

Patient-controlled analgesia in the management of postoperative pain in children and adolescents

Danguolė Rugytė, Karl Erik Edberg¹

Clinic of Anesthesiology, Kaunas University of Medicine Hospital, Lithuania,

¹Department of Pediatric Anesthesia and Intensive Care, The Queen Silvia Children's Hospital, Gothenburg, Sweden

Key words: *pain management, postoperative, patient-controlled analgesia, morphine, child.*

Summary. *Objective. We aimed to evaluate the efficacy, morphine requirements and side effects in patients managed with patient-controlled analgesia postoperatively.*

Methods. Eighty-seven patients, 7 to 22 (median 14) years of age, after orthopedic, abdominal or thoracic surgery, were studied retrospectively. All patients had a preset standard continuous morphine infusion of 10 µg/kg/h, 20 µg/kg bolus dose, 8 min lock-out time and 100 µg/kg/h maximal dose. All patients were additionally treated with non-steroidal anti-inflammatory drugs. Respiratory rate, pain intensity, morphine requirements and nausea/ vomiting were evaluated every 3 hours. Pain was assessed using 6-point scale (1-no pain, 6-the worst pain).

Results. Median time for pain management was 51 h. Median (range) used dose of morphine was 19.9 (4.9–75.2) µg/kg/h. Sixty-one percent of the patients had a mean pain score of 1 or 2, 26% – 3, 13% – 4 or 5. Nausea/ vomiting occurred in 78% of cases. Respiratory rate less than 10 breaths per min was observed in 5.7% of patients. No patient required opioid antagonist to treat respiratory depression.

Conclusions. In the majority of patients patient-controlled analgesia was effective and used doses of morphine were low. Though nausea/ vomiting was the most common side effect, decreased respiratory rate was observed in some patients. Regular patient evaluation for vital signs and side effects is recommended.

Introduction

Intravenous patient-controlled analgesia (PCA) with opioids is now widely accepted technique for postoperative pain management. Studies on PCA point out that better analgesic efficacy, decreased risk for pulmonary complications and good patient acceptance are the advantages over conventional opioid administration methods (1, 2).

Followed by the experience in adults, PCA became popular in pediatric patients as well. In our previous review paper we described general principles and current recommendations for the use of PCA in children over 5 years of age (3). The aim of the present paper is to describe a 3-year experience in the use of PCA in a pediatric university hospital. We were especially interested in the efficacy of the technique and morphine doses used, as well as any side or inadvertent effects, associated with PCA. In order to answer these questions we undertook a retrospective follow up study of pediatric and adolescent patients treated with PCA during the period from May 1996 through November 1999.

Material and methods

Patient-controlled analgesia protocols of 87 patients treated for pain after major surgery were analyzed. The previous anesthetic procedure was not considered.

During preoperative visit the staff member of pain management service introduced PCA pump to the patients and gave relevant instructions for its use. Treatment started immediately after recovering from anesthesia when patients were able to use the device. Standard solutions containing 1 mg/ml of morphine were used. Initial PCA settings were programmed according to the existing hospital guidelines, which recommended a bolus dose of 20 µg/kg, lockout time of 8 minutes, maximal hourly dose of 90–100 µg/kg and the background infusion of 10 µg/kg/h. If needed, the settings could be changed by pain management staff. In addition, all patients got regular supplemental treatment by paracetamol 90 mg/kg/24 h or diclofenac 2.5 mg/kg/24 h suppositories.

Attending nurses checked the PCA pump performance, infused morphine doses, patient's respiratory and pulse rates and the level of sedation every 3 hours until

the end of treatment. Awake patients indicated the amount of pain they experienced using 6 point faces scale (1-no pain, 6-the worst pain) (4). The results of the observation as well as the episodes of nausea/vomiting were noted down on the PCA protocols.

PCA was discontinued when morphine requirements had ceased for a period of at least 6h and constantly low pain scores established.

We used PCA protocols as a basic material in our analysis. Gathered information consisted of the patient age, weight, gender and type of surgery, duration of PCA treatment, morphine consumption every 6 hours and total morphine consumption over 48 hours, average pain scores, respiratory and pulse rates and presence of any side effects.

Results are expressed as means, medians (ranges) or ratios (%), where appropriate. Spearman's test was used for correlation analysis. Significance was considered when $p < 0.05$.

Results

Demographic data of the patients and surgical procedures are shown in Table 1.

Duration of PCA treatment ranged from 15 to 117 hours, and median duration was 51 h

Morphine consumption was fairly constant throughout the period of the first 48 h and resulted in 19.9 (4.9-75.2) $\mu\text{g}/\text{kg}/\text{h}$ (median (ranges)). The highest observed hourly morphine dose throughout the treatment was 155.5 $\mu\text{g}/\text{kg}$ (Fig.1).

