Pain management following spinal surgeries in pediatric patients. Preliminary results

Lucas Piantoni, Carlos A. Tello, Ida A. Francheri Wilson, Rodrigo Remondino, Eduardo Galaretto, Ernesto S. Bersusky, Mariano A. Noel

Spinal Conditions Department, Hospital de Pediatría "Prof. Dr. Juan P. Garrahan" (Buenos Aires, Argentina)

ABSTRACT

Introduction: Around 80% of pediatric patients who undergo spinal surgery report moderate to severe pain in the immediate postoperative (POP) period, and only half of them are treated according to an adequate and standardized pain management scheme. We aimed to: describe the type and intensity of postoperative pain in children who underwent spinal surgery and evaluate the effectiveness of the current pain management protocol. **Materials and Methods:** We assessed children between 10 and 18 years of age who were able to understand the purpose of the study. We recorded presence of pain, time of postoperative pain onset, location, and referred intensity of the pain using a numeric rating scale (NRS), among other variables. **Results:** Overall, 84 pediatric patients were evaluated. Mean age at surgery: 12 years and 9 months. Etiology: idiopathic (41 patients), neuropathic (14 patients), syndromic (10 patients), muscular (7 patients), and miscellaneous (12 patients). Mean preoperative NRS was 2.1, and 7.3 on post-op day 1, 6.6 on post-op day 2, 6.2 on post-op day 3, 5.1 on post-op day 4, 3.7 on post-op day 5, and 3.3 on post-op day 6/at discharge. Mean hospital stay was 6.3 days. The mean cost of hospital stay was USD 1090 per patient. **Conclusions:** A high percentage of pediatric patients who underwent spinal surgery reported moderate to severe pain in the postoperative period, and just half of them received a standardized pain management protocol. A pain management protocol with a multimodal focus should be considered in a near future.

Key words: Postoperative pain; pain management guidelines; pain relief; multimodal therapy; spinal surgery; pediatrics.

Level of evidence: III

Manejo del dolor posoperatorio por cirugía de columna en la población pediátrica. Resultados preliminares

RESUMEN

Introducción: Aproximadamente el 80% de los pacientes pediátricos sometidos a cirugía de columna refiere dolor moderado o severo en el posoperatorio inmediato. **Objetivos:** Describir la presencia de dolor y su intensidad durante el posoperatorio de una cirugía de columna en pacientes pediátricos y evaluar la eficacia del tratamiento analgésico actual. **Materiales y Métodos:** Se evaluaron pacientes sometidos a cirugía de columna, de entre 10 y 18 años, con capacidad mental para entender el propósito del estudio. Se utilizó el esquema de medicación estándar actual posoperatorio del hospital. Se constataron la presencia del dolor, la hora de comienzo, la localización y la intensidad (escala de valoración numérica), entre otras variables. **Resultados:** Se evaluó a 84 pacientes pediátricos, con una edad promedio de 12 años y 9 meses, al momento de la cirugía. Las etiología fueron: idiopática (41 casos), neuropática (14 casos), sindrómica (10 casos), muscular (7 casos) y misceláneas (12 casos). El puntaje promedio en la escala de valoración numérica fue de 2,1 antes de la cirugía; de 7,3 el día 1 posoperatorio y de 3,3 el día 6 posoperatorio/alta. El tiempo promedio de internación fue de 6.3 días, el costo económico global de la internación fue de USD1090 por paciente. **Conclusiones:** Un importante porcentaje de pacientes pediátricos refiere dolor moderado o severo en el posoperatorio de una cirugía de columna, tan solo la mitad recibe un esquema de manejo de dolor estandarizado y adecuado. El objetivo ulterior de este estudio será protocolizar el manejo del dolor con un enfoque multimodal.

Palabras clave: Dolor posoperatorio; guías prácticas de dolor; analgesia; terapia multimodal; cirugía de columna; pediatría.

Nivel de Evidencia: III

Received on December 18th, 2018. Accepted after evaluation on February 8th, 2019 • LUCAS PIANTONI, MD • lucaspiantoni@gmail.com

How to cite this paper: Piantoni L, Tello CA, Francheri Wilson IA, Remondino R, Galaretto E, Bersusky ES, Noel MA. Pain management following spinal surgeries in pediatric patients. Preliminary results. *Rev Asoc Argent Ortop Traumatol* 2019;84(3):224-235. http://dx.doi.org/10.15417/issn.1852-7434.2019.84.3.931

INTRODUCTION

Proper pain management in the pediatric population undergoing spinal surgery represents a challenge for the healthcare team during the postoperative period, and multimodal therapy is strongly recommended.[1-22] According to the international literature, 75% of this population experiences acute pain during the postoperative period, and 80% of them describe it as moderate or severe[1-23], while half of the patients report adequate pain relief.[23] Sanders *et al.* concluded that more than 7% of their patients had pain moderate to severe pain two years after surgery; on the other hand, Landman *et al.* showed that up to 64% of their pediatric patients reported poor pain management one year after surgery.

Inadequate pain control in the immediate postoperative period negatively affects quality of life and produces a higher rate of anxiety, depression, disability and absence from school; [24] delays functional recovery of integrated motor activities; increases the risk of continuous postoperative pain and lengthens the hospital stay, which, in turn, increases the rate of complications and hospitalization costs.[1,3] A systematic review of the literature[1,2,22,25-28] revealed that there is consensus that optimal pain management begins before surgery, adapting pain killers dosages to the patient's own needs and the surgical procedure to which they will be subjected. In turn, there are descriptions suggesting that pre-, intra- and postoperative pain management strategies improve pain management during hospitalization and after immediate hospital discharge.

After an extensive systematic review, the American Pain Society, together with the American Society of Anesthesiologists (ASA) outlined treatment recommendations consisting of: the use of multimodal therapies; the adaptation of the pain management strategy to the patient's needs; the use of validated scales to assess postoperative pain; pre- and perioperative education of the patient and his family on aspects related to pain relief and, finally, the development of hospital policies that guarantee adequate relief of postoperative pain. This motivated the Spinal Conditions Department to evaluate current pain management during the postoperative period of spinal surgery in a pediatric population. This study was approved by the hospital's Ethics Committee. The objectives of this study were: 1) to describe the presence of pain and its intensity in the postoperative period of spinal surgery in pediatric patients; 2) to evaluate the efficacy of pain management, with the aim, in a future study, of improving and standardizing, in a multimodal manner, the management of postoperative pain during hospitalization after spinal surgeries.

MATERIALS AND METHODS

A prospective evaluation of the pediatric population operated for a spinal condition was carried out between November 2016 and February 2017. The inclusion criteria were: postoperative kyphoscoliosis patients between 10 and 18 years of age, with adequate mental capacity to understand the purpose of the study. Patients with delayed maturation, recent history of substance abuse (<3 months) and known history of adverse drug effects were excluded (Table 1). The relatives or guardians in charge of the patient signed the required informed consent. The population studied received the actual pain management dosages used in the hospital during the postoperative period of a spinal surgery (Table 2).

