



ORIGINAL ARTICLE

Efficacy, safety and satisfaction of sedation-analgesia in Spanish emergency departments^{☆,☆☆}

Concepción Míguez Navarro, Niki Oikonomopoulou^{*}, Arístides Rivas García, Andrea Mora Capín, Gloria Guerrero Márquez, on behalf of the Analgesia and Sedation Group of the Spanish Society of Pediatric Emergencies¹, Concepción Míguez Navarro^{aa}, Niki Oikonomopoulou^{aa}, Arístides Rivas García^{aa}, Andrea Mora Capín^{aa}, Gloria Guerrero Márquez^{aa}, Ana Isabel Fernández Lorente^{ab}, Pilar Storch de Gracia Calvo^{ac}, Eva Benito Ruiz^{ad}, Elena Sancho Gracia^{ad}, Olga Serrano Ayestarán^{ae}, Cecilio Palomino Muñoz^{af}, Cristina Cordero Castro^{ag}, Sofía Mesa García^{ah}, Cristina Muñoz López^{ai}, Nuria Clerigué Arrieta^{aj}, Jorge Álvarez García^{aj}, Isabel Cubero^{ak}, José Luis Fernández Arribas^{al}, Alberto Barasoain Millán^{am}, Juan Alonso Cozar Olmo^{an}, José Luis Cuevas Cervera^{an}, Carlos García Vao Bel^{ao}, M. José Carbonero Celís^{ap}, M. José Carpio Linde^{ap}, M. Teresa Alonso Salas^{aq}

Servicio de Urgencias Pediátricas, Hospital General Universitario Gregorio Marañón, Madrid, Spain^{aa} Paediatric Emergency Department, Hospital General Universitario Gregorio Marañón, Madrid

^{ab} *Paediatric Emergency Department, Hospital General de Basurto, Basurto*

^{ac} *Paediatric Emergency Department, Hospital Infantil Niño Jesús, Madrid*

^{ad} *Paediatric Emergency Department, Hospital Infantil Miguel Servet, Zaragoza*

^{ae} *Paediatric Emergency Department, Hospital de Salamanca, Salamanca*

^{af} *Paediatric Emergency Department, Hospital Rey Juan Carlos, Mostoles*

^{ag} *Paediatric Emergency Department, Hospital de Getafe, Getafe*

^{ah} *Paediatric Emergency Department, H. Doce de Octubre, Madrid*

^{ai} *Paediatric Emergency Department, Hospital Infanta Leonor, Madrid*

^{aj} *Paediatric Emergency Department, Complejo Hospitalario de Navarra B, Navarra*

[☆] Please cite this article as: Míguez Navarro C, Oikonomopoulou N, Rivas García A, Mora Capín A, Guerrero Márquez G, en representación del Grupo de Analgesia y Sedación de la Sociedad Española de Urgencias de Pediatría. Eficacia, seguridad y satisfacción de los procedimientos de sedoanalgesia en las urgencias españolas. An Pediatr (Barc). 2019;90:32–41.

^{☆☆} *Previous presentations:* the findings of this study were presented under the title *Eficacia, seguridad y satisfacción de los procedimientos de sedoanalgesia en los servicios de urgencias pediátricos españoles* (Niki Oikonomopoulou, Concepción Míguez, Arístides Rivas [Hospital General Universitario Gregorio Marañón, Madrid], Working Group on Analgesia and Sedation of the Sociedad Española de Urgencias de Pediatría: Ana Isabel Fernández, Pilar Storch, Gloria Guerrero, Eva Benito and Elena Sancho, Olga Serrano, Cristina Cordero, Cecilio Palomino, Sofía Mesa, Cristina Muñoz, Nuria Clerigué and Jorge Álvarez García, Isabel Cubero, José L Fernández, Alberto Barasoain, Juan Alonso Cozar and José Luis Cuevas, Clara García y Carlos García Vao, M. José Carbonero and M. José Carpio Linde, M. Teresa Alonso, Vicente Barea) at the 21 Annual Meeting of the Sociedad Española de Urgencias de Pediatría, April 14–16, 2016; Valencia, Spain.

^{*} Corresponding author.

E-mail address: nik.oik87@gmail.com (N. Oikonomopoulou).

¹ Appendix A lists all the authors of the article.

^{ak} Paediatric Emergency Department, Hospital Clínico San Cecilio, Granada

^{al} Paediatric Emergency Department, Hospital Río Hortega, Valladolid

^{am} Paediatric Emergency Department, Fundación Alcorcón, Alcorcon

^{an} Paediatric Emergency Department, Hospital San Agustín, Linares

^{ao} Paediatric Emergency Department, Hospital del Tajo, Aranjuez

^{ap} Paediatric Emergency Department, Hospital Virgen de la Macarena, Seville

^{aq} Paediatric Emergency Department, Hospital Virgen del Rocío, Seville

Received 1 November 2017; accepted 10 March 2018

Available online 30 November 2018

KEYWORDS

Sedation-analgesia procedure;
Adverse drug reactions;
Effectiveness;
Parental satisfaction

Abstract:

Objectives: To offer analgesia and sedation should be a priority in paediatric emergency departments. The aim of this study was to determine the effectiveness and safety of the sedation-analgesia procedure, as well as the satisfaction of the doctors, patients and parents. **Methods:** A multicentre, observational, and prospective analytical study was conducted on the sedation-analgesia procedure performed on children younger than 18 years old in 18 paediatric emergency departments in Spain from February 2015 until January 2016.

