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Case report

INHALED SEDATION WITH SEVOFLURANE IN A CRITICALLY ILL PEDIATRIC PATIENT

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Abstract

In pediatric intensive care units (PICU), achieving adequate sedation for patients can be a challenging task for healthcare staff. While the use of intravenous sedatives helps improve comfort and treatment tolerance, it is a priority to develop strategies to use in patients who are difficult to sedate. This case study presents the first reported use of inhaled sevoflurane in a patient admitted to a PICU who was unresponsive to conventional intravenous sedatives. Sevoflurane was a safe and effective alternative.

Key words: sevoflurane, intensive care units, pediatrics, inhaled anesthetics, invasive ventilation

Resumen

Sedación inhalatoria con sevoflurano en un paciente pediátrico críticamente enfermo

El uso de sedantes intravenosos ayuda a mejorar el confort de los pacientes durante la estadía en las unidades de cuidados intensivos pediátricos (UCIP). Lograr un adecuado objetivo de sedación en algunos pacientes puede ser una tarea difícil, por esto es prioritario desarrollar estrategias alternativas para esta población. En este caso se presenta el primer uso reportado de sevoflurano inhalado en un paciente internado en una UCIP que no respondía a los sedantes intravenosos convencionales. El sevoflurano resultó ser una alternativa segura y efectiva.

Palabras clave: sevoflurano, unidad de cuidados intensivos, pediatría, sedación inhalada, ventilación mecánica

Inhaled anesthetics are widely used in pediatric practice for surgical procedures due to their hypnotic, sedative, and amnesic effects. In critical care units, their application is limited to populations with difficult-to-manage sedation. Although their use is increasing, the available evidence is still primarily based on case reports and cohort studies[1].

Inhaled sedation with sevoflurane or isoflurane in intensive care units offers several benefits over intravenous agents. These volatile anesthetics are primarily eliminated through the lungs, minimizing hepatic metabolism, and have rapid onset and offset times, allowing for quick induction and recovery. Additionally, these agents are easily titratable, providing precise control over sedation levels from light to deep sedation. Sevoflurane can cause cardiovascular, gastrointestinal, and neurological side effects, such as hypotension, nausea, vomiting, agitation, and hypo- or hyperthermia, among others.

Prolonged exposure to this gas may lead to elevated serum fluoride levels, potentially causing nephrotoxicity.

Despite the positive outcomes that allow safely achieving the desired sedation goals, there are no publications in Latin America on the use of inhaled anesthetics in pediatric critical care units. In this context, we present the case of an 11-month-old patient admitted to the PICU of a high-complexity university hospital where sevoflurane was implemented as a therapeutic strategy.

Clinical case

An 11-month-old boy with a complex chronic condition (CCC) and diagnosis of type III esophageal atresia and severe tracheal stenosis was admitted to the PICU after undergoing airway reconstruction. The intervention included resection, tracheal anastomosis, and closure of the tracheocutaneous stoma, with intraoperative use of extracorporeal pump circuit for hemodynamic and respiratory support. The patient was admitted in the immediate postoperative period with nasotracheal intubation and the indication of deep sedation to prevent complications related to the tracheal suture (target RASS -4, Richmond Agitation-Sedation Scale). A multimodal sedoanalgesia approach was planned with propofol and dexmedetomidine as sedatives, morphine, and dipyrone as analgesics, monitored by non-invasive brain function and analgesia nociception index devices (Sedline® and ANI®, Masimo, USA, respectively).

On the third postoperative day, despite increasing the sedative doses guided by monitoring, the target RASS was not maintained, so it was decided to start inhaled sedation with sevoflurane using the Sedaconda® Anesthetic Conserving Device (ACD) (SEDANA Medical AB, Sweden), with an end-tidal exhaled gas target of 0.5-1.0% (Fig. 1). After starting sevoflurane, the target Patient State Index (PSI) and a RASS of -4 were achieved, allowing the suspension of other intravenous sedatives.