Before surgery, the patients underwent a complete clinical evaluation, laboratory tests, a EKG, respiratory function tests, chest and spine x-rays, a spine MRI and, eventually, a CT scan of the same region, if necessary. The variables studied were: age, sex, underlying condition, preoperative degree of scoliosis and kyphosis, type of surgical procedure performed, number of operated spinal levels, type of osteotomies performed (Frank Schwab), ASA score, surgical time, pre- and

Table 1. Current medication for the management of postoperative pain after spinal surgery

Preoperative
No intervention.

Postoperative (day 0 to hospital discharge)
IV morphine 0.1 mg/kg/day + IV dipyrone 5 mg/kg/day in the immediate postoperative period and hospitalization (first 48 hours by convention).
IV diazepam 0.1 mg/kg/day (no convention).
IV dexamethasone 0.6 mg/kg/day (no convention).
Swtich to oral as per patient's tolerance and pain progression.
No pain assessment scales are used (except in the ICU).

Hospital discharge
NSAIDs, during 72 hours and further by convention if pain continues.
No protocol for interdisciplinary follow-up of postoperative pain management.

postoperative pain scale (numerical assessment scale, from 0 to 10, where 0 indicates absence of pain and 10, the worst pain possible) once a day, first thing in the morning (60 minutes after administering analgesia) until hospital discharge—questions were asked about when the pain began, where it is localated, how it improves (if it improves)—, postoperative signs and symptoms—such as nausea, vomiting, dizziness, headache—, transition time to usual oral diet (expressed in postoperative hours), time until removal of the drainage from the surgical site (expressed in postoperative hours), time until removal of the bladder catheter (expressed in postoperative hours), first bladder emptying (expressed in postoperative hours), transition from intravenous (IV) to oral analgesia (expressed in postoperative hours), mobilization with physical therapy, length of hospital stay (days), and estimated hospital cost (only bed value and in US dollars). In "postoperative hours", "hour zero" was defined as the precise moment in which the patient leaves the operating room after surgery.

Table 3. Validated evaluation methods to determine pain intensity

Numeric rating scale	0-10 points (0: no pain, 10: worst pain possible)
Face rating scale	Wong-Baker FACES Pain Rating Scale
Oral rating scale	0-4/0-6/0-7 points
Visual analog scale	0-10 cm /0-100 mm

The total costs per patient were determined as follows: surgical procedure USD 4,114; surgical day USD 245; hospitalization day in General Ward USD 150; and hospitalization day in the ICU USD 250. Hospitalization days include pathology, hemotherapy service, imaging studies, supplementary oxygen, physical therapy and nursing are, and exclude drugs administered during hospitalization.

The postoperative evaluation consisted of daily clinical and imaging check ups by the Spinal Conditions and Medical Departments during hospitalization and successive periodic follow-ups after hospital discharge by the Spinal Conditions Department.

RESULTS

84 pediatric patients (61 girls and 23 boys) were evaluated during the postoperative period of spinal surgery. The average age at the time of surgery was 12 years and 9 months (min. 10, max. 17 years + 9 months). The etiologies found were: idiopathic (41 cases), neuropathic (14 cases), syndromic (10 cases), muscular (7 cases) and miscellaneous (12 cases). The average preoperative degrees were: 60.6º (min. 10º, max. 140º) of scoliosis and 37.5º (min. 5º, max. 130º) of kyphosis.

These patients had an ASA score of 2.4 (min. 1, max. 3). An average of 10.9 spinal levels were operated on per patient (min. 2, max. 18). According to the type of osteotomy, 70 patients underwent Smith Petersen osteotomies; 2 to pedicle subtraction osteotomies and 1 to a complete vertebrectomy. The onset of pain was recorded, on average, at 3.9 hours after surgery (min. 1 h, max. 12 h). The average score of the numerical rating scale was 2.1 (min. 0, max. 9) during the preoperative period; 7.3 (min. 2, max. 10) on day 1 postoperatively; 6.6 (min. 2, max. 10) on day 2; 6.2 (min. 1, max. 9) on day 3; 5.1 (min. 1, max. 9) on day 4; 3.7 (min. 2, max. 9) on day 5; 3.3 (min. 1, max. 6) on day 6/at hospital discharge. The average surgical time was 3 hours and 55 minutes (min. 90 min, max. 8 h and 30 min). It was observed that the average transition time to a solid diet was 37.7 h (min. 12 h, max. 60 h), the average time to removal of the drainage from the surgical site was 55.4 h (min. 24 h, max. 96 h), and the time to removal of the bladder catheter, of 58.8 h (min. 24 h, max. 72 h). The average time of transition from IV to oral analgesia was 54.4 h (min. 18 h, max. 96 h). The average hospitalization time was 6.34 days (min. 3, max. 20), with an average economic cost of hospitalization plus surgical procedure of USD 1,090 per patient (min. 450, max. 4,900).

Sixty-seven patients (79.9%) reported nausea and vomiting in the first 24 hours after surgery. The complications recorded were: a case of superficial infection of the wound that was treated with surgical cleaning and IV antibiotics; a case of hemothorax, solved in a bloodless manner, with periodic clinical follow-ups by imaging studies; and a case of decreased intraoperative motor evoked potentials without post-surgical sequelae (Table 3).