Results: A total of 658 procedures were recorded. The effectiveness was good in 483 cases (76.1%; 95% CI: 72.7–79.4%), partial in 138 (21.7%; 95% CI: 18.5–24.9%), and poor in 14 (2.2%; 95% CI: 1.1–3.4). The effectiveness was better when the doctor in charge was an emergency paediatrician (OR: 3.14; 95% CI: 1.10–8.95), and when a deeper level of sedation was achieved (OR: 2.37; 95% CI: 1.68–3.35). Fifty two children (8.4%) developed adverse drug reactions, more usually gastrointestinal, neurological or respiratory ones (89.9% were resolved in <2 h). One patient was intubated. The older child and a deeper level of sedation were found to be independent risk factors for adverse reactions (OR: 1.18; 95% CI: 1.09–1.28 and OR: 1.86; 95% CI: 1.22–2.83, respectively). Thirteen children (5%) developed late adverse drug reactions, more commonly, dizziness and nausea. A combination of midazolam/ketamine had been used in all the cases (RR: 24.46; 95% CI: 11.78–50.76). The perceived satisfaction level (0–10) was obtained from 604 doctors (mean: 8.54; SD: 1.95), 526 parents (mean: 8.86; SD: 1.49), and 402 children (mean: 8.78; SD: 1.70).

Conclusions: The sedation-analgesia procedure performed in paediatric emergency departments by trained paediatricians seems to be useful, effective and safe, as well as satisfactory for all participants.

© 2017 Asociación Española de Pediatría. Published by Elsevier España, S.L.U. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

PALABRAS CLAVE

Procedimientos de sedoanalgesia;
Eventos adversos;
Eficacia;
Satisfacción parental

Eficacia, seguridad y satisfacción de los procedimientos de sedoanalgesia en las urgencias españolas

Resumen

Objetivos: La sedoanalgesia debe ser una prioridad de los servicios de urgencias pediátricas. Analizamos la eficacia y seguridad de los procedimientos de sedoanalgesia así como la satisfacción del personal, pacientes y padres.

Métodos: Estudio multicéntrico, prospectivo, observacional y analítico de los procedimientos de sedoanalgesia realizados a niños hasta los 18 años en 18 servicios de urgencias entre febrero de 2015 y enero de 2016.

Resultados: Se registraron 658 procedimientos (edad media: 6,8; DE: 4 años). La eficacia fue buena en 483 niños (76,1%; IC 95%: 72,7-79,4%), parcial en 138 (21,7%; IC 95%: 18,5-24,9%) y mala en 14 (2,2%; IC 95%: 1,1-3,4). Se asoció con eficacias mejores la realización por el pediatra de urgencias (OR: 3,14; IC 95%: 1,10-8,95) y un mayor nivel de sedación alcanzado (OR: 2,37; IC 95%: 1,68-3,35). Presentaron eventos adversos precoces 52 (8,4%) niños, siendo los más frecuentes: digestivos, neurológicos y respiratorios (el 89,9% remitieron en <2 h). Un paciente requirió intubación. La mayor edad y la mayor profundidad de sedación fueron factores de

riesgo independientes para presentar eventos adversos (OR: 1,18; IC 95%: 1,09-1,28 y OR: 1,86; IC 95%: 1,22-2,83, respectivamente). Trece niños (5%) presentaron eventos adversos tardíos, siendo el mareo y las náuseas/vómitos los más frecuentes; en todos ellos se usó la combinación midazolam/ketamina (RR: 24,46; IC 95%: 11,78-50,76). Registramos la satisfacción percibida (puntuación de 0-10) de 604 profesionales (media: 8,54, DE: 1,95), de 526 padres (media: 8,86; DE: 1,49) y de 402 niños (media: 8,78; DE: 1,70).

Conclusiones: Los procedimientos de sedoanalgesia realizados por profesionales entrenados en los servicios de urgencias pediátricas españoles resultan útiles, eficaces y seguros, además de satisfactorios para todos los participantes.

© 2017 Asociación Española de Pediatría. Publicado por Elsevier España, S.L.U. Este es un artículo Open Access bajo la licencia CC BY-NC-ND (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Health care professionals in paediatric emergency departments (PEDs) have the duty to treat pain related to either disease and to the pain caused by invasive procedures, safely and efficiently, independently of the age and maturity of the child and the severity of disease, for physiological, moral, humane and ethical reasons.¹

Adequate relief of pain and anxiety in diagnostic and therapeutic procedures is a quality indicator of the care given in PEDs.²

Sedation and analgesia procedures (SAPs) in PEDs are frequently performed by physicians who are not anaesthesiologists and are considered safe and effective.^{2,3} However, it is important to remember that sedatives and analgesics can cause adverse events.^{3,4} For this reason, scientific societies such as the American Academy of Pediatrics (AAP) and the American Society of Anesthesiologists (ASA) have issued guidelines and recommendations on SAPs. These societies consider that these procedures are safe as long as they are performed by physicians that are familiar with the use of these drugs and adequately trained in the identification of complications and basic life support skills.^{2,3}

The success of SAPs can be assessed by considering their efficacy (completing a procedure without the patient having a bad experience or unpleasant memories from it), safety (adverse events) and the level of satisfaction expressed by the patients, the families and the health care providers that delivered sedation/analgesia.

Objective

Our main goal was to analyse the efficacy and safety of SAPs. Our secondary objective was to assess the satisfaction of health care staff, patients and parents and to identify the factors associated with adverse events.

Materials and methods

We conducted a multicentre prospective observational and inferential study of SAPs performed in Spanish PEDs.

The study was approved by the competent ethics and research boards of each participating centre, in adherence with the Declaration of Helsinki. All participating centres

requested a study classification according to the scheme of the Agencia Española de Medicamentos y Productos Sanitarios (Spanish Agency of Medicines and Medical Devices) of EPA-SP (post-authorisation observational prospective follow-up study).

We obtained the informed consent of the parents and/or legal guardians of all patients that participated in the study.

Study sample and setting

We conducted the study in 18 PEDs between February 1, 2015 and January 31, 2016. Participating hospitals belonged to the Working Group on Analgesia and Sedation of the Sociedad Española de Urgencias de Pediatría (Spanish Society of Paediatric Emergency Medicine).

We selected children that underwent some type of SAP with a dissociative anaesthetic, sedative and/or analgesic. We excluded patients that had only received a topical or local anaesthetic.

