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National survey revealed variable practices in paediatric procedural sedation and patient monitoring

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Abstract

Paediatric procedures requiring sedation are increasingly being performed off site, but there are no national guidelines for paediatric procedural sedation in Finland or studies on it. Therefore, the aim of this survey was to assess national practices for paediatric procedural sedation outside operation rooms and intensive care units in terms of indications, sedative medication, treatment facilities, patient safety and training of the personnel.

An online survey including single- and multiple-choice questions and open-ended questions was sent to Finnish paediatricians, paediatric surgeons and paediatric anaesthesiologists via the electronic mailing lists of national societies in December 2019.

A total of 71 responses were received. Lumbar puncture (41%), intra-articular injections (38%) and MRI (17%) were the most common procedures that required routine sedation. Benzodiazepines were the most frequently used sedatives during both painful procedures (80%) and imaging (61%). Pulse oximetry monitoring was reported by 75% of the respondents, but other physiological parameters were rarely monitored (ECG 28%; blood pressure 39%; respiratory rate 34%). The level of sedation was not objectively assessed. Adrenaline (72%) and equipment for managing adverse respiratory outcomes (supplemental oxygen 98%; ventilation equipment 92%) were available in most facilities in which sedation was performed. Only one-third of the respondents had undergone training for paediatric procedural sedation, and only 39% of the hospital units compiled statistical data on sedation-related adverse events.

The paediatric procedural sedation practices vary across hospitals. National guidelines for patient monitoring and training of personnel could improve treatment quality and patient safety.

1 | INTRODUCTION

Several diagnostic and therapeutic procedures during hospitalization are uncomfortable and painful or may require staying still for a relatively long period of time.[1,2] In paediatric patients, nonmedical methods, such as swaddling, use of a pacifier and distraction techniques are commonly used,[3,4] but sedative premedication is often required for successful completion of procedures.

Patient comfort and, in painful procedures, also analgesia are the main goals for paediatric procedural sedation, and a variety of drugs with different sedative, analgesic, pharmacodynamic and safety profiles are used.[5] Opioids, nitrous oxide and ketamine, are beneficial during painful procedures, while benzodiazepines have anxiolytic and amnestic properties without analgesic effects.[5-7] Dexmedetomidine is a novel sedative with analgetic properties and minimal effects on the respiratory drive.[5] Propofol is a potent and

rapidly effective anaesthetic which potentially has serious side effects, so only anaesthesiologists can administer propofol in many countries.[8]

Sedation provided outside the operation room and intensive care units is becoming more common. However, there is a high risk of complications in children undergoing anaesthesia, especially in young infants and children with acute illness and comorbidities.[9] Thus, precautions for patient safety should be properly considered in off-site administration of procedural sedation.[10] The most common adverse events are airway obstruction, apnoea and oxygen desaturation, while agitation, nausea, laryngospasms and haemodynamic instability occur occasionally.[11] International guidelines emphasise the evaluation of individual patient-related risks and proper training for administration of sedation and management of adverse events, including handling of age- and size-appropriate equipment for monitoring, securing the airway and ventilating the patient.[12,13]

While in some countries, medical staff undergo specialised training in paediatric sedation and management of adverse events before they start practising,[5,14] in Finland, there are no national guidelines for paediatric procedural sedation. Therefore, the aim of this study was to assess the current sedation practices outside operation rooms and intensive care units in terms of indications, sedative medication, treatment facilities, patient safety and training of the personnel by using a nationwide survey.

2 | METHODS

In Finland, most of the diagnostic and therapeutic paediatric procedures requiring sedation are performed in 5 university hospitals and 16 central hospitals. Also some private hospitals in the largest cities perform small procedures in children. A cross-sectional nationwide online survey was distributed via email to all Finnish paediatricians, paediatric surgeons and paediatric anaesthesiologists in December 2019. The electronic mailing lists were obtained from Finnish Paediatric Society, The Finnish Society of Anaesthesiologists and Finnish Association of Paediatric Surgeons. To ensure geographical coverage of this survey, the questionnaire link was also sent to all heads of paediatric departments with a request to forward it to the doctors responsible for sedation practices in their units. Widely distributed survey together with a focused request for a subgroup of clinicians aimed at obtaining responses from doctors, who sedate paediatric patients off-site as part of their daily routine.