Efficacy of PCA, according to pain scores is shown in Fig.2. Over 60% of patients had a mean pain score less or equal to 2, about 26% of patients had a mean pain score of 3, and nearly 13% had a mean pain score of 4 or 5.

Morphine consumption throughout the treatment by PCA and the duration of treatment only slightly correlated with the mean pain scores ($r=0.52$, $p < 0.01$ and $r=0.42$, $p < 0.01$, respectively).

Patients' age did not correlate with pain scores ($r=0.15$, $p > 0.05$) or morphine consumption ($r=0.06$, $p > 0.05$).

All patients had normal pulse rates, 78 (67-112) beats/min, median (range).

The majority of patients (94.3%) had respiratory rates ranging from 10 to 32 breaths/min, median 17 breaths/min. In 5 patients (5.7%) respiratory rates below 10 breaths/min were occasionally observed. In 2 patients pulse oxymetry (SpO_2) was used for respiratory monitoring. One of these patients had the lowest respiratory rate of 8 breaths/min, and another one 10 breaths/min. No patient required naloxone administration for respiratory depression. Table 2 provides more detailed description of these patients, including age, surgical procedure and hourly morphine consumption.

Nausea/vomiting was scored in 17 patients only. Fourteen of them (78%) experienced this side effect.

Discussion

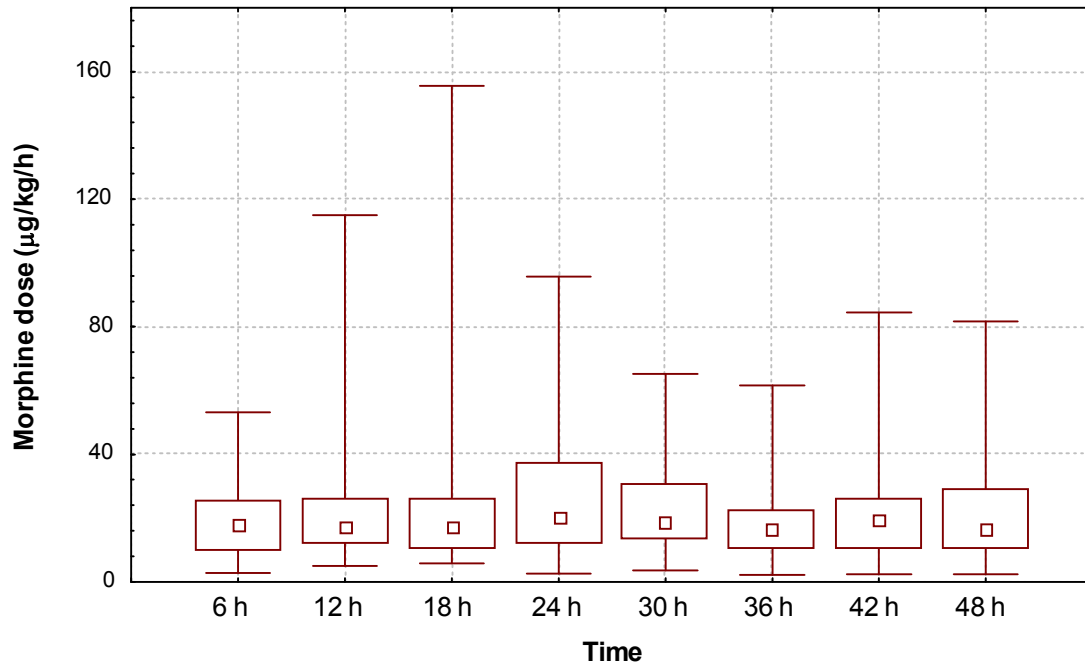
Major surgery in children is associated with a significant postoperative pain. Opioids can be administered by intermittent boluses or intravenous infusions. However, intermittent boluses do not prevent from the episodes of pain exacerbation and continuous infusions were shown to be less efficient if low doses were used (5). Patient-controlled analgesia enables the patient to self-administer the small doses of opioid whenever necessity appears. After initiating PCA in children, promising results with good efficacy and patient acceptance were demonstrated (6). Thus, PCA became a widely accepted technique in the management of pediatric postoperative pain.