On the fifth postoperative day, a sedation window and spontaneous breathing trial were performed, during which the patient developed subcutaneous cervical emphysema secondary to suture dehiscence of the previous stoma. The patient underwent a new surgery, in which a tracheoplasty and a new tracheostomy were performed. Given the reintervention, continuing the inhaled sedation strategy was chosen and maintained for a total of 5 days without adverse events related to the infusion. Besides the tracheal suture dehiscence, the patient developed surgical site infection and hyperactive delirium. Finally, he evolved favorably, was weaned off mechani-

Figure 1 | FA: Patient on mechanical respiratory support, connected to an inhalation sedation device (Sedaconda® Anesthetic Conserving Device) with a non-invasive brain function monitoring sensor placed (Sedline®). B: Alternative configuration of the inhalation sedation device for tidal volumes less than 200 ml or the requirement of active humidification. The gas analyzer shows a capnography curve, as well as the end-tidal carbon dioxide and the anesthetic used (sevoflurane)

cal ventilation, and was discharged from the hospital two months after surgery.

Parental consent to publish the medical case report of the child in a scientific journal was obtained.

Discussion

In the presented case, the use of inhaled sedatives proved beneficial in achieving the goal of deep sedation in a patient with difficult-to-manage sedation due to the development of tachyphylaxis to the usual intravenous sedatives used in the PICU. In critical care units, patients requiring mechanical respiratory assistance commonly receive intravenous sedatives along with analgesics such as opioids and anti-inflammatories[2].

The paradigm of the critically ill patients being deeply sedated and unable to communicate is shifting towards lighter sedation that allows interaction with the environment during the critical phase of the illness[3]. However, some patients require deep sedation for longer periods, developing tolerance to the conventional regimens used in the PICU. A survey conducted in Argentina indicated that midazolam and fentanyl are the most commonly used drugs for sedation and analgesia, respectively[4]. Benzodiazepines are reported to be directly associated with the development of delirium and other adverse outcomes, so it is essential to reduce their use, either through implementing protocols or alternative therapeutic strategies[5,6]. This is especially important in patients with difficult-to-manage sedation, a term that still lacks a uniform definition, where pharmacological options are limited. In this population, propofol, ketamine, and phenobarbital are still the most commonly used drugs, but their adverse effects limit their long-term use[7,8]. In Argentina, dexmedetomidine, chloral hydrate, and clonidine are used as adjuncts[4].

To date, there are no published reports on the use of inhaled sedation in Argentina, while a recent European survey reports that less than 1% of participating PICUs use them[8]. Sevoflurane and isoflurane are inhaled anesthetics commonly used in pediatric anesthesia, noted for their rapid induction and recovery, lower accumulation, and few adverse effects. In adults, meta-analyses published by Jerath et al and Aseri et al, support the reduction of extubation time and intensive care unit (ICU) stay with the use of inhaled sedation[9,10]. In pediatrics, the articles of Mencia et al and Pavcnik et al, demonstrated that sevoflurane sedation is effective in critically ill children[11,12]. Additionally, Berger et al reported a reduction in benzodiazepine use in the largest pediatric cohort published to date[1]. In Spain, the society and foundation of pediatric intensive care suggest that inhaled sedation is at least as effective as propofol in achieving sedation goals, and propose considering its use as an alternative, especially in patients with obstructive respiratory pathology, acute respiratory distress syndrome, cardiological and neurocritical conditions[13]. Following the favorable results of Meiser et al, published in The Lancet in 2021, the results of the IsoCOMFORT study are awaited[14]. This is a multicenter, prospective, randomized, controlled, and blinded phase IV protocol that will evaluate the safety and efficacy of isoflurane compared to midazolam in mechanically ventilated children[15].

Regarding economic matters, a cost modeling conducted by the manufacturer and reviewed by the economic assessment committee of the National Institute for Health and Care Excellence (NICE) demonstrates that Sedaconda ACD-S is cost-effective compared to traditional intravenous sedation methods. Over a 30-day period, it is cost-saving in adults compared to intravenous propofol and in children compared to intravenous midazolam. These savings primarily result from reduced time on mechanical ventilation. Despite uncertainties, NICE recommended Sedaconda ACD-S as an option for delivering sedation in both adult and pediatric intensive care settings[16].