Table 2. Demography and results of the variables considered

Patient	Age	Sex	Underlying condition	Degree of scoliosis (PREOP/ POSTOP)	Degree of kyphosis (PREOP/ POSTOP)	Operated levels	Osteotomoies (SPO/PeSO/ CVR)	ASA score	Surgical time (h)	PREOP/POSTOP daily NRE	When did postoperative pain start? (h)	Where does it hurt?	How is the pain relieved?	Postoperative signs and symptoms (nausea, vomiting, infection, neurological injury)	Transition to solid diet (POSTOP h)	Drainage removal (POSTOP h)	Bladder catheter removal (POSTOP h)	Switch from IV to oral pain killers (POSTOP h)	POSTOP hospital stay (days) (ICU-GW)	Estimated hospital costs (x hospitalization days, thousands of USD)
1	17.3	M	Congenital	49°/32°	81°/65°	8	SPO	2	4.2	pre6/7/5/4/5/3/3	6	Lower lumbar and thoracic spine	Lateral decubitus	No	18	40	18	18	6 (GW)	900
2	13.6	M	Osteo-genesis imperfecta	72°/34°	51°/45(R0)	11	SPO	3	5	pre3/8/5/4/6/3	12	Lower lumbar spine	Lateral decubitus	Vomiting	24	48	18	48	4 (ICU) 1 (GW)	1150
3	14.9	F	Idiopathic	41°/67°	11°/12°	8	SPO	3	4.5	pre0/9/5/5/4	6	Higher thoracic spine	Lateral decubitus	Vomiting	36	60	48	36	4 (GW)	600
4	10.4	M	Congenital	60°/25°	41°/44°	8	Hemivertebra resection SPO	3	4.5	pre0/8/6/2/2/1	12	Whole spine	Lateral decubitus	No	12	36	36	24	5 (GW)	750
5	13.3	F	Neuropa-thic	82°/38°	35°/34°	17	CVR across apex	3	4.3	pre3/10/3/4/2/3/4/2/3/4 /3/4/3/2/2	6	Lower lumbar spine	Lateral decubitus	Surgical wound infection	12	48	48	48	7 (ICU) 7 (GW)	2800
6	12	F	Idiopathic	55°/28°	21°/30°	9	SPO	2	3.5	pre2/8/2/3/4/5	6	Lower thora-cic spine	NA	Vomiting	24	36	60	48	5 (GW)	750
7	13.3	F	Neuropa-thic	65°/45°	29°/33°	12	SPO	3	4.8	pre3/5/8/6/8/2/3/4	6	Whole spine	Lateral decubitus	Vómitos	24	48	72	60	7 (GW)	1050
8	15.9	F	Neuropa-thic	38°/51°	23°/29°	5	None	3	5.3	pre3/4/3/6/4/2/3	2	Whole spine	Lateral decubitus	No	12	48	60	40	6 (GW)	900
9	10	F	Muscular	104°/45°	110°/75°	17	SPO	3	8.5	pre2/8/5/4/6/4/5/7/4/3/4/6/ 3/5/3/4/5/3/3/3/3	8	Higher thoracic spine	Lateral decubitus	Vomiting, decrease in right MIP during the second stage	24	60	48	72	19 (ICU) 1 (GW)	4900
10	14	F	Idiopathic	58°/49°	29°/33°	9	SPO	1	3	pre3/7/9/7/3/4/3	12	Whole spine	Lateral decubitus	Nausea	36	48	48	48	6 (GW)	900
11	13.3	M	Muscular	43°/68°	67°/55°	17	SPO	3	3.2	pre2/7/5/6/8/4/2/3/2/4/ 3/2/3/2/2	12	Whole spine	Lateral decubitus	Vomiting	36	48	48	48	4 (ICU) 10 (GW)	2500
12	13.2	M	Muscular	57°/20°	54°/47°	10	No	3	4.2	pre2/7/6/5/8/5/4/3/5/3/ 5/3/6/4/5	6	Higher tho-racic spine	Lateral decubitus	No	12	24	36	24	7 (ICU) 7 (GW)	2800
13	17.3	M	Congenital	118°/77°	130°/77°	14	SPO	3	4.8	pre5/8/8/7/8/6/6/7/3/3	4	Whole spine	Lateral decubitus	Vomiting	36	96	72	96	4 (ICU) 5 (GW)	1750
14	14.6	F	Idiopathic	28°/50°	31°/33°	7	SPO	2	2.5	pre2/6/8/5/7/3	6	Whole spine	NS/NC	Vomiting	36	48	48	60	5 (ICU)	1250
15	19	M	Neuro-pathic	62°/34°	5°/17°	12	SPO	2	5	pre3/8/6/5/3/2	6	Thoracic spine	Lateral decubitus	Vomiting	36	60	72	60	5 (GW)	750
16	10	F	Syndromic	30°/64°	64°/45°	6	SPO	3	4.3	pre1/8/6/5/4/2	4	Higher tho-racic spine	Lateral decubitus	No	12	48	72	72	5 (GW)	750
17	14	F	Idiopathic	40°/60°	65°/58°	13	SPO	2	5.1	pre1/4/6/5/7/4	2	Higher tho-racic spine	Lateral decubitus	Vomiting	36	60	48	60	5 (GW)	750

(Cont.)

Rev Asoc Argent Ortop Traumatol 2019; 84 (3): 224-235 • ISSN 1852-7434 (online)

Table 2. (*cont.*)

Patient	Age	Sex	Underlying condition	Degree of scoliosis (PREOP/ POSTOP)	Degree of kyphosis (PREOP/ POSTOP)	Operated levels	Osteotomoies (SPO/PeSO/ CVR)	ASA score	Surgical time (h)	PREOP/POSTOP daily NRE	When did postoperative pain start? (h)	Where does it hurt?	How is the pain relieved?	Postoperative signs and symptoms (nausea, vomiting, infection, neurological injury)	Transition to solid diet (POSTOP h)	Drainage removal (POSTOP h)	Bladder catheter removal (POSTOP h)	Switch from IV to oral pain killers (POSTOP h)	POSTOP hospital stay (days) (ICU-GW)	Estimated hospital costs (x hospitalization days, thousands of USD)
18	12	F	Neuropathic	40°/85°	45°/44°	13	SPO	2	4.1	pre 2/5/4/5/7/3/3	2	Whole spine	Dorsal decubitus	Nausea	24	60	48	60	6 (ICU)	1500
19	14.6	M	Neuropathic	CPU	40°/48°	14	SPO	3	5.1	pre 2/2/3/1/4/2/2/2/3	6	Whole spine	Dorsal decubitus	Nausea, vomiting	36	60	48	48	5 (ICU) 3 (GW)	1700
20	10	F	Neuropathic	44°/49°	34°/40°	6	None	3	3.1	pre 3/9/8/8/7/5	2	Whole spine	Dorsal decubitus	Nausea, vomiting, fever	48	48	60	72	5 (ICU)	1250
21	16.2	F	Neuropathic	100°/45°	23°/22°	14	SPO	3	3.6	pre 1/7/5/7/5/3/2/4/2	1	Whole spine	Dorsal decubitus	Nausea, vomiting	36	60	60	72	6 (GW)	900
22	11.1	F	Muscular	94°/42°	73°/18°	18	SPO	3	4	pre 1/9/10/7/8/6/4/3	4	Higher thoracic spine	Dorsal decubitus	Vomiting, fever	24	60	72	72	4 (ICU) 4 (GW)	1600
23	15.6	M	Idiopathic	58°/47®	28°/24°	14	SPO	2	4	pre 1/8/7/4/4/3/4	6	Torácico izq.	Dorsal decubitus	Vomiting, hemothorax	24	72	72	48	7 (GW)	1050
24	12.6	F	Congenital	43°/55°	60°/45°	14	SPO	2	4	pre 1/8/4/7/5/4/4	2	Higher thoracic spine	Dorsal decubitus	Nausea, vomiting	36	48	72	72	6 (GW)	900
25	12	M	Muscular	57°/81°	11°/13°	17	SPO	3	5	pre 1/7/6/5/3/4/3/3	2	Whole spine	Dorsal decubitus	Hypotension, vomiting	24	72	60	48	3 (ICU) 4 (GW)	1350
26	10	M	Cifosis poslaminectomía	35°/33°	60°/45°	7	SPO	3	3	pre2/7/6/8/4/3/4/2	2	Whole spine	Dorsal decubitus	None	12	72	60	48	5 (GW)	750
27	10	F	Muscular	60°/15°	24°/27°	17	SPO	3	3.3	pre1/7/6/7/4/3	6	Higher thoracic spine	Dorsal decubitus	None	12	72	72	60	4 (ICU) 3 (GW)	1450
28	15.6	M	Disc herniation	No	No	2	No	1	1.5	pre3/7/6/4	6	Whole spine	Dorsal decubitus	Nausea, vomiting	40	48	72	60	3 (GW)	450
29	13.3	F	Idiopathic	55°/22°	23°/32°	9	OSP	1	3	pre1/9/7/8/4/3/5	2	Whole spine	Dorsal decubitus	Nausea	48	48	60	48	6 (ICU)	1500
30	12.2	F	Idiopathic	65°/22°	24°/29°	11	OSP	2	3.5	pre2/7/8/6/4/3/4/6/4/3/3	1	Whole spine	Dorsal decubitus	Hypotension, vomiting	48	48	48	60	4 (ICU) 6 (GW)	1900
31	11.2	F	Muscular	140°/45°	118°/55°	18	OSP	3	4.3	pre3/7/6/5/5/3/4/3/4/5/3/2/2/3	2	Whole spine	Dorsal decubitus	None	12	72	72	48	4 (ICU) 9 (GW)	2350
32	15.6	F	Idiopathic	37°/46°	19°/17°	12	OSP	2	4.3	pre2/8/6/7/4/3	4	Rib cage	Dorsal decubitus	None	12	60	72	72	5 (GW)	750
33	11.8	M	Congenital	93°/34°	66°/46°	17	OSP	3	4.5	pre3/9/8/7/5/4/3/4/5/3/4/3/2	2	Whole spine	Dorsal decubitus	Vomiting, fever	60	60	72	72	4 (ICU) 8 (GW)	2200
34	12.5	F	Idiopathic	50°/60°	25°/31°	12	OSP	2	3.5	pre2/7/8/6/5	1	Higher thoracic spine	Lateral decubitus	Nausea	60	72	72	72	4 (GW)	600
35	15.5	F	Idiopathic	56°/37°	11°/12°	9	OSP	2	3.4	pre1/7/8/6/5/2/3	2	Whole spine	Dorsal decubitus	Nausea	36	72	48	48	6 (ICU)	1500