The survey contained questions about the respondents' speciality and care facility. Additionally, questions about indications for sedation, sedatives used and patient monitoring were asked, along with questions about education and training in sedation administration and reporting of adverse events (the questionnaire is available as an electronic supplement). Multiple-choice and single-choice questions, as well as open-ended questions were used. Some of the questions had a null option or an "I don't know" option. The questions were focussed on routine sedation and on-demand sedation. Routine sedation was defined as the procedure for sedation in the majority of the patients, provided there were no contraindications. On-demand sedation was defined as the procedure in which sedation was provided only if anyone involved in the patient's care (that is, the doctor, nurse, patient or parent) deemed that the patient would benefit from the sedation or if the procedure could not be done without sedation.

It was not mandatory to respond to all the questions in the questionnaire, but the questionnaire could not be returned until all the pages had been opened. Participation was voluntary, and confidentiality and anonymity were guaranteed to avoid potential participation bias.

The results were analysed and reported as the percentage of the total number of responses to each question. Differences in frequencies between specialities and sedation variables were tested using chi-squared tests. If the chi-squared test showed a difference, the standard normal deviate (SND) test was used to determine the statistical significance of the difference between distributions. *P*-values below .05 were considered significant. The chi-squared test was performed with IBM SPSS, version 23, and the SND test was performed with the StatsDirect statistical software, version 3.2.10.

Editorial Comment

This nice survey-based assessment of current pediatric sedation practices in Finland provides further evidence for the need to standardize and provide more appropriate training in this area, at least based on this Nordic experience.

3 | RESULTS

The total number of respondents was 71, and 69 (97%) of them were specialists. The response rate to individual questions varied between 41% and 100%. The majority of the respondents (65%) administered sedation to their patients at least once a week. Most of the respondents were paediatricians (72%), and the majority of them worked at a university hospital (66%). With regard to the location of the sedative practices reported, 22% were performed in emergency rooms, 30% in wards and 31% in outpatient clinics. Detailed information on the respondents' speciality, hospitals and hospital units is provided in Figure 1.

3.1 | Indications for sedation

The indication for sedative premedication was most often (in 80% of the cases) the providing doctor's decision that the procedure could not be performed without sedation. Patient's and parent's wish for sedation administration was indicated in 44% and 54% of