The results of this retrospective study indicate that over 60% of patients had excellent or good pain relief. About a quarter of patients still experienced moderate pain. Median morphine consumption was about 20 $\mu\text{g}/\text{kg}/\text{h}$, which is a low value to compare with 40 to 60 $\mu\text{g}/\text{kg}/\text{h}$ reported by other investigators (7, 8). The difference may be explained by supplemental treatment of our patients with non-steroidal anti-inflammatory drugs, which are known to decrease morphine requirements by about 30% (9, 10). However, the great variation in morphine requirements was seen, with the highest values approach-

Table 1. Demographics

Type of surgery	Age ^a years	Body weight ^a kg	Gender		Total
			female	male	
Orthopedic	14 (7-16)	44 (21-78)	15	25	40
Abdominal	13 (8-22)	44.75 (29-71)	12	25	37
Thoracic (noncardiac)	14.5 (12-20)	60 (40-67)	3	7	10
Total	14 (7-22)	46 (21-78)	30	57	87

^a - values are median (ranges).



Small boxes – median values, large boxes – 25 or 75 percentiles, bars – ranges.

Fig.1. Morphine consumption during the period of 48 hours

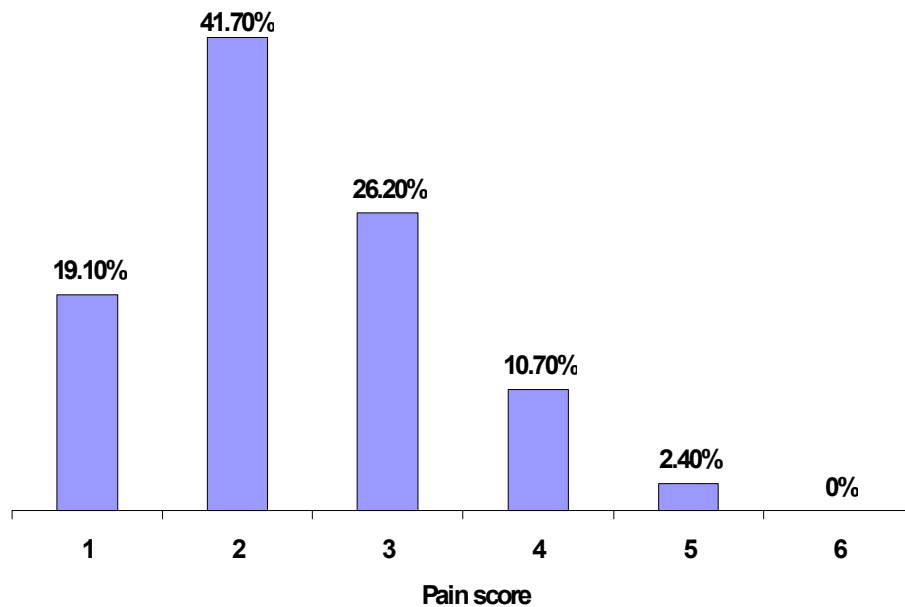


Fig.2. Distribution of patients according to pain scores

ing 150 µg/kg/h. Such variation is not unusual and is frequently observed in patients treated by PCA. Among possible causes is the severity of surgical stress, psychological differences and differences in pain perception between patients (8, 11).

The small number of patients, however, did not reach effective analgesia, in spite of high morphine doses used. The similar fact was reported in the study by G. M. Chumbley et al., who assessed 200 adult patients, using PCA (1). Patient's own evaluation of the pain control resulted in 11.2% of patients with fair and 3% with no

pain control, compared to 13% of children in our study with poor pain control. Occasionally unacceptable VAS scores in children were also observed in the study by R. J. Bray et al. (7). They stated it to be unlikely, that doses of systemic opioids, which permit adequate spontaneous ventilation, would provide perfect pain relief all the time. Certain patients may still be in pain, and other forms of analgesia, including neural blocks and non-opioid analgesics should be considered.

The most frequent side effect, observed during PCA treatment was nausea/ vomiting. In a small number of

Table 2. Characteristics of patients with decreased respiratory rates

Patients	Age (years)	Type of surgery	Mean hourly morphine dose ($\mu\text{g}/\text{kg}/\text{h}$)	Lowest respiratory rate (breaths per minute)	SpO ₂ (%)
patient 1	14	orthopedic	47.6	9	–
patient 2	16	orthopedic	30.5	9	–
patient 3	13	abdominal	15.1	8	–
patient 4	18	abdominal	80.8	8	93–96
patient 5	19	abdominal	30.6	9	–
patient 6	20	abdominal	35.4	10	94–96

patients we observed 78% incidence of nausea/ vomiting. Other sources indicate 33 to 87% incidence (8, 12). Opioid induced nausea/ vomiting results from the action on several central and peripheral sites, thus prevention and treatment is complicated and of limited success. 5-HT₃ antagonists may be preferable due to the lack of side effects, seen with other antiemetics (13). Currently dexamethasone is under clinical investigation and the first results are promising (14). Decrease or elimination of a background infusion from the PCA regimen was also associated with the decreased incidence of nausea/ vomiting in children (15).