To our knowledge, this is the first reported case in Latin America of the use of inhaled sedation in a PICU. Although evidence on inhaled gases in pediatric patients is limited, the trend is promising in terms of efficacy and safety in prolonged use. Our work is logically limited by being a single case report from a high-complexity university center in Buenos Aires. Its relevance lies in demonstrating the feasibility of using sevoflurane administered through a volatile anesthetic delivery device in critically ill pediatric patients. Sevoflurane was effective as an alter-

native to conventional intravenous sedatives, safely achieving the sedation goal and facilitating the spontaneous breathing trial after its discontinuation. The need for healthcare personnel training and the development of higher quality evidence on the prolonged use of inhaled sedatives in critically ill pediatric populations is highlighted.

Conflict of interest: None to declare

References

1. Berger L, Soreze Y, Rambaud J, et al. Halogenated volatile anaesthetics for prolonged sedation in pediatric intensive care unit: first experience in two French pediatric intensive care units. *Intensive Care Medicine - Paediatric and Neonatal* 2023; 1: 1-8.
2. MacDonald I, Alvarado S, Marston MT, et al. A systematic review of clinical practice guidelines and recommendations for the management of pain, sedation, delirium and iatrogenic withdrawal syndrome in pediatric intensive care. *Front Pediatr* 2023; 11: 1264717.
3. Lin JC, Srivastava A, Malone S, et al. Caring for critically Ill children with the ICU Liberation Bundle (ABCDEF): results of the pediatric collaborative. *Pediatr Crit Care Med* 2023; 24: 636-51.
4. Taffarel P, Bonetto G, Jorro Barón F, et al. Sedation and analgesia in patients on mechanical ventilation in pediatric intensive care units in Argentina. *Arch Argent Pediatr* 2018; 116: e196-e203.
5. Mody K, Kaur S, Mauer EA, et al. Benzodiazepines and development of delirium in critically Ill children: estimating the causal effect. *Crit Care Med* 2018; 46: 1486-91.
6. Taffarel P, Widmer J, Fiore Á, et al. Impact of the implementation of a sedation and analgesia protocol in a pediatric intensive care unit. *Arch Argent Pediatr* 2023; 121: e202202806.
7. Snoek A, James P, Arenas-López S, et al. Levomepromazine for difficult sedation in pediatric intensive care. *Pediatr Crit Care Med* 2014; 3: 53-7.
8. Daverio M, von Borell F, Ramelet A-S, et al. Correction to: Pain and sedation management and monitoring in pediatric intensive care units across Europe: an ESPNIC survey. *Crit Care* 2022; 26: 139.
9. Jerath A, Panckhurst J, Parotto M, et al. Safety and efficacy of volatile anesthetic agents compared with standard intravenous midazolam/propofol sedation in ventilated critical care patients: a meta-analysis and systematic review of prospective trials. *Anesth Analg* 2017; 124: 1190-9.
10. Aseri ZA, Alansari MA, Al-Shami SA, et al. The advantages of inhalational sedation using an anesthetic-conserving device versus intravenous sedatives in an intensive care unit setting: A systematic review. *Ann Thorac Med* 2023; 18: 182-9.
11. Mencía S, Palacios A, García M, et al. An exploratory study of sevoflurane as an alternative for difficult sedation in critically Ill children. *Pediatr Crit Care Med* 2018; 19: e335-e341.
12. Pavcnik M, Groselj Grenc M. Sevoflurane sedation for weaning from mechanical ventilation in a pediatric intensive care unit. *Minerva Anestesiol* 2019; 85: 951-61.
13. Cuesta AP, Florido AV, Prados FJP. Sedación inhalatoria en Cuidados Intensivos Pediátricos. In: https://www.aeped.es/sites/default/files/documentos/10_sedacion_inhalatoria.pdf; accessed June 2024.
14. CTG Labs - NCBI. In: https://clinicaltrials.gov/study/NCT04684238, accessed January 2023.
15. Meiser A, Volk T, Wallenborn J, et al. Inhaled isoflurane via the anaesthetic conserving device versus propofol for sedation of invasively ventilated patients in intensive care units in Germany and Slovenia: an open-label, phase 3, randomised controlled, non-inferiority trial. *Lancet Respir Med* 2021; 9: 1231-40.
16. Pruski M, O'Connell S, Knight L, Morris R. Sedaconda ACD-S for sedation with volatile anaesthetics in intensive care: A NICE Medical Technologies Guidance. Appl Health Econ Health Policy 2024. doi: 10.1007/s40258-024-00903-2.