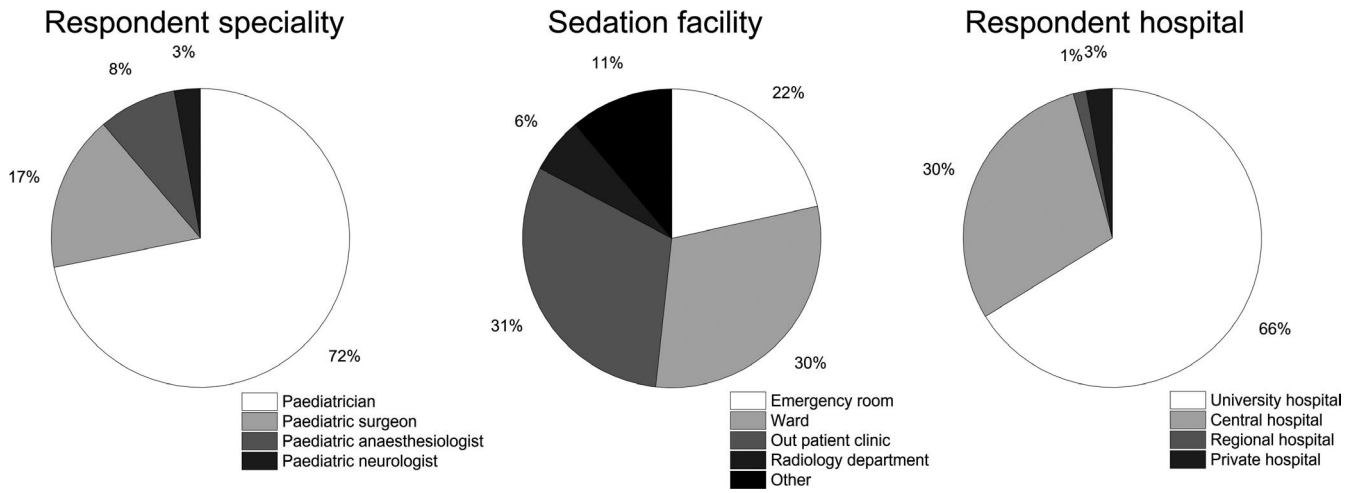

FIGURE 1 Respondents' characteristics in terms of their specialties, units and institutions

the responses respectively. Routine use of sedation in painful procedures was reported by 15% of the respondents and on-demand use by 37% of the respondents, while routine and on-demand use of sedation for imaging studies was reported by 8% and 39% of the respondents respectively.

Lumbar puncture (41%), intra-articular injection (38%) and MRI (17%) were the most common procedures for which sedation was the routinely used (Table 1). None of the respondents reported routine use of sedation for intravenous cannulation, venous blood sampling or suprapubic aspiration, while on-demand sedation for these procedures was provided relatively often (Table 1).

3.2 | Sedative medications

Benzodiazepines were the most frequently used sedatives (Table 2), and midazolam was frequently used for both painful procedures and imaging studies. It was administered via multiple routes, with the oral route being the most common one. Opiates were mainly used for painful procedures (Table 2).

The selection of sedatives for painful procedures did not differ according to the respondents' specialities, while anaesthesiologists (100%) reported using propofol sedation for imaging studies significantly more often than paediatricians (33%, $P < .01$) and paediatric surgeons (25%, $P = .01$). Additionally, anaesthesiologists reported significantly more frequent use of thiopenthal ($P = .01$) and fentanyl ($P = .002$) in comparison to paediatricians. Chloral hydrate was mainly prescribed for imaging studies by paediatricians.

Other commonly used sedatives were ketamine and dexmedetomidine. Ketamine was more popular during painful procedures, while dexmedetomidine was used for both painful procedures and imaging studies (Table 2). Dexmedetomidine was mainly administered intranasally. Although the questionnaire did not have a question regarding combining different sedatives, the combination of ketamine and midazolam was mentioned by 10 respondents in their open-ended answers.

3.3 | Treatment facilities

The eligibility for sedation was assessed and the administration of sedative medication was ordered mainly by paediatricians, resident paediatricians, anaesthesiologists and resident anaesthesiologists. The question concerning who prescribes sedative medication in their unit was answered by 68 of the 71 (96%) respondents. The paediatrician or anaesthesiologist was reported as the doctor in charge in 72% or 66% of the units, respectively, while paediatric and anaesthesiology residents were reported as being in charge in 60% and 47% of the units respectively. Doctors in other specialties were less commonly reported as being in charge: emergency doctor 7%; resident in emergency medicine 7%; paediatric surgeon 7%; and paediatric neurologist 4%. One respondent (1%) stated that a nurse was responsible for sedation in their unit.

Forty-five percent of the respondents had a sedation protocol in their unit: sedation protocols for patients aged 1-5 years was reported in 84% of these units, while protocols for patients older than 5 years was reported in 82% of the units. With regard to the fasting protocol, the patients were either not required to fast at all or required to fast for at least 4 hours before sedation. (Table 3).

