from the American Heart Association and the Advanced Pediatric Life Support Course (APLS) from the American Academy of Pediatrics and American College of Emergency Physicians, support the use of multiple-choice examinations with minimum pass scores to obtain certification.

In addressing the need to increase clinical competence, physicians most often choose to learn by individual reading; however, when the focus involves technical, procedural or communication skills, physicians are more likely to choose formal CME.[31] In this study, the formal CME event might have been perceived as a more practical, efficient and effective method of learning highly desirable information. Unlike other CME events that are generally designed to meet the broad needs of individuals, this event was developed based on the specific needs of the target audience. We provided in-depth learning of emergency procedural sedation along with case-based scenarios that were directly applicable to practice. The clinical decision models included options to broaden the applicability of the clinical practice guidelines to individual practice.

Table 3. Stratified examination scores.

Variable	Median score (range)
Faculty exam scores, compared with trainees*	
ED attending physicians (*n* = 28)	80.0% (43.5–96.5)
Trainees† (*n* = 20)	80.0% (56.6–93.3)
Stratification by EM experience‡	
≤2 years ED practice (*n* = 24)	79.7% (43.5–93.3)
>2 years ED practice (*n* = 24)	81.4% (56.6–96.6)
Stratification by subspecialty training§	
Pediatric EM fellowship (*n* = 31)	80.0% (43.5–96.5)
Other or no subspecialty (*n* = 17)	79.3% (65.5–89.6)

*p = 0.83 (Wilcoxon 2-sample test)
†Trainees include fourth year pediatric residents and EM fellows
‡p = 0.09 (Wilcoxon 2-sample test)
§p = 0.33 (Wilcoxon 2-sample test)
ED = emergency department; EM = emergency medicine

Guideline implementation

Improved knowledge of sedation practices and guidelines will ultimately improve the quality of ED care by reducing complications and improving patient satisfaction. However, successful implementation must also include strategies to facilitate the adoption of improved practices.[32–35] Ockene and colleagues demonstrated that education alone is insufficient for implementing guidelines.[36] Strategies, that enable clinicians to implement the recommended clinical processes and reinforce their use, are needed. Clinical systems and procedures that will aid in this process include patient tracking and provider reminders. Although we introduced measures, such as the procedural sedation record and sedation pocket cards, chart audits and feedback to monitor physician compliance and health care outcomes are currently being evaluated.

Study strengths

The self-study group was randomly selected from the study population and we assumed it was similar to the formal teaching group. Participants were unaware of their group allocation until the day of assessment, at which time they either participated in the course or wrote the multiple-choice examination. As a result, participants in both groups had equal opportunity to review the course material. Participants randomized to take the course all had the same instructors, ensuring that all participants were exposed to the same information during the course. We made every attempt to ensure construct and discriminate validity of the examination. Examination questions were based on the learning objectives and measured knowledge and understanding of sedation guidelines, as well as problem solving and decision making skills in clinical scenarios.

Limitations

The examination was not designed to determine predictive validity, although further studies may determine its effect on future examinations or physician performance. Although competence may not be guaranteed by a multiple-choice examination, it does measure knowledge transfer, which is a prerequisite for professional competence.

We did not ask participants to record how much time they spent reviewing the study material before the assessment. It is conceivable that the self-study group spent less time reviewing the material due to an unperceived knowledge gap. In addition, although it is conceivable that the formal teaching group simply had more knowledge of sedation, we believe that the study participants were a relatively homogeneous group of physicians with experience in the ED and exposure to the same sedation practices.

This study did not analyze the effect of repeated-measurement testing because we did not administer a pre- and post-test to the same individual. A pre-test in the formal teaching group could result in the recall of items in the post-test rather than knowledge gained in the educational intervention. The physicians in this study were from a tertiary care centre and are more accustomed to regular formal teaching sessions. Physicians in the community setting may be more isolated and thus may be more motivated to undertake self-directed learning, which may affect the generalizabililty of our results to other populations.

Despite excellent course evaluations and a significant improvement in physician knowledge of sedation practices following the sedation course, this may not necessarily translate into change in physician behaviour or patient outcomes. Evaluation of behaviour involves the transfer of learning to the workplace. Future studies will focus on change in physician behaviour in adhering to sedation guidelines.

Conclusion

The multifaceted sedation course was more effective in improving physician knowledge and understanding of sedation guidelines and practices than unstructured self-directed learning.

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Competing interests: None declared.

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