When opioids are administered to the patients, there is a potential for severe respiratory depression. Oxygen saturation below 90% in room air and respiratory rates as low as 9 breaths/min were described in children using PCA (7, 15). In this study, respiratory rates below 10 were occasionally observed in 5 patients. Mean morphine consumption in these patients varied from 15 to 81 $\mu\text{g}/\text{kg}/\text{h}$. No patient in this study required opioid antagonist for respiratory depression. Nevertheless, vigilance is required, as the cases of severe respiratory depression, requiring treatment by naloxone were described in children and adults (16, 17). Such cases were associated with the prescription of additional sedatives and antiemetics, additional doses of opioids, administered by

nurses or physicians, inappropriate PCA use by the patient, resulting in an overdose. Other factors, such as concomitant respiratory disease, advanced organ dysfunction and hypovolemia were also described (18, 19). Before starting the PCA treatment it is important to recognize the patients, who may be at increased risk for severe respiratory depression. Appropriate patient information is also important. The use of standard morphine solutions and standard PCA pump settings by the qualified staff, familiar with the equipment, may reduce programming errors, which may cause an overdose. Repeated patient assessment for vital signs, morphine consumption and pump performance is of importance, treating patients by PCA (20).

Conclusions

Patient-controlled analgesia was effective in a great majority of patients 7 to 22 years of age after major surgery. Routine supplemental use of non-steroidal anti-inflammatory drugs resulted in a low morphine dose. High incidence of nausea/ vomiting should be anticipated and prophylactics or treatment used as appropriate. Patient-controlled analgesia was safe in all patients with no inadvertent side effects, but respiratory rates below 10 breaths/min were occasionally observed in 5.7% of cases. Appropriate monitoring at regular time intervals is recommended.

Vaikų ir paauglių pooperacinio skausmo gydymas skiriant paciento kontroliuojamą analgeziją

Danguolė Rugytė, Karl Erik Edberg¹

Kauno medicinos universiteto klinikų Anesteziologijos klinika, ¹Karalienės Silvijos vaikų ligoninės Vaikų intensyviosios terapijos ir anesteziologijos skyrius, Goteborgas, Švedija

Raktažodžiai: skausmo malšinimas, pooperacinis, paciento kontroliuojama analgezija, morfinas, vaikas.

Santrauka. Darbo tikslas. Įvertinti skausmo malšinimo kokybę, morfino dozes ir šalutinius poveikius vaikams ir paaugliams po operacijos naudojant paciento kontroliuojamą analgeziją.

Metodai. Retrospektyviai ištirti 87 ligoniai 7–22 (mediana 14) metų, kuriems buvo atlikta ortopedinė, pilvo ar

krūtinės organų operacija. Pooperaciniam skausmui malšinti buvo parinktos šios morfino dozės: boluso dozė 20 µg/kg esant 8 min. užrakinimo laikui, pastovi infuzija 10 µg/kg/val., maksimali dozė 100 µg/kg/val. Visiems ligoniams papildomai skirta nesteroidinių vaistų nuo uždegimo. Skiriant paciento kontroliuojamą analgeziją ligoniai buvo stebėti kas 3 valandas, vertintas kvėpavimo dažnis, skausmas, suvartoto morfino kiekis, pykinimas bei vėmimas. Skausmas buvo vertinamas naudojant 6 balų skalę (1 – skausmo nėra, 6 – stipriausias skausmas).

Rezultatai. Paciento kontroliuojama analgezija truko 51 valandą (mediana). Morfino dozė suvartota per dvi paras svyravo tarp 4,9–75,2 µg/kg/val. (mediana 19,9). 61 proc. ligonių vidutinis skausmas buvo 1 ar 2, 26 proc. – 3, 13 proc. – 4 ar 5 balų. Pykino arba vėmė 78 proc. ligonių. 5,7 proc. ligonių buvo suretėjęs kvėpavimo dažnis (mažiau kaip 10 kartų per min.). Opioidų antagonistu nereikėjo nė vienam pacientui.

Išvados. Daugumai ligonių paciento kontroliuojama analgezija buvo veiksminga, o suvartoto morfino dozės mažos. Nors dažniausiai pasitaikė pykinimas arba vėmimas, o ryškus kvėpavimo slopinimas buvo retas, reguliari ligonių priežiūra, skiriant paciento kontroliuojamą analgeziją, yra būtina.

Adresas susirašinėjimui: D. Rugytė, KMUK Anesteziologijos klinika, Eivenių 2, 3007 Kaunas
El. paštas: rugyte@kmu.lt

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