In most cases, a nurse (84%) or the parents (22%) monitored the patient after procedural sedation, and the typical follow-up time was 1-2 hours after drug administration (39%). The recovery room was used for patient monitoring after the procedures when the anaesthesiologist sedated the patient (100%), but monitoring also took place in the patient rooms in outpatient clinics (42%), hallways (22%) and regular wards (50%). Anaesthesiologists more often had predetermined discharge criteria for patients after sedation (100%) than other specialists (paediatricians, 55% [$P = .04$]; paediatric surgeons, 45% [$P = .02$]).

3.4 | Patient safety and personnel training

Pulse oximetry was the most frequently used (75%) method for patient monitoring, whereas other physiological parameters were only

TABLE 1 Procedures for which sedative premedication is prescribed

On-demand sedation						
	Total n	**Paediatricians n (%)[a]**	**Paediatric surgeons n (%)[a]**	**Anaesthesiologists n (%)[a]**	**Chi-squared test for difference between groups**	**Difference (95% CI) and *P*-value**
Number of responses	67	51 (76)	11 (16)	5 (7)		
Painful procedures						
	Total n (%)[b]	**Paediatricians n (%)[b]**	**Paediatric surgeons n (%)[b]**	**Anaesthesiologists n (%)[b]**	**Chi-squared test for difference between groups**	**Difference (95% CI) and *P*-value[c]**
Lumbar puncture	45 (67)	38 (75)	4 (36)	3 (60)	0.01	Paed vs. Surg: 41% (9.74-65.79), *P* =.01
Intravenous cannulation	33 (49)	29 (57)	2 (18)	2 (40)	0.03	Paed vs. Surg: 41% (8.18-61.01), *P* =.01
Intra-articular injection	32 (48)	25 (49)	5 (45)	2 (40)	0.69	
Venous blood sampling	23 (34)	20 (39)	2 (18)	1 (20)	0.31	
Intra-arterious cannulation	18 (27)	14 (27)	2 (18)	2 (40)	0.62	
Wound stitching	13 (19)	7 (14)	3 (27)	3 (60)	0.08	
Fracture reposition	15 (22)	4 (8)	8 (73)	3 (60)	0.00	Paed vs. Surg: -65% (−83.84 to −33.71), *P* <.00 Paed vs. Anae: -52% (−81.45 to −13.40), *P* =.01
Suprapubic aspiration	11 (16)	7 (14)	2 (18)	2 (40)	0.47	
Imaging studies						
MRI	39 (58)	28 (55)	7 (64)	4 (80)	0.28	
TTE	21 (31)	18 (35)	1 (9)	2 (40)	0.24	
CT	18 (27)	10 (20)	4 (36)	4 (80)	0.02	Paed vs. Anae: −60% (−80.29 to −14.89), *P* =.01
Other	13 (19)	9 (18)	4 (36)	0	0.01	Paed vs. Surg: -24% (−53.97 to 0.36), *P* =.04
Routine sedation						
	Total n	**Paediatricians n (%)[a]**	**Paediatric surgeons n (%)[a]**	**Anaesthesiologists n (%)[a]**	**Chi-squared test for difference between groups**	**Difference (95% CI) and *P*-value[c]**
Number of responses	29	25 (86)	3 (10)	1 (3)		
Painful procedures						
	Total n (%)[b]	**Paediatricians n (%)[b]**	**Paediatric surgeons n (%)[b]**	**Anaesthesiologists n (%)[b]**	**Chi-squared test for difference between groups**	**Difference (95% CI) and *P*-value[c]**
Lumbar puncture	12 (41)	12 (48)	0	0	0.164	
Intra-articular injection	11 (38)	10 (40)	1 (33)	0	0.688	
Intra-arterious cannulation	4 (14)	4 (16)	0	0	1.00	
Wound stitching	2 (7)	2 (8)	0	0	1.00	
Fracture reposition	7 (24)	4 (16)	3 (100)	0	0.023	Paed vs. Surg: −83% (−93.42 to −23.59), *P* =.006

(Continues)

TABLE 1 (Continued)

Painful procedures

	Total n (%)[b]	Paediatricians n (%)[b]	Paediatric surgeons n (%)[b]	Anaesthesiologists n (%)[b]	Chi-squared test for difference between groups	Difference (95% CI) and *P*-value[c]
Imaging studies						
MRI	5 (17)	4 (16)	0	1 (100)	0.254	
CT	3 (10)	2 (8)	0	1 (100)	0.131	

Abbreviations: Anae, anaesthesiologist; CT, computed tomography; MRI, magnetic resonance imaging; Paed, paediatrician; Surg, surgeon; TTE, transthoracic echocardiography.