The inclusion criteria were age 18 years and informed consent for participation by the parents or legal guardians or, if the patient was mature enough, the patient.

All the selected patients met the inclusion criteria, and none were excluded from the study.

Data collection

A data collection notebook was filled out for each patient. Each hospital assigned a code to each of those notebooks using an alphanumeric sequence to safeguard patient confidentiality.

Every month, the researcher in each hospital submitted the collected data electronically to the principal investigator.

We collected epidemiological variables, patient-related variables (ASA physical classification, fasting, physical examination), technical variables (reason for sedation/analgesia, type of procedure, monitoring, pharmacological strategy, provider in charge, informed consent and parental presence), efficacy and safety of the procedure (early and late adverse events) and participant level of satisfaction.

Definitions

Type of analgesia or sedation procedure: (1) simple analgesia (administration of analgesics with the aim of preventing pain from a painful stimulus); (2) sedation (administration of sedatives/hypnotics with the aim of decreasing the level of consciousness and activity of the patient to a variable degree); (3) sedation and analgesia (administration of sedatives combined with analgesics or dissociative agents to induce a state that allows the patient to endure unpleasant procedures). This includes sedation/analgesia for mildly painful through very painful procedures.⁴

Pharmacological strategy: use of 1 drug or a combination of 2 or more drugs.

Depth of sedation: depth of sedation categorised as defined by the ASA into minimal sedation, moderate sedation, deep sedation and general anaesthesia.³

Outcome measures

We defined the effectiveness of sedation as the creation of conditions necessary to safely facilitate the completion of a procedure.⁵ We considered effectiveness high if the procedure could be completed without resistance from the patient or the patient developing unpleasant memories, moderate if there was a certain level of unexpected pain or anxiety but the procedure was completed, and low if the procedure had to be abandoned or the patient reported having a bad experience.

We defined safe procedure as one where the number and severity of adverse events was minimised. Early adverse events were those that developed in the first 2 h since performance of the SAP⁵ and late adverse events those that developed in the following 24 h. To find the incidence of the latter, we made a phone call in the subsequent 48 h to the parents/legal guardians of the patient.

We defined adverse events based on the classification of Pediatric Emergency Research Canada (PERC) and the Pediatric Emergency Care Applied Research Network (PECARN) consensus.⁵

We assessed the satisfaction of the participating health care professionals, parents/legal guardians and children on a Likert scale from 0 to 10 points, where 0 points stood for "totally dissatisfied" and 10 points for "totally satisfied".

Statistical analysis

We analysed the collected data with the software SPSS version 21.0.

We have expressed categorical variables as absolute frequencies and percentages.

We have expressed quantitative variables with a symmetrical distribution as mean and standard deviation, and those with an asymmetrical distribution as median and interquartile range (IQR). We developed univariate and multivariate logistic regression models to analyse the association between risk factors, effectiveness and safety. To measure the strength of the association, we calculated the odds ratio (OR) or the relative risk (RR) with their corresponding 95% confidence intervals (CIs). We compared early and late adverse events by means of the chi square or the

Fisher exact test. We compared satisfaction scores by means of the Student *t* test or ANOVA.

We defined statistical significance as a *P*-value of less than .05.

Results

We detected 658 SAPs performed in 18 Spanish PEDs. The median age of the patients was 6 years (IQR, 3–10 years).

Table 1 presents the characteristics of the sample.

The decision to combine 2 or more drugs seemed to be associated with the type of procedure (simple analgesia, 5.3%; sedation, 19.2%; sedation/analgesia for mildly painful procedures, 29.5%; sedation/analgesia for very painful procedures, 62.1%; $P < .001$), the ASA physical status (I, 43.1%; II, 30.4%; III, 33.3%; IV, 0%; $P = .038$) and the facility ($P = .022$), but not with the type of provider that carried out the procedure (emergency paediatrician, 41.4%; other paediatrician, 40.9%; 3rd–4th year medical intern-resident [MIR], 41.4%; 1st–2nd year MIR, 34.2%; other, 25%; $P = .243$). However, in the multivariate analysis, the only variable that was significantly associated with the choice of pharmacological strategy was the type of procedure ($P < .001$), while the facility was not associated with the choice ($P = .972$).

The effectiveness was assessed for 635 SAPs, and was high in 483 patients (76.1%; 95% CI, 72.7%–79.4%), moderate in 138 (21.7%; 95% CI, 18.5%–24.9%) and low in 14 (2.2%; 95% CI, 1.1%–3.4%).

Table 2 shows the effectiveness outcomes based on patient characteristics and the sedation/analgesia procedures used.

The drugs used most frequently by specialist physicians differed from the drugs used by medical residents, although in the multivariate analysis, only the higher depth of sedation achieved and the presumably greater experience of the provider that delivered the intervention were independently associated with greater effectiveness (Table 3). When it came to the provider performing the intervention, we only found a statistically significant difference in emergency paediatricians, with an OR of 3.14 (95% CI, 1.10–8.95).

A total of 52 children experienced early adverse events, the most frequent of which were neurological, respiratory and gastrointestinal (vomiting and nausea). Most of these adverse reactions (89.8%) resolved within 2 h (Table 4).

We identified age as an independent risk factor for the development of early adverse events, with the number of adverse events increasing with increasing age (median, 9 [IQR, 6–11.75] vs median, 6 [IQR, 3–10]), which was also the case with the depth of sedation (proportion of patients with adverse events: minimal sedation, 5%; moderate sedation, 9.3%; deep sedation, 18%; general anaesthesia, 40%). We found a decreasing trend in the incidence of adverse events associated with the use of nitrous oxide that was nearly statistically significant (Table 5).

Respiratory adverse events consisted of decreases in oxygen saturation, and there were no cases of aspiration of gastric contents. The measures used to manage these events included head repositioning (10 children), bag-valve-mask ventilation (2 children) and tracheal intubation (1 child).

We observed an increased risk of vomiting in children who had fasted longer than 3 h compared to a shorter time (RR,

Table 1 Characteristics of the patients and of the sedation and analgesia procedures.