(Cont.)

Table 2. (*cont.*)

Patient	Age	Sex	Underlying condition	Degree of scoliosis (PREOP/ POSTOP)	Degree of kyphosis (PREOP/ POSTOP)	Operated levels	Osteotomoies (SPO/PeSO/ CVR)	ASA score	Surgical time (h)	PREOP/POSTOP daily NRE	When did postoperative pain start? (h)	Where does it hurt?	How is the pain relieved?	Postoperative signs and symptoms (nausea, vomiting, infection, neurological injury)	Transition to solid diet (POSTOP h)	Drainage removal (POSTOP h)	Bladder catheter removal (POSTOP h)	Switch from IV to oral pain killers (POSTOP h)	POSTOP hospital stay (days) (ICU-GW)	Estimated hospital costs (x hospitalization days, thousands of USD)
36	13.6	F	Idiopathic	48°/19°	20°/19°	5	SPO	2	3	pre2/7/6/7/4	4	Lower lumbar spine	Dorsal decubitus	None	48	60	72	48	4 (GW)	600
37	13.8	F	Idiopathic	60°/16°	13°/14°	13	SPO	1	5	pre2/6/5/7/3	1	Whole spine	Lateral decubitus	Nausea, vomiting	24	72	60	48	4 (GW)	600
38	15.6	F	Idiopathic	48°/37°	18°/21°	7	SPO	2	3	pre2/7/8/6/4	1	Whole spine	Lateral decubitus	Nausea	48	72	72	60	4 (GW)	600
39	14.9	M	Scheuermann	None	75°/55°	11	SPO	2	4	pre3/8/7/8/5/4	2	Rib cage	Lateral decubitus	None	12	48	60	72	5 (GW)	750
40	15.1	F	Idiopathic	40°/79°/80°	23°/25(R0)	14	SPO	2	4.5	pre2/8/6/7/5/3	6	Torácico alto	Dorsal decubitus	Nausea	24	48	72	60	5 (GW)	750
41	13.6	F	Idiopathic	51°/37°	18°/21°	10	SPO	2	4	pre2/8/6/7/4/2	2	Lumbar	Dorsal decubitus	Nausea	24	48	60	48	4 (GW)	600
42	17	F	Scheuermann	66°/22°	21°/20°	14	Material removal	3	1	pre9/8/7/5/3/4/2	1	Ciática izq.	Lateral decubitus	Nausea, vomiting	32	no uso	48	72	6 (GW)	900
43	5.1	F	Idiopathic	Retiro del material	No	4	None	2	3	pre1.8/7/8/5	1	Higher thoracic spine	Lateral decubitus	Nausea	24	48	48	72	4 (GW)	600
44	14.9	F	Idiopathic	65°/35°	53°/34°	8	SPO	3	3.5	pre2/8/6/5/6/3/3	4	Rib cage	Lateral decubitus	Nausea, vomiting	18	72	60	60	5 (GW)	750
45	15.2	M	Neuropathic	56°/21°	22°/21°	16	SPO	3	5.7	pre2/7/8/6/5/2/3/4/3	1	Hombro der.	Lateral decubitus	Nausea	48	60	48	48	5 (ICU) 4 (GW)	1850
46	17	F	Idiopathic	122°/65°	34°/31°	11	SPO	3	5	pre2/8/7/5/6	1	Rib cage	Lateral decubitus	Nausea	12	48	60	60	4 (GW)	600
47	15.8	F	Idiopathic	80°/44°	35°/41°	13	SPO	3	4.4	pre3/8/6/7/5/3/1	2	Whole spine	Lateral decubitus	None	12	60	72	72	6 (GW)	900
48	13	F	Idiopathic	60°/110°	71°/45°	13	SPO	2	4.1	pre2/8/7/5/4/2/3	6	Whole spine	Dorsal decubitus	Vomiting	60	60	72	72	6 (GW)	900
49	13.9	M	Neuropathic	56°/18°	25°/27°	9	SPO	3	5.1	pre6/7/8/9/8/5/3	2	Lumbar spine	Dorsal decubitus	Nausea	48	48	60	48	6 (GW)	900
50	14.9	M	Laminectomy sequela, meningioma	77°/33°	18°/31°	11	SPO	3	4	pre2/8/6/5/3/2/1	4	Left sciatica	Lateral decubitus	Vomiting	36	72	48	48	6 (GW)	900
51	15.8	F	Congenital	21°/17°	79°/49°	11	Resección hemivértebra T11	3	5.5	pre5/8/9/8/7/5/4/3	6	Higher thoracic spine	Lateral decubitus	None	12	60	72	60	7 (GW)	1050
52	15	F	Idiopathic	62°/18°	75°/56°	10	SPO	2	4	pre5/9/8/7/6/3/2	2	Rib cage	Lateral decubitus	Nausea, dizziness	24	48	60	48	6 (GW)	900

(Cont.)