[a]Number of respondents from each specialty, with the percentage of total respondents they represent in parentheses.

[b]Number of responses, with the percentage of responses they comprise in parentheses column-wise.

[c]*P* values according to the standard normal deviate test.

TABLE 2 Sedative medication used during painful procedures and imaging studies

	Sedative medication used during painful procedures (n = 71)	Sedative medication used during imaging studies (n = 56)
Drug	n (%)	n (%)
Midazolam	57 (80)	34 (61)
Nitrous oxide	44 (62)	1 (2)
Ketamine	37 (52)	14 (25)
Dexmedetomidine	27 (38)	23 (41)
Fentanyl	27 (38)	10 (8)
Propofol	22 (31)	22 (39)
Morphine	22 (31)	3 (5)
Oxycodone	19 (27)	1 (2)
Diazepam	18 (25)	9 (16)
Chloral hydrate	14 (20)	15 (27)
Thiopenthal	7 (10)	12 (21)
Alfentanil	2 (3)	—
Sevoflurane	—	1 (2)

rarely monitored (Table 3). Vital parameters were generally recorded manually in electronic databases (78%) or paper sheets (18%). Pain was assessed with a pain scale according to 8% of the respondents, while none of the respondents reported evaluating the level of sedation with a sedation scale.

Equipment for airway-related adverse events (laryngeal mask 62%; intubation equipment 75%), intravenous cannulation equipment (79%) and adrenaline (72%) were often available in the facilities where sedation was administered (Table 4).

One-fifth of the respondents knew that sedation-related adverse events had occurred in their facility, while one-third did not know whether there had been any adverse events. Adverse events were recorded in individual patients' clinical records in 79% of the cases, and only 39% of the respondents reported recording the adverse events in a hospital database. One-third of the respondents had received specialized education for administering sedative medications, and 23% had undergone training for the management of adverse events.

4 | DISCUSSION

This nationwide survey revealed that although sedative premedication is commonly used, only 23% of the physicians prescribing sedation for minor procedures off-site have been trained to manage potential sedation-related adverse events. Although almost as low numbers have previously been reported by Sauer et al,[15] this raises concerns on patient safety. Regular training and national guidelines could improve the safety of procedural sedation and might reduce the high variation in pre-anaesthetic evaluation, monitoring and follow-up.[16]

Patient monitoring during procedural sedation appears to rely mainly on peripheral oxygen saturation, and only one-third of the respondents reported that heart rate, blood pressure or respiratory rate was being monitored. Sedation guidelines recommend maintenance of physiological homeostasis by monitoring oxygenation, heart rate, ventilation and blood pressure.[12,13] Capnography would provide a very sensitive assessment of respiratory insufficiency,[17] but appears not to be commonly used. None of the respondents reported assessing the level of the sedation with a sedation scale. As a deeper level of sedation correlates with a higher rate of adverse events,[12] it is important to assess the level of sedation routinely and manage it at a level that is suitable for each patient. Limited patient monitoring may lead to situations where milder adverse events or high-risk situations are not detected.

Systematic reporting of the adverse events is not yet a common practice, even though detecting adverse events is a key component for improving the quality of care and patient safety during procedural sedation.[11] Only 39% of the respondent reported recording the adverse events in the hospital database, which would allow systematic evaluation better than recording the events only in patient files. Despite the fact that minority of clinicians had undergone special training for the management of adverse events, the equipment for resolving adverse respiratory outcomes (suction, supplemental oxygen, ventilation equipment, etc) and adrenaline were commonly, but not always, available in the facilities in which sedation was performed.