	<i>n</i> (%)
Physical examination: documented in 652 patients (99%)	
Normal	610 (93.6)
Potential risk of complications	3 (0.5)
ASA physical status: documented in 593 patients (90%)	
I	529 (80.4)
II	56 (8.5)
III	6 (0.9)
IV	2 (0.3)
Fasting: documented in 538 patients (81%)	
< 1 h	30 (4.6)
1–2 h	208 (31.6)
2–3 h	16 (2.4)
3–4 h	81 (12.3)
4–6 h	94 (14.3)
>6 h	109 (16.6)
Reason for sedation/analgesia	
Trauma-related procedures	236 (35.9)
Surgical procedures	187 (28.4)
Medical procedures	124 (18.8)
Nursing procedures	86 (13.1)
Imaging test	14 (2.1)
Other	11 (1.6)
Type of procedure	
Simple analgesia	57 (8.7)
Anxiolysis/sedation	44 (6.7)
SA for mildly painful procedure	275 (41.8)
SA for very painful procedure	282 (42.9)
Monitoring	
No monitoring	178 (27.1)
Pulse oximetry	460 (69.9)
Intermittent HR/BP monitoring	127 (19.3)
Cardiac monitoring	94 (14.3)
Antidote preparation	58 (8.8)
Supplemental oxygen from beginning	35 (5.3)
Capnography	21 (3.9)
Provider performing sedation/analgesia	
Emergency paediatrician	423 (64.3)
Non-emergency paediatrician	44 (6.7)
3 rd –4 th year resident physician	133 (20.2)
1 st –2 nd year resident physician	38 (5.8)
Other	20 (3.0)
Pharmacological strategy	
1 Drug	392 (59.6)
Nitrous oxide 50%	225 (57.4)
Ketamine	20 (5.1)
Midazolam	61 (15.6)
Fentanyl	54 (13.8)
Morphine	24 (6.1)
Propofol	1 (0.3)
Other	7 (1.8)

Table 1 (Continued)

	<i>n</i> (%)
Drug combination	
Midazolam + ketamine	162 (60.9)
Fentanyl + nitrous oxide	47 (17.7)
Midazolam + fentanyl	32 (12.0)
Morphine + nitrous oxide	7 (2.6)
Ketamine + fentanyl	3 (1.1)
Other	6 (2.3)
Combination of 3 or more drugs	9 (3.4)
Informed consent request	
Verbal	205 (31.2)
Written	444 (67.5)
Not requested	9 (1.4)
Parental presence during procedure	
No	306 (46.5)
Yes	352 (53.5)

ASA, American Society of Anesthesiologists; BP, blood pressure; HR, heart rate; SA, sedation/analgesia.

Results expressed as absolute frequencies and percentages.

1.63; 95% CI, 1.27–2.08). There were no cases of vomiting in children who had fasted for less than 2 h.

We received reports of 13 late adverse events (5.0%; 95% CI, 2.4%–5.7%), the most frequent of which were dizziness, nausea/vomiting and somnolence (Table 4). All these patients had received a combination of midazolam/ketamine, which corresponded to a probability of 24.46% of adverse events using this combination (95% CI, 11.78%–50.76%).

We analysed whether children that developed late adverse events also experienced early ones, and found no association between the two ($P = .345$).

A total of 185 children (28.1%) required hospital admission, in 1.7% of these cases, it was due to the adverse event secondary to the SAP.

The satisfaction of the professionals that performed the SAPs was assessed in 604 cases (91.7%), and the mean score was 8.54 (SD, 1.95); parental satisfaction was assessed in 526 (80%), with a mean score of 8.86 (SD, 1.49) and patient satisfaction in 402 (61%), with a mean score of 8.78 (SD, 1.70).

We analysed the association between the level of satisfaction and effectiveness, and found higher satisfaction scores in providers, parents/guardians and patients when effectiveness was high compared to when effectiveness was moderate or low ($P < .001$). Furthermore, we found statistically significant differences in satisfaction based on the indication for sedation and analgesia ($P < .001$), with parents giving better ratings to sedation and analgesia for nursing procedures (mean: 9.23; SD: 1.2) and children worse ratings to trauma-related procedures (mean: 8.61; SD: 1.63).

We did not find significant differences based on the presence or absence of adverse events or the type of professional that carried out the SAP (Table 6).

Table 2 Effectiveness of sedation/analgesia by patient characteristics and type of procedure.

	High		Moderate		Low		Not assessed		Total
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>
<i>Anxiety</i>									
Gronninger 1	118	77.1	28	18.3	2	1.3	5	3.3	153
Gronninger 2	125	73.5	38	22.4	3	1.8	4	2.4	170
Gronninger 3	85	64.9	37	28.2	3	2.3	6	4.6	131
Gronninger 4	95	78.5	17	14.0	3	2.3	6	5.0	121
Gronninger 5	24	72.7	6	18.2	1	3.0	2	6.1	33
Not assessed	36	72.0	12	24.0	2	4.0	0	0.0	50
<i>Pharmacological strategy</i>									
2 or more drugs	207	77.8	42	15.8	6	2.3	11	4.1	266
1 drug	276	70.4	96	24.5	8	2.0	12	3.1	392
<i>Provider</i>									
Emergency paediatrician	340	80.4	67	15.8	8	1.9	8	1.9	423
Other paediatrician	30	68.2	13	29.5	1	2.3	0	0	44
MIR 3–4	78	58.6	39	29.3	5	3.8	11	8.3	133
MIR 1–2	26	68.4	11	28.9	0	0	1	2.6	38
Other	9	45	8	40	0	0	3	15	20
<i>ASA physical status</i>									
I	392	74.1	104	19.7	14	2.6	19	3.6	529
II	47	83.9	7	12.5	0	0	2	3.6	56
III	2	33.3	3	50	0	0	1	16.7	6
IV	2	100	0	0	0	0	0	0	2
V	0	0	0	0	0	0	0	0	0
Not assessed	40	61.5	24	36.9	0	0	1	1.5	65
<i>Type of procedure</i>									
Simple analgesia	39	68.4	18	31.6	0	0	0	0	57
Sedation	29	65.9	12	27.3	1	2.3	2	4.5	44
SA, mildly painful procedure	208	75.6	50	18.2	8	2.9	9	3.3	275
SA, very painful procedure	207	73.4	58	20.6	5	1.8	12	4.3	282
<i>Depth of sedation</i>									
Minimal sedation	257	67.8	104	27.4	10	2.6	8	2.1	379
Moderate sedation	125	83.3	19	12.7	2	1.3	4	2.7	150
Deep sedation	81	91	6	6.7	1	1.1	1	1.1	89
General anaesthesia	5	100	0	0	0	0	0	0	5
Not documented	15	42.9	9	25.7	1	2.9	10	28.6	35