Rev Asoc Argent Ortop Traumatol 2019; 84 (3): 224-235 • ISSN 1852-7434 (online)

Table 2. (*cont.*)

Patient	Age	Sex	Underlying condition	Degree of scoliosis (PREOP/ POSTOP)	Degree of kyphosis (PREOP/ POSTOP)	Operated levels	Osteotomoies (SPO/PeSO/ CVR)	ASA score	Surgical time (h)	PREOP/POSTOP daily NRE	When did postoperative pain start? (h)	Where does it hurt?	How is the pain relieved?	Postoperative signs and symptoms (nausea, vomiting, infection, neurological injury)	Transition to solid diet (POSTOP h)	Drainage removal (POSTOP h)	Bladder catheter removal (POSTOP h)	Switch from IV to oral pain killers (POSTOP h)	POSTOP hospital stay (days) (ICU-GW)	Estimated hospital costs (x hospitalization days, thousands of USD)
53	14.3	F	Idiopathic	64°/41°	11°/21°	13	SPO	2	3.7	pre1/7/8/9/4/5	1	Right shoulder	Dorsal decubitus	Vomiting, dizziness, headache	36	60	72	48	5 (GW)	750
54	14.3	F	Idiopathic	64°/19°	35°/31°	13	SPO	2	3.8	pre2/7/8/9/7/5	2	Higher thoracic spine	Dorsal decubitus	Nausea	48	48	60	48	5 (GW)	750
55	14.9	F	Syndromic	70°/74°	23°/25°	11	SPO	3	4	pre2/8/6/5/7/3/3	4	Whole spine	Dorsal decubitus	Vomiting	60	60	48	36	6 (GW)	900
56	10	F	Congenital	40°/60°	21°/25°	8	SPO	3	4	pre2/7/8/4/5/4/4	1	Rib cage	Dorsal decubitus	Nausea	48	60	48	48	6 (GW)	900
57	15.4	F	Idiopathic	15°/11°	70°/56°	10	SPO	2	4.2	pre1/9/8/7/5/4/3	2	Whole spine	Dorsal decubitus	Nausea, vomiting	12	48	60	60	6 (GW)	900
58	15.8	F	Idiopathic	50°/51°	5°/21°	11	SPO	2	4.5	pre2/8/6/7/4	6	Higher thoracic spine	Dorsal decubitus	Nausea	12	60	72	72	4 (GW)	600
59	15.6	M	Neurofibromatosis	49°/43°	36°/32°	11	SPO	3	6.8	pre2/7/5/7/3	2	Lumbar spine	Lateral decubitus	Nausea	60	48	72	72	4 (ICU) 5 (GW)	1750
60	16	F	Congenital	82°/52°	32°/33°	8	SPO	3	3.7	pre2/7/8/8/4	4	Lower lumbar spine	Lateral decubitus	None	12	48	60	48	4 (GW)	600
61	11.2	F	Idiopathic	20°/11°	45°/41°	14	SPO	2	4.1	pre3/8/7/7/5/3	2	Higher thoracic spine	Dorsal decubitus	Vomiting	48	72	60	48	5 (GW)	750
62	15.4	F	Idiopathic	65°/74°	17°/33°	12	SPO	2	4	pre2/8/7/8/6/4/3/3	4	Rib cage	Dorsal decubitus	Nausea	48	60	72	60	7 (GW)	1050
63	12.6	F	Neuropathic	38°/50°	36°/32°	12	SPO	3	4	pre2/8/9/8/9/5	2	Whole spine	Lateral decubitus	Nausea	24	60	60	48	8 (GW)	1200
64	12.4	F	Idiopathic	73°/33°	22°/25°	5	SPO	3	3.5	pre0/9/8/8/8/5/	2	Higher thoracic spine	Dorsal decubitus	Nausea, vomiting	36	60	72	60	5 (GW)	750
65	13.5	F	Idiopathic	65°/16°	20°/31°	8	SPO	3	3.6	pre0/9/8/9/7/3	4	Thoracic spine	Lateral decubitus	Nausea, vomiting	48	60	60	48	4 (GW)	600
66	14.9	F	Idiopathic	67°/12°	25°/26°	14	None	2	2.5	pre3/9/8/7/8/4/3	12	Whole spine	Lateral decubitus	Vomiting	48	60	48	48	4 (GW)	600
67	12.7	F	Idiopathic	45°/17°	19°/29°	13	SPO	3	6.8	pre1/9/8/8/7/4/2	2	Higher thoracic spine	Dorsal decubitus	Nausea	36	48	48	72	6 (GW)	900
68	14.6	M	Lumbar kyphosis	75°/58°	71°/48°	7	PeSO	3	3.7	pre2/8/8/7/4/2/4/5/8/5/6/4/4	6	Lower lumbar spine	Dorsal decubitus	None	48	36	60	36	12 (GW)	1800
69	16.9	F	Idiopathic	No	40°/-15°	9	SPO	2	4.1	pre2/9/6/4/3	4	Rib cage	Dorsal decubitus	Vomiting	48	72	48	48	4 (GW)	600
70	17.9	M	Idiopathic	46°/11°	32°/36°	6	SPO	2	4	pre2/10/8/9/7/6/4	2	Whole spine	Dorsal decubitus	Nausea, vomiting	48	72	72	48	4 (GW)	600

(Cont.)

Table 2. (*cont.*)