The sedation protocols varied across different units. With regard to the fasting protocol, either the patients were not required to fast at all, or they were required to fast for at least 4 hours. When anaesthesiologists were responsible for sedating the patient, most of the patients were requested to fast before sedation and had predetermined

TABLE 3 Fasting prior to procedural sedation and patient monitoring during sedation

Duration of fasting prior to sedation for elective procedures				
	All n	**Paediatricians n (%)[a]**	**Paediatric surgeons n (%)[a]**	**Anaesthesiologists n (%)[a]**
Number of responses	57	41 (72)	10 (18)	6 (11)
	All n (%)[b]	Paediatricians n (%)[b]	Paediatric surgeons n (%)[b]	Anaesthesiologists n (%)[b]
No fasting	20 (43)	13 (32)	7 (70)	—
1-2 h	4 (9)	4 (10)	—	—
2-4 h	3 (6)	3 (7)	—	—
More than 4 h	30 (64)	21 (51)	3 (30)	6 (100)
Duration of fasting prior to sedation for emergency procedures				
	All n	**Paediatricians n (%)[a]**	**Paediatric surgeons n (%)[a]**	**Anaesthesiologists n (%)[a]**
Number of responses	52	37 (71)	10 (19)	5 (10)
	All n (%)[b]	Paediatricians n (%)[b]	Paediatric surgeons n (%)[b]	Anaesthesiologists n (%)[b]
No fasting	37 (71)	27 (73)	8 (80)	2 (40)
1-2 h	1 (2)	1 (3)	—	—
2-4 h	—	—	—	—
More than 4 h	14 (27)	9 (24)	2 (20)	3 (60)
Monitoring during sedation				
	All n	**Paediatricians n (%)[a]**	**Paediatric surgeons n (%)[a]**	**Anaesthesiologists n (%)[a]**
Number of responses	71	53 (75)	12 (17)	6 (8)
	All n (%)[b]	Paediatricians n (%)[b]	Paediatric surgeons n (%)[b]	Anaesthesiologists n (%)[b]
Peripheral oxygen saturation by pulse oximetry	53 (75)	39 (74)	9 (75)	5 (83)
Heart rate by pulse oximetry	41 (58)	30 (57)	9 (75)	2 (33)
Heart rate by ECG	20 (28)	17 (32)	2 (17)	1 (17)
Blood pressure	28 (39)	23 (43)	5 (42)	0 (0)
Manually measured respiratory rate	24 (34)	18 (34)	3 (25)	3 (50)
Respiratory rate by capnography	3 (4)	1 (2)	1 (8)	1 (17)
Other physiologic parameters	2 (3)	1 (2)	1 (8)	0 (0)
Sedation scale	0 (0)	0 (0)	0 (0)	0 (0)
Pain scale	5 (7)	4 (8)	0 (0)	1 (17)
Not followed	8 (11)	7 (13)	0 (0)	1 (17)

Abbreviation: ECG, electrocardiography.

[a] Number of respondents from each specialty, with the percentage of total respondents they represent in parentheses.

[b] Number of responses, with the percentage of total responses they comprise in parentheses column-wise.

discharge criteria, while other specialists appeared less strict in these precautions. The guidelines for paediatric sedation recommend fasting before procedural sedation for preventing pulmonary aspiration,[12,13] although some evidence indicates that routine fasting before sedation might not be necessary to prevent vomiting and aspiration.[18]

Procedural sedation was most often provided during procedures that either require good co-operation (eg MRI) or are painful (eg lumbar puncture, intra-articular injections). Procedural sedation in an outpatient clinic instead of general anaesthesia in the operation room can be both cost-effective and successful.[19] Sedation for wound stitching or fracture reposition was rarely reported in our survey, which may reflect the common use of local anaesthesia in these procedures, as well as the low number of paediatric surgeons and lack of emergency medicine physicians among the respondents.