ASA, American Society of Anesthesiologists; MIR, medical intern-resident; SA, sedation/analgesia. Results expressed as absolute frequencies and percentages.

Discussion

The effectiveness of SAPs depends on the adequate use of analgesics and/or sedatives.⁶ In our study, the effectiveness of SAP was high in two thirds of the patients, and low in only a very few cases.

Some studies have found an association between age and a decreased efficacy, as fear of adverse events may lead to underdosing in younger patients.⁷ In our study, we did not find differences in effectiveness based on age.

Emergency paediatricians achieved a higher effectiveness compared to resident physicians or other providers. This may be due to the emergency paediatricians having more experience on this area. Among other requirements, current guidelines recommend that non-anaesthesiologists performing SAPs receive specific training on and be

well acquainted with the pharmacology of sedatives and analgesics.^{3,8,9}

We found that some SAPs were performed by first- and second-year medical residents who used drugs, alone or in combination, that could produce serious adverse events. This practice contravenes international guidelines, which recommend that any provider performing SAPs must be knowledgeable of the drugs and have the skills to rescue patients whose level of sedation becomes deeper than initially intended and to identify and manage complications.^{3,8} For this reason, certain providers should not be performing SAPs without the supervision of professionals with specialised training.

Some procedures are potentially more painful than others, but we did not find any differences in effectiveness based on the reason for using sedation/analgesia. A possible

Table 3 Association of different factors with the effectiveness of the sedation/analgesia procedure in the univariate and multivariate analyses.

	Univariate			Multivariate		
	P	OR	(95% CI)	P	OR	(95% CI)
Age	.072	1.04	(1.00–1.09)			
Anticipatory anxiety	.985	1.00	(0.85–1.17)			
Pharmacological strategy (2 or more drugs)	.014	1.63	(1.10–2.40)	.119	0.67	(0.41–1.11)
Type of provider	<.001	1.42	(1.22–1.66)	<.001	1.35	(1.15–1.58)
Emergency paediatrician	.006	4.03	(1.51–10.79)	.032	3.14	(1.10–8.95)
ASA physical status	.481	1.22	(0.70–2.14)			
Type of procedure	.104	1.13	(0.98–1.31)			
Depth of sedation	<.001	2.43	(1.74–3.41)	<.001	2.37	(1.68–3.35)
Midazolam	.750	0.94	(0.65–1.37)			
Ketamine	<.001	3.90	(2.30–6.60)	.203	1.66	(0.76–3.60)
Fentanyl	.062	0.66	(0.43–1.02)			
Morphine	.304	0.69	(0.34–1.40)			
Nitrous oxide	.813	1.05	(0.72–1.51)			

ASA, American Society of Anesthesiologists.

We measured the strength of the association by means of the odds ratio (OR) with the corresponding 95% confidence interval (CI). We present statistically significant results in boldface.

Table 4 Early and late adverse events associated with sedation and analgesia.

	n (%)
Early (assessed in 658 children)	52 (7.9)
Neurologic/change in behaviour	21 (40.4)
Dizziness/vertigo	12 (57.1)
Agitation	4 (19.0)
Excitatory movements (myoclonus, muscle rigidity)	2 (9.5)
Paradoxical response	2 (9.5)
Unpleasant reaction during recovery	1 (4.8)
Respiratory	16 (30.8)
Hypoxia	7 (43.8)
Central apnoea	4 (25.0)
Total or partial obstructive apnoea	3 (18.8)
Other	2 (12.5)
Gastrointestinal	15 (28.8)
Nausea	6 (40.0)
Vomiting	9 (60.0)
Permanent sequelae (neurologic impairment/death)	0 (0)
Late (assessed in 258 children)	13 (5.0)
Dizziness/vertigo	3 (23.0)
Somnolence	2 (15.4)
Nausea/vomiting	2 (15.4)
Hallucinations	1 (7.7)
Other (dry mouth, difficult urination, asthenia)	5 (38.5)

Results expressed as absolute frequencies and percentages.

explanation is that the choice of a specific pharmacological strategy depends on multiple factors, and not only on the indication for sedation/analgesia, such as age, the intrinsic characteristics of the patient, the expected level of pain,

the type of SAP, the duration of the diagnostic or therapeutic procedure to be performed and the expertise of the provider performing the SAP.¹⁰

The selected pharmacological strategy did not vary based on the type of provider delivering sedation/analgesia nor the age of the patient; we only found differences based on the type of SAP, which may suggest the presence of protocols that establish to a varying degree which drugs are used depending on the type of SAP.