Patient	Age	Sex	Underlying condition	Degree of scoliosis (PREOP/ POSTOP)	Degree of kyphosis (PREOP/ POSTOP)	Operated levels	Osteotomoies (SPO/PeSO/ CVR)	ASA score	Surgical time (h)	PREOP/POSTOP daily NRE	When did postoperative pain start? (h)	Where does it hurt?	How is the pain relieved?	Postoperative signs and symptoms (nausea, vomiting, infection, neurological injury)	Transition to solid diet (POSTOP h)	Drainage removal (POSTOP h)	Bladder catheter removal (POSTOP h)	Switch from IV to oral pain killers (POSTOP h)	POSTOP hospital stay (days) (ICU-GW)	Estimated hospital costs (x hospitalization days, thousands of USD)
71	10	F	Syndromic	46°/8°	46°/41°	5	No	3	4	pre3/8/7/3	6	Higher thoracic spine	Dorsal decubitus	Nausea	24	48	60	48	3 (GW)	450
72	14.1	F	Syndromic	75°/23°	30°/33°	12	SPO	3	3.5	pre2/8/9/7/5/3/3	2	Lumbar spine	Lateral decubitus	Nausea	36	48	72	48	3 (ICU) 3 (GW)	1200
73	15.1	M	Achondroplasia	56°/22°	15°/22°	10	SPO	3	3.6	pre2/8/6/8/5	4	Lower lumbar spine	Lateral decubitus	Vomiting	24	48	48	48	4 (GW)	600
74	15	F	Idiopathic	45°/25°	75°/65°	16	SPO	3	3	pre4/8/7/6/5/3/4/3	4	Whole spine	Lateral decubitus	Vomiting	36	36	60	48	3 (ICU) 4 (GW)	1350
75	12.2	F	Idiopathic	112°/39°	80°/47°	9	SPO	1	3.4	pre1/8/7/4/3	2	Higher thoracic spine	Dorsal decubitus	Nausea	36	48	48	72	4 (GW)	600
76	13.4	F	Idiopathic	70°/21°	22°/33°	11	SPO	1	4.6	pre1/10/9/9/9/8/7/6/4	6	Lower lumbar spine	Dorsal decubitus	None	12	36	60	36	8 (GW)	1200
77	14.9	F	Neuropathic	80°/30°	30°/32°	14	SPO	3	4.5	pre1/8/9/7/8/6/4/3/3	4	Rib cage	Dorsal decubitus	Vomiting	48	72	48	48	4 (ICU) 4 (GW)	1600
78	14.3	F	Idiopathic	81°/30°	35°/34°	13	SPO	2	5.5	pre0/9/7/5/2	2	Whole spine	Dorsal decubitus	Nausea, vomiting	48	72	72	48	4 (GW)	600
79	10.4	F	Idiopathic	66°/20°	33°/38°	8	SPO	2	3	pre0/9/8/3/2	6	Higher thoracic spine	Dorsal decubitus	None	24	48	60	48	4 (GW)	600
80	10.8	M	Neuropathic	50°/15°	20°/31°	18	SPO	3	6	pre1/8/9/8/7/5/4/3/3	2	Lumbar spine	Lateral decubitus	Nausea	36	48	48	48	5 (ICU) 3 (GW)	1700
81	12.6	M	Osteoid osteoma C5	95°/41°	20°/21°	3	Tumor resection	2	3.6	pre8/5/6/5/4	4	Lower lumbar spine	Lateral decubitus	Vomiting	24	48	48	48	4 (ICU)	1000
82	17.3	F	Idiopathic	Tumor C5	Tumor C5	10	SPO	2	2.8	pre0/9/7/4/3	4	Rib cage	Dorsal decubitus	Vomiting	36	72	60	36	4 (GW)	600
83	14	F	Idiopathic	59°/22°	30°/31°	6	SPO	2	4.5	pre1/8/9/6/3/3	2	Whole spine	Dorsal decubitus	Nausea, vomiting	48	72	72	48	5 (GW)	750
84	11.8	F	Syndromic	65°/17°	23°/28°	7	SPO	2	5	pre2/7/6/7/4/3/3/2/3	6	Lumbar spine	Dorsal decubitus	Nausea, vomiting	24	48	60	60	3 (ICU) 5 (GW)	1500

PREOP = preoperative period, POP = postoperative period, SPO = Smith-Peterson osteotomy, PeSO = pedicle subtraction osteotomy, CVR = complete vertebral resection, ASA = American Society of Anesthesiologists, NRE = numerical rating scale, IV = intravenous, PJK = proximal junction kyphosis , ICU = Intensive Care Unit, GW = General Ward, NA = no answer.

DISCUSSION

Postoperative pain is described as a subjective symptom affected by multiple factors and a major challenge for healthcare teams. We do not know of any local consensus on pain management in the postoperative period of spinal surgeries in the pediatric population. This study was carried out with the objective of describing, first and foremost, the presence of pain and its intensity in the postoperative period of a spinal surgery in the pediatric population, and to evaluate the efficacy of pain management.

It has been described that poor management of postoperative pain alters concentration and affects cognition and sociabilization. In the pediatric population, these mechanisms can become behavioral disorders in critical developmental stages and, if untreated, can last until adulthood.

After a systematic review, the American Pain Society, together with the ASA, outlined treatment recommendations: 1) to provide pre- and perioperative education on pharmacological pain management to the patient and the family,[1,5,6] thus promoting shorter hospitalization[5,7-10] and, consequently, reducing the rate of postoperative complications. This educational task during preoperative consultations will be subject to the patient's age, and patient's level of understanding and cultural or linguistic competence—and that of their family or guardian[1]. 2) To provide tools to the family or guardian to assess the intensity of the pain and communicate it to nurses or caregivers in the ward.[11] These two recommendations were taken into account for future studies. 3) To evaluate comorbidities; medication history; and history of chronic pain, substance abuse and hospitalizations in order to rule out and identify these variables. 4) To adapt the protocol to pain relief and adverse effects detected (a criterion that we share in this hospital). 5) To use an internationally validated pain scale (numerical rating scale or visual analog scale), and to use it 1 or 2 hours after the pharmacological intervention as per the protocol. We adopted this recommendation and, thus, our patients were evaluated daily.[13,25,29] 6) To use multimodal therapies for pain management (Psychopathology and Physical Therapy Service). 7) To adopt oral instead of IV methods.[30,31] We also agree with both recommendations. 8) As per intenational reccommendations, to use an analgesic pump that can be self-administered by the patient.[32,33] In our setting, we do not have this nor the infusion of drugs by epidural catheter due to the need for Intensive Care for all our patients in the immediate postoperative period. 9) To include acetaminophen or an NSAID in the multimodal pain management protocol due to the potentiation effect of both drugs.[14,17,34] 10) To administer pregabalin (150-300 mg/day) or gabapentin (600-1200 mg/day), since both are associated with better postoperative pain scores and lower postoperative opioid usage. As they are administered only orally, they cannot be used in the immediate postoperative period.[18-21,26,27,35] 11) To promote the development of policies and standardized procedures for the correct implementation of the pain management protocol in the postoperative period of a spinal surgery, and to designate a team for its control in order to assure implementation.[36] We share these concepts, and the last two recommendations will be further explored in future studies.

Landman *et al.* found that the population with idiopathic scoliosis often referred pain before surgery, and that 50% had no change in pain intensity, 25% reported less pain and 25% reported more intense pain during the postoperative period.[24]

In a study by Hayes *et al.*, the administration of NSAIDs as an adjuvant to opioids in postoperative management was beneficial, since pain scores decreased and, in turn, so did the administration of opioids.[37] We share this concept and incorporated it to our protocol.

Weisman *et al.*, like the other studies, concluded that the administration of an antineuritic agent, such as gabapentin, before surgery decreases the use of morphine within the first 48 hours of the postoperative period and improves pain scores.[22] At present, it is not included in our protocol, but it is in consideration for future updates.

Another therapeutic option is the intrathecal infusion of pain killers/morphine, which lasts 12 to 18 hours after surgery; on the other hand, epidural catheter infusion with longer-acting pain killers with a less variable analgesic effect, especially at night, when control is lost to the use of patient-controlled analgesia, is standard for the control of postoperative pain.[38] Both types of infusions require close monitoring in the ICU during the immediate postoperative period, something that we do not frequently have avaible; therefore, we do not prescribe it. On the other hand, a patient-controlled analgesia device is not available in our center; therefore, the morphine infusion pump becomes the most widely used method for the management of postoperative pain in our hospital. One of the advantages of a continuous morphine infusion is that it does not require collaboration or coparticipation of the patient/family and maintains a stable plasmatic level during the night or during the sedation period of the patient.[39]

Connelly *et al.* found no relationship between certain variables (age, sex, body mass index, family economic status, degree of deformity and surgical time) and their representation of pain during the postoperative period, which helped to conclude that pain is a response to multiple factors with no relation between the severity of the deformity

and the demographic variables.[40-44] From the perspective of our heterogeneous population, and upon re-evaluating it in subgroups, we agree with that argument. In another study, the same authors made reference to the fact that the representation of preoperative pain is an important predictive factor of the length of hospital stay after surgery, so it is necessary to control it pharmacologically and not pharmacologically before the surgical procedure.[40-43] We agree with this methodology, the use of multimodal therapy and the administration of preoperative drugs to improve the postoperative state of the patient. This methodology is reserved for future research.