TABLE 4 Rescue equipment available at the sedation facilities

Rescue equipment available for sedating paediatric patients				
	All n	**Paediatricians n (%)[a]**	**Paediatric surgeons n (%)[a]**	**Anaesthesiologists n (%)**
Number of responses	61	45 (74)	10 (16)	6 (10)
	All n (%)[b]	Paediatricians n (%)[b]	Paediatric surgeons n (%)[b]	Anaesthesiologists n (%)[b]
Suction	56 (92)	43 (96)	7 (70)	6 (100)
Supplemental oxygen	60 (98)	45 (100)	9 (90)	6 (100)
Ventilation equipment	56 (92)	42 (93)	8 (80)	6 (100)
Oro-pharyngeal tube	49 (80)	36 (80)	7 (70)	6 (100)
Laryngeal mask	38 (62)	26 (58)	6 (60)	6 (100)
Intubation equipment	42 (75)	30 (70)	6 (60)	6 (100)
Intravenous cannula	48 (79)	36 (84)	6 (60)	6 (100)
Intraosseal cannulation equipment	25 (41)	20 (47)	2 (20)	3 (50)
Defibrillator	23 (38)	18 (42)	3 (30)	2 (33)
Medication				
Adrenaline	44 (72)	34 (79)	4 (40)	6 (100)
Sedative medication for intubation	27 (44)	20 (47)	3 (30)	4 (67)
Naloxone	19 (31)	13 (30)	2 (20)	4 (67)
Flumazenil	15 (25)	10 (23)	1 (10)	4 (67)

[a]Number of respondents from each specialty, with the percentage of total respondents they represent in parentheses.
[b]Number of responses, with the percentage of total response they comprise in parentheses column-wise.

However, the finding differed from a recent survey performed in emergency departments in the Netherlands, in which wound management, fractures and joint dislocations were the most common indications for paediatric procedural sedation.[20]

Midazolam was the most popular sedative in our survey, and as per published reports, it appears to be in widespread use for paediatric sedation around Europe.[15,20] Propofol and thiopental were more commonly prescribed by anaesthesiologists, reflecting the current recommendations of the European Society of Anaesthesiology.[8] However, there were also several paediatricians who reported the use of propofol for procedural sedation; which highlights the importance of adequate training for all physicians who perform sedation in paediatric patients. Different sedative medications have different adverse effects,[21,22] but once proper precautions are taken, the speciality of the administering personnel does not have an impact on the adverse event rates.[9,23]

Our study has limitations that need to be addressed. *First*, the exact number of questionnaires sent could not be reliably assessed and, thus, the response rate could not be determined. However, we managed to ensure nationwide coverage of responses and received responses from university hospitals and central hospitals, as well as from the private sector, so we believe our results reliably present the current national practices in Finland. Additionally, the number of respondents is comparable to that of previously published surveys assessing paediatric procedural sedation.[15,20] *Second*, the number of anaesthesiologists and paediatric surgeons responding to the survey was significantly lower than the number of paediatricians. However, as surgeons and anaesthesiologists mainly work at operation rooms and intensive care units, we believe that our results reliably correspond to current off-site sedation practices. *Third*, as all the questions in the questionnaire were not mandatory, some of the questions received fewer responses. Unfortunately, it is not clear whether the questions were not answered because they were considered irrelevant to the unit by the participant or for some other reason. However, all the respondents proceeded to the last page of the questionnaire, so we assumed that they had completed the survey. The responses were analysed as a percentage of the total responses to each of the questions. As a result, the responses to questions for which it was not possible to give a null answer and questions with a low response rate might have been overestimated.

In conclusion, off-site procedural sedation appears to be common in paediatric care, but only one-third of the doctors providing sedation have undergone special training. Paediatric procedural sedation, patient monitoring and managing the adverse events should be included as a distinct entity in the curriculum for all who perform procedures in children. National guidelines for paediatric patient monitoring during sedation and regular training of personnel could improve treatment quality and patient safety.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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