Although we found no differences in effectiveness based on the chosen pharmacological strategy, the univariate analysis suggested that effectiveness improved with the use of ketamine. Ketamine is widely used in PEDs because it provides sedation and analgesia effectively and safely without compromising the protective reflexes of the airways.^{11–13}

In our study, we found a proportion of early adverse events of 7.9%. The incidence in other studies has ranged from the 2.3% reported by Pena and Krauss¹⁴ to the 17% reported by Roback et al.,⁷ Pitetti et al.¹⁵ or Wenzel and Schweitzer.¹⁶ These differences may be due to differences in the definitions of complications. Pena and Krauss¹⁴ defined hypoxia as an oxygen saturation of 90% or less, while Pitetti et al.¹⁵ used a threshold of 93%. In our study, we defined hypoxia as a decrease in O₂ saturation below 94% lasting more than 15 seconds and requiring supplemental oxygen.⁵

Other studies have tried to identify risk factors for adverse events related to SAPs. Coté et al.¹⁷ identified a few, such as sedation outside the hospital setting, poor monitoring, lack of an adequate evaluation before sedation, medication errors and absence of an independent observer.

In our study, the only factors associated with the incidence of adverse events were age and depth of sedation, with increasing age and increasing depth of sedation correlating to a greater probability of adverse events. Pitetti

Table 5 Association of different factors with the development of early adverse events in the univariate and multivariate analyses.

	Univariate			Multivariate		
	P	OR	(95% CI)	P	OR	(95% CI)
Day of the week	.738	0.95	(0.72–1.26)			
Time	.952	1.01	(0.80–1.26)			
Hours of fasting	.031	1.22	(1.02–1.46)	.252	1.12	(0.92–1.37)
Sex	.229	0.69	(0.37–1.27)			
Age	.003	1.11	(1.04–1.19)	<.001	1.18	(1.09–1.28)
Provider	.882	0.98	(0.77–1.26)			
Type of procedure	.525	1.09	(0.84–1.41)			
Pharmacological strategy (2 or more drugs)	.002	2.54	(1.42–4.55)	.578	1.32	(0.50–3.45)
Depth of sedation	<.001	2.09	(1.50–2.91)	.004	1.86	(1.22–2.83)
ASA physical status	.043	0.63	(0.40–0.99)	.127	0.71	(0.46–1.10)
Midazolam	.004	2.35	(1.32–4.18)	.683	0.84	(0.37–1.94)
Ketamine	<.001	3.25	(1.83–5.78)	.842	0.89	(0.27–2.91)
Fentanyl	.951	1.02	(0.51–2.05)			
Morphine	.512	0.62	(0.14–2.63)			
Nitroso	.002	0.36	(0.18–0.69)	.062	0.45	(0.19–1.04)

ASA, American Society of Anesthesiologists.

We measured the strength of the association by means of the odds ratio (OR) with the corresponding 95% confidence interval (CI). We present statistically significant results in boldface.

Table 6 Satisfaction scores in parents, children and health care providers.

	Parental satisfaction Mean (SD)	Patient satisfaction Mean (SD)	Provider satisfaction Mean (SD)
<i>Effectiveness</i>			
High	9.26 (1.02)	9.30 (0.97)	9.28 (0.99)
Moderate	7.65 (1.68)	6.74 (2.06)	6.61 (1.99)
Low	4.56 (3.09)	4.00 (3.46)	2.00 (1.00)
<i>Indication for sedation/analgesia</i>			
Trauma-related procedure	8.84 (1.3)	8.61 (1.6)	8.58 (1.1)
Surgical procedure	8.87 (1.6)	8.81 (2.0)	8.40 (2.2)
Medical procedure	8.50 (1.8)	8.86 (1.7)	8.45 (2.1)
Nursing procedure	9.23 (1.2)	9.11 (1.3)	8.85 (1.5)
<i>Provider</i>			
Emergency paediatrician	8.97 (1.51)	8.91 (1.75)	8.57 (2.01)
Paediatrics MIR	8.58 (1.51)	8.38 (1.74)	8.20 (2.01)
Non-emergency paediatrician	8.96 (1.51)	8.87 (1.73)	8.47 (2.03)
Nurse	8.82 (1.52)	8.76 (1.75)	8.46 (2.02)
<i>Early adverse event</i>			
Yes	8.77 (1.24)	8.38 (1.84)	7.59 (2.58)
No	8.82 (1.51)	8.73 (1.74)	8.46 (2.00)

MIR, medical intern-resident.

Results expressed as mean and standard deviation (SD).

et al. also observed this correlation with age (mean age in adverse event group, 7.4 vs 6.6 years in group without adverse events; $P = .02$).¹⁵

There is evidence that the risk of adverse events increases with the use of 2 or more analgesics.^{15,17,18} Our data suggested a similar trend in the univariate analysis, but the association was not confirmed by the multivariate analysis.

There were few respiratory adverse events in our patients (<3%), most of which corresponded to decreases in oxygen saturation. This incidence was lower than those reported by Pitetti et al. (14%)¹⁵ and Wenzel and Schweitzer (4.2%).¹⁶

We ought to highlight that most of our patients were monitored by means of pulse oximetry and capnography, a method that allows earlier and more frequent detection of changes in saturation^{19,20} in a small percentage (3%).

The proportion of vomiting as an adverse reaction was low (2%) and inferior to the proportions reported in other case series.^{7,15}

The published evidence has not established a clear association between a short duration of fasting and the development of vomiting.^{21–23} In our study, the risk of vomiting was greater when the duration of fasting exceeded 3 h. The underlying mechanism of this finding is unknown; a possible explanation is that prolonged fasting leads to hypoglycaemia and subsequently to ketosis, which can cause nausea and vomiting. Some recent guidelines recommend consumption of clear fluids with carbohydrates up to 2 h before surgery to prevent dehydration and increases in catabolism.^{21,22,24}

The duration of fasting before a SAP is a controversial subject. Fasting rules are defined in reference to the guidelines of the ASA,² but in emergency care decisions need to be made on a case-by-case basis, weighing the risks of potential vomiting against the benefits of sedation/analgesia taking into account the desired depth of sedation.^{2,22} In agreement with other published series, we did not observe any cases of aspiration of gastric contents.^{7,15,23}

At the time of discharge of a child that has undergone a SAP, it is important to give instructions regarding potential late adverse events and to ensure that an adult is supervising the child. In our study, we found adverse events in 5% of patients (vomiting, dizziness and somnolence), all of whom had received a combination of midazolam and ketamine. Other studies have reported greater proportions of late adverse events (10%–22.4%).^{15,24–27} On the other hand, Wathen et al.²⁵ did not find any differences between the use of ketamine alone and its use in combination with midazolam, while other studies have found an association between a higher incidence of late adverse events and the combined use of ketamine and midazolam²⁶ or of midazolam alone compared to the exclusive use of nitrous oxide²⁷.