In multiple studies, Haber *et al*. referred to the importance of standardized and multimodal pain management strategies after spinal surgery, and to the reduction in the use of opioid equivalents in pain management protocols, and emphasized on comprehensive postoperative spinal pain management,[12] which would contribute to shorten the hospital stay and the financial costs. This served, to a large extent, as the main trigger for this research study.

One of the limitations of our study could be the heterogeneity of the population evaluated and perhaps the difficult interpretation of its results trying to correlate one condition with the other, which we will not discuss on this paper. Another limitation could be that only posterior approach procedures were considered, while those with combined or anterior approaches were excluded.

These recommendations do not apply to all patients and clinical situations. Future validation studies will be required to determine whether inclusion of these variables within multimodal therapy is useful in daily practice or not.

CONCLUSIONS

Postoperative pain management after spinal surgery in the pediatric population is a real challenge to the healthcare team. A high percentage of patients report regular or poor postoperative pain management. The medical literature notes that optimal pain management begins before surgery and is based on the continuous evaluation of the patient and the standardized development of a multimodal analgesic protocol which, at the same time, is individualized according to the surgical procedure and the patient's comorbidities. This would promote a more satisfactory cost-effective social care, with better functional results for the patient, their family and the hospital.

Acknowledgement

To Lawrence Haber, MD for his kindness in providing us with information on multimodal management of postoperative pain in the pediatric population after spinal surgeries.

Conflict of interest: Authors claim they do not have any conflict of interest.

C. A. Tello ORCID iD: http://orcid.org/0000-0003-1402-3724
I. A. Francheri Wilson ORCID iD: http://orcid.org/0000-0003-2634-0719
R. Remondino ORCID iD: http://orcid.org/0000-0002-8388-298X
E. Galaretto ORCID iD: http://orcid.org/0000-0003-4121-8228
E. S. Bersusky ORCID iD: http://orcid.org/0000-0002-3121-9326
M. A. Noel ORCID iD: http://orcid.org/0000-0002-6668-1342

REFERENCES

1. Chou R, Gordon DB, de León-Casasola OA, Rosenberg JM, Bickler S, Brennan T, et al. Guidelines on the Management of Postoperative Pain Management of Postoperative Pain: A Clinical Practice Guideline from the American Pain Society, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists' Committee on Regional Anesthesia, Executive Committee, and Administrative Council. *J Pain* 2016;17(2):131-57. https://doi.org/10.1016/j.jpain.2015.12.008
2. Gan TJ, Habib AS, Miller TE, White W, Apfelbaum JL. Incidence, patient satisfaction, and perceptions of postsurgical pain: Results from a US national survey. *Curr Med Res Opin* 2014;30:149-60. https://doi.org/10.1185/03007995.2013.860019
3. Kehlet H, Jensen T, Woolf C. Persistent postsurgical pain: risk factors and prevention. *Lancet* 2006;367:1618-25. https://doi.org/10.1016/S0140-6736(06)68700-X
4. Chou R, Thames LL, Dana T, Pappas M, Mitchell JP. *Evidence review on the management of postoperative pain*. Glenview, IL: American Pain Society; 2016.
5. Egbert LD, Battit GE, Welch CE, Bartlett MK. Reduction of postoperative pain by encouragement and instruction of patients. A study of doctor-patient rapport. *N Engl J Med* 1964:270:825-7. https://doi.org/10.1056/NEJM196404162701606
6. Langer EJ, Janis IL, Wolfer JA. Reduction of psychological stress in surgical patients. *J Exp Soc Psychol* 1975;11:155-65. https://doi.org/10.1016/S0022-1031(75)80018-7
7. Crowe J, Henderson J. Pre-arthroplasty rehabilitation is effective in reducing hospital stay. *Can J Occup Ther* 2003;70:88-96. https://doi.org/10.1177/000841740307000204
8. Doering S, Katzlberger F, Rumpold G, Roessler S, Hofstoetter B, Schatz DS, et al. Videotape preparation of patients before hip replacement surgery reduces stress. *Psychosom Med* 2000;62:365-73. PMID: 10845350
9. Arthur HM, Daniels C, McKelvie R, Hirsh J, Rush B. Effect of a preoperative intervention on preoperative and postoperative outcomes in low-risk patients awaiting elective coronary artery bypass graft surgery. A randomized, controlled trial. *Ann Intern Med* 2000;133:253-62. https://doi.org/10.7326/0003-4819-133-4-200008150-00007
10. Wilson JF. Behavioral preparation for surgery: Benefit or harm? *J Behav Med* 1981;4:79-102. PMID: 7026795
11. Kankkunen P, Vehviläinen-Julkunen K, Pietilä AM, Halonen P. Is the sufficiency of discharge instructions related to children's postoperative pain at home after day surgery? *Scand J Caring Sci* 2003;17:365-72. PMID: 14629639
12. Haber L. How to accelerate recovery of AIS patients after posterior spinal fusion. Multiple modality pain protocols. Scoliosis Research Society Annual Meeting, Minneapolis, MN, 2015.
13. Beyer JE, Bournaki MC. Assessment and management of postoperative pain in children. *Pediatrician* 1989;16:30-8. PMID: 2566985
14. Pettersson PH, Jakobsson J, Owall A. Intravenous acetaminophen reduced the use of opioids compared with oral administration after coronary artery bypass grafting. *J Cardiothorac Vasc Anesth* 2005;19:306-9. PMID: 16130055
15. Li Q, Zhang Z, Cai Z. High-dose ketorolac affects adult spinal fusion: a meta-analysis of the effect of perioperative non steroidal anti-inflammatory drugs on spinal fusion. *Spine* 2011;36: E461-E468. https://doi.org/10.1097/BRS.0b013e3181dfd163
16. Dodwell ER, Latorre JG, Parisini E, Zwettler E, Chandra D, Mulpuri K, et al. NSAID exposure and risk of nonunion: A meta-analysis of case-control and cohort studies. *Calcif Tissue Int* 2010;87:193-202. https://doi.org/10.1007/s00223-010-9379-7
17. Sucato DJ, Lovejoy JF, Agrawal S, Elerson E, Nelson T, McClung A. Postoperative ketorolac does not predispose to pseudoarthrosis following posterior spinal fusion and instrumentation for adolescent idiopathic scoliosis. *Spine* 2008;33:1119-24. https://doi.org/10.1097/BRS.0b013e31816f6a2a
18. Rusy LM, Hainsworth KR, Nelson TJ, Czarnecki ML, Tassone JC, Thometz JG, et al. Gabapentin use in pediatric spinal fusion patients: a randomized, double-blind, controlled trial. *Anesth Analg* 2010;110:1393-8. https://doi.org/10.1213/ANE.0b013e3181d41dc
19. Amin SM, Amr YM. Comparison between preemptive gabapentin and paracetamol for pain control after adenotonsillectomy in children. *Anesth Essays Res* 2011;5:167-70. https://doi.org/10.4103/0259-1162.94758
20. Agarwal A, Gautam S, Gupta D, Agarwal S, Singh PK, Singh U. Evaluation of a single preoperative dose of pregabalin for attenuation of postoperative pain after laparoscopic cholecystectomy. *Br J Anaesth* 2008;101:700-4. https://doi.org/10.1093/bja/aen244
21. Chang SH, Lee HW, Kim HK, Kim SH, Kim DK. An evaluation of perioperative pregabalin for prevention and attenuation of postoperative shoulder pain after laparoscopic cholecystectomy. *Anesth Analg* 2009;109:1284-6. https://doi.org/10.1213/ane.0b013e3181b4874d
22. Hayes J, Pehora C, Bissonnette B. The use of NSAIDs in pediatric scoliosis surgery - a survey of physicians' prescribing practice. *Paediatr Anaesth* 2009;19(8):756-63. https://doi.org/10.1111/j.1460-9592.2009.03060.x