The satisfaction of the involved parties (health providers, patients and family members) was another important factor to consider in relation to SAPs. Our scores were highly satisfactory in all groups, improving with increasing effectiveness and varying based on the reason that the SAP was performed.

In most of the studies that we reviewed, parental or patient satisfaction was used as a measure for comparison of 2 pharmacological strategies,^{28–30} but we found no references in the literature that analysed satisfaction in relation to the indication for sedation or analgesia, the type of SAP or the staff performing the procedure.

There are several limitations to our study. Firstly, all participating PEDs belong to the Working Group on Analgesia and Sedation of the Sociedad Española de Urgencias de Pediatría, which may limit the generalisation of our findings to other centres. However, the participating PEDs represented hospitals of different levels of care and in different geographical regions, which in our opinion makes them a group that is quite representative of Spanish PEDs overall. Second, the frequency distribution of SAPs by type of professional was uneven, as most procedures were performed by emergency paediatricians. Last of all, we were only able to investigate the development of late adverse events through a telephone call in 258 children (39% of the

sample), which may have led to underestimation of their incidence.

In conclusion, the use of sedation and analgesia for pain and anxiety relief seems safe and effective, especially when these procedures are performed by trained professionals. Furthermore, its use is associated with a high level of satisfaction in providers as well as patients and their families.

Conflicts of interest

The authors have no conflicts of interest to declare.

Authors.

Concepción Míguez Navarro (Paediatric Emergency Department, Hospital General Universitario Gregorio Marañón, Madrid).

Niki Oikonomopoulou (Paediatric Emergency Department, Hospital General Universitario Gregorio Marañón, Madrid).

Aristides Rivas García (Paediatric Emergency Department, Hospital General Universitario Gregorio Marañón, Madrid).

Andrea Mora Capín (Paediatric Emergency Department, Hospital General Universitario Gregorio Marañón, Madrid).

Gloria Guerrero Márquez (Paediatric Emergency Department, Hospital General Universitario Gregorio Marañón, Madrid).

Ana Isabel Fernández Lorente (Paediatric Emergency Department, Hospital General de Basurto, Basurto).

Pilar Storch de Gracia Calvo (Paediatric Emergency Department, Hospital Infantil Niño Jesús, Madrid).

Eva Benito Ruiz (Paediatric Emergency Department, Hospital Infantil Miguel Servet, Zaragoza).

Elena Sancho Gracia (Paediatric Emergency Department, Hospital Infantil Miguel Servet, Zaragoza).

Olga Serrano Ayestarán (Paediatric Emergency Department, Hospital de Salamanca, Salamanca).

Cristina Cordero Castro (Paediatric Emergency Department, Hospital Rey Juan Carlos, Mostoles).

Cecilio Palomino Muñoz (Paediatric Emergency Department, Hospital de Getafe, Getafe).

Sofía Mesa García (Paediatric Emergency Department, H. Doce de Octubre, Madrid).

Cristina Muñoz López (Paediatric Emergency Department, Hospital Infanta Leonor, Madrid).

Nuria Clerigué Arrieta (Paediatric Emergency Department, Complejo Hospitalario de Navarra B, Navarre).

Jorge Álvarez García (Paediatric Emergency Department, Complejo Hospitalario de Navarra B, Navarre).

Isabel Cubero (Paediatric Emergency Department, Hospital Clínico San Cecilio, Granada).

José Luis Fernández Arribas (Paediatric Emergency Department, Hospital Río Hortega, Valladolid).

Alberto Barasoain Millán (Paediatric Emergency Department, Fundación Alcorcón, Alcorcón).

Juan Alonso Cozar Olmo (Paediatric Emergency Department, Hospital San Agustín, Linares).

José Luis Cuevas Cervera (Paediatric Emergency Department, Hospital San Agustín, Linares).

Carlos García Vao Bel (Paediatric Emergency Department, Hospital del Tajo, Aranjuez).

M. José Carbonero Celis (Paediatric Emergency Department, Hospital Virgen de la Macarena, Seville).

M. José Carpio Linde (Paediatric Emergency Department, Hospital Virgen de la Macarena, Seville).

M. Teresa Alonso Salas (Paediatric Emergency Department, Hospital Virgen del Rocío, Seville).

References

- Godwin SA, Burton JH, Gerardo CJ, Hatten BW, MacE SE, Silvers SM, et al. Clinical policy: procedural sedation and analgesia in the emergency department. *Ann Emerg Med.* 2014;63:247–58.
- Fein JA, Zempsky WT, Cravero JP, Committee on Pediatric Emergency Medicine and Section on Anesthesiology and Pain Medicine; American Academy of Pediatrics. Relief of pain and anxiety in pediatric patients in emergency medical systems. *Pediatrics.* 2012;130:1391–405.
- Gross JB, Bailey PL, Connis RT, Coté CJ, Davis FG, Epstein BS, et al., American Society of Anesthesiologists Task Force on Sedation and Analgesia by non anesthesiologists. Practice Guidelines for sedation and analgesia by non anesthesiologists. *Anesthesiology.* 2002;96:1004–17.
- Krauss B, Green SM. Sedation and analgesia for procedures in children. *N Engl J Med.* 2000;342:938–45.
- Bhatt M, Kennedy RM, Osmond MH, Krauss B, McAllister JD, Ansermino JM, et al. Consensus Panel on Sedation Research of Pediatric Emergency Research Canada (PERC) and the Pediatric Emergency Care Applied Research Network (PECARN) Consensus-based recommendations for standardizing terminology and reporting adverse events for emergency department procedural sedation and analgesia in children. *Ann Emerg Med.* 2009;53:426–35.
- Borker A, Ambulkar I, Gopal R, Advani SH. Safe and efficacious use of procedural sedation and analgesia by non-anesthesiologists in a pediatric hematology-oncology unit. *Indian Pediatr.* 2006;43:309–14.
- Roback MG, Wathen JE, Bajaj L, Bothner JP. Adverse events associated with procedural sedation and analgesia in a pediatric emergency department: a comparison of common parenteral drugs. *Acad Emerg Med.* 2005;12:508–13.
- Coté CJ, Wilson S, American Academy of Pediatrics, American Academy of Pediatric Dentistry. Guidelines for monitoring and management of pediatric patients before, during, and after sedation for diagnostic and therapeutic procedures: update 2016. *Pediatrics.* 2016;138:e20161212.
- Sury M, Bullock I, Rabar S, Demott K. Sedation for diagnostic and therapeutic procedures in children and young people: summary of NICE guidance. *BMJ.* 2010;341:c6819.
- Aldecoa V, Baraibar R, Sociedad Española de Urgencias de Pediatría. Óxido nitroso. In: *Manual de analgesia y sedación en Urgencias de Pediatría.* 11.ª ed Madrid: Ergon; 2006. p. 140–5.
- Craven R. Ketamine. *Anaesthesia.* 2007;62 Suppl. 1:48–53.
- Hartling L, Milne A, Foisy M, Lang ES, Sinclair D, Klassen TP, et al. What works and what's safe in pediatric emergency procedural sedation: an overview of reviews. *Acad Emerg Med.* 2016;23:519–30.
- Grunwell JR, Travers C, McCracken CE, Scherrer PD, Stormorken AG, Chumpitazi CE, et al. Procedural sedation outside of the operating room using ketamine in 22,645 children: a report from the Pediatric Sedation Research Consortium. *Pediatr Crit Care Med.* 2016;17:1109–16.
- Pena BM, Krauss B. Adverse events of procedural sedation and analgesia in a pediatric emergency department. *Ann Emerg Med.* 1999;34:483–91.
- Pitetti RD, Singh S, Pierce MC. Safe and efficacious use of procedural sedation and analgesia by nonanesthesiologists in a pediatric emergency department. *Arch Pediatr Adolesc Med.* 2003;157:1090–6.
- Wenzel-Smith G, Schweitzer B. Safety and efficiency of procedural sedation and analgesia (PSA) conducted by medical officers in a level 1 hospital in Cape Town. *S Afr Med J.* 2011;101:895–8.
- Coté CJ, Karl HW, Notterman DA, Weinberg JA, McCloskey C. Adverse sedation events in pediatrics: analysis of medications used for sedation. *Pediatrics.* 2000;106:633–44.
- Hoffman GM, Nowakowski R, Troshynski TJ, Berens RJ, Weisman SJ. Risk reduction in pediatric procedural sedation by application of an American Academy of Pediatrics/American Society of Anesthesiologists process mode. *Pediatrics.* 2002;109:236–43.
- Mora Capin A, Míguez Navarro C, López López R, Marañón Pardo R. Utilidad de la capnografía en la monitorización durante procedimientos de sedoanalgesia. Influencia de la administración de oxígeno en los parámetros monitorizados. *An Pediatr (Barc).* 2014;80:41–6.
- Deitch K, Miner J, Chudnofsky CR, Dominici P, Latta D. Does end tidal CO₂ monitoring during emergency department procedural sedation and analgesia with propofol decrease the incidence of hypoxic events? A randomized, controlled trial. *Ann Emerg Med.* 2010;55:258–64.
- Agrawal D, Manzi SF, Gupta R, Krauss B. Preprocedural fasting state and adverse events in children undergoing procedural sedation and analgesia in a pediatric emergency department. *Ann Emerg Med.* 2003;42:636–46.
- Preisberga KMD. A child needs sedation: when is it ok? *Medscape.* 2013:1–6.
- Cravero JP, Beach M, Blike GT, Gallagher SM, Hertzog JH. Incidence and nature of adverse events during pediatric sedation/anesthesia for procedures outside the operating room: report from the Pediatric Sedation Research Consortium. *Pediatrics.* 2006;118:1087–96.
- Newman DH, Azer MM, Pitetti RD, Singh S. When is a patient safe for discharge after procedural sedation? The timing of adverse effect events in 1367 pediatric procedural sedations. *Ann Emerg Med.* 2003;42:627–35.
- Wathen JE, Roback MG, Mackenzie T, Bothner JP. Does midazolam alter the clinical effects of intravenous ketamine sedation in children? A double-blind, randomized, controlled, emergency department trial. *Ann Emerg Med.* 2000;36:579–88.
- Godambe SA, Elliot V, Matheny D, Pershad J. Comparison of propofol/fentanyl versus ketamine/midazolam for brief orthopedic procedural sedation in a pediatric emergency department. *Pediatrics.* 2003;112:116–23.
- Luhmann JD, Kennedy RM, Porter FL, Miller JP, Jaffe DM. A randomized clinical trial of continuous-flow nitrous oxide and midazolam for sedation of young children during laceration repair. *Ann Emerg Med.* 2001;37:20–7.
- Traivaree C, Jindakam W, Monsereenusorn C, Rujkijyanont P, Lumkul R. The factors of ketamine that affect sedation in children with oncology procedures: parent satisfaction perspective. *J Med Assoc Thai.* 2014;97:19–24.
- Da Silva PS, de Aguiar VE, Waisberg DR, Passos RM, Park MV. Use of ketofol for procedural sedation and analgesia in children with hematological diseases. *Pediatr Int.* 2011;53:62–7.
- Shah A, Mosdossy G, McLeod S, Lehnhardt K, Peddle M, Rieder M. A blinded, randomized controlled trial to evaluate ketamine/propofol versus ketamine alone for procedural sedation in children. *Ann Emerg Med.* 2011;57:425–33.