23. Apfelbaum JL, Chen C, Mehta SS, Gan TJ. Postoperative pain experience: Results from a national survey suggest postoperative pain continues to be undermanaged. *Anesth Analg* 2003;97:534-40. https://doi.org/10.1213/01.ane.0000068822.10113.9e
24. Bastrom TP, Marks MC, Yaszay B, Newton PO; Harms Study Group. Prevalence of postoperative pain in adolescent idiopathic scoliosis and the association with preoperative pain. *Spine (Phila Pa 1976)* 2013;38(21):1848-52. https://doi.org/10.1097/BRS.0b013e3182a4aa97
25. Beyer JE, Villarruel AM, Deynes MJ. *The Oucher: User's manual and technical report*. Disponible en: www.oucher.org/downloads/2009_Users_Manual.pdf. Consulta: 8 de enero, 2016.
26. Freedman BM, O'Hara E. Pregabalin has opioid-sparing effects following augmentation mammaplasty. *Aesthet Surg J* 2008;28:421-4. https://doi.org/10.1016/j.asj.2008.04.004
27. Jokela R, Ahonen J, Tallgren M, Haanpää M, Korttila K. Premedication with pregabalin 75 or 150 mg with ibuprofen to control pain after day-case gynaecological laparoscopic surgery. *Br J Anaesth* 2008;100:834-40. https://doi.org/10.1093/bja/aen098
28. Bradley EH, Herrin J, Mattera JA, Holmboe ES, Wang Y, Frederick P, et al. Quality improvement efforts and hospital performance: rates of beta-blocker prescription after acute myocardial infarction. *Med Care* 2005;43:282-92. PMID: 15725985
29. Buchholz M, Karl HW, Pomietto M, Lynn A. Pain scores in infants: a modified infant pain scale versus visual analogue. *J Pain Symptom Manage* 1998;15:117-24. PMID: 9494310
30. Tramèr MR, Williams JE, Carroll D, Wiffen PJ, Moore RA, McQuay HJ. Comparing analgesic efficacy of non-steroidal anti-inflammatory drugs given by different routes in acute and chronic pain: a qualitative systematic review. *Acta Anaesthesiol Scand* 1998;42:71-9. PMID: 9527748
31. U.S. Food and Drug Administration. Extended release-long acting opioid analgesics. Disponible en: www.fda.gov/Safety/MedWatch/SafetyInformation/ucm396503. htm. Consulta: 9 de diciembre, 2015.
32. Saudan S, Habre W, Ceroni D, Meyer PA, Greenberg RS, Kaelin A, et al. Safety and efficacy of patient controlled epidural analgesia following pediatric spinal surgery. *Paediatr Anaesth* 2008;18:132-9. https://doi.org/10.1111/j.1460-9592.2007.02383.x
33. Jarzyna D, Jungquist CR, Pasero C, Willens JS, Nisbet A, Oakes L, et al. American Society for Pain Management Nursing Guidelines on Monitoring for Opioid-Induced Sedation and Respiratory Depression. *Pain Manag Nurs* 2011;12:118-45. https://doi.org/10.1016/j.pmn.2011.06.008
34. Ong CK, Seymour RA, Lirk P, Merry AF. Combining paracetamol (acetaminophen) with nonesteroidal anti-inflammatory drugs: a qualitative systematic review of analgesic efficacy for acute postoperative pain. *Anesth Analg* 2010;110:1170-9. https://doi.org/10.1213/ANE.0b013e3181cf9281
35. Ravish M, Muldowney B, Becker A, Hetzel S, McCarthy JJ, Nemeth BA, et al. Pain management in patients with adolescent idiopathic scoliosis undergoing posterior spinal fusion: combined intrathecal morphine and continuous epidural versus PCA. *J Pediatr Orthop* 2012;32(8):799-804. https://doi.org/10.1097/BPO.0b013e3182694f00
36. Reynolds MA. Postoperative pain management discharge teaching in a rural population. *Pain Manag Nurs* 2009;10:76-84. https://doi.org/10.1016/j.pmn.2008.07.003
37. Sieberg CB, Simons LE, Eldestein MR, DeAngelis MR, Pielech M, Sethna N, et al. Pain prevalence and trajectories following pediatric spinal fusion surgery. *J Pain* 2013;14(12):1694-702. https://doi.org/10.1016/j.jpain.2013.09.005
38. Milbrandt TA, Singhal M, Minter C, McClung A, Talwalkar VR, Iwinski HJ, et al. A comparison of three methods of pain control for posterior spinal fusions in adolescent idiopathic scoliosis. *Spine (Phila Pa 1976)* 2009;34(14):1499-503. https://doi.org/10.1097/BRS.0b013e3181a90ceb
39. Poe-Kochert C, Tripi PA, Potzman J, Son-Hing JP, Thompson GH. Continuous intravenous morphine infusion for postoperative analgesia following posterior spinal fusion for idiopathic scoliosis. *Spine (Phila Pa 1976)* 2010;35(7):754-7. https://doi.org/10.1097/BRS.0b013e3181bc9a00
40. Landman Z, Oswald T, Sanders J, Diab M; Spinal Deformity Study Group. Prevalence and predictors of pain in surgical treatment of adolescent idiopathic scoliosis. *Spine (Phila Pa 1976)* 2011;36(10):825-9. https://doi.org/10.1097/BRS.0b013e3181de8c2b
41. Hiller A, Helenius I, Nurmi E, Neuvonen PJ, Kaukonen M, Hartikainen T, et al. Acetaminophen improves analgesia but does not reduce opioid requirement after major spine surgery in children and adolescents. *Spine (Phila Pa 1976)* 2012;15;37(20):E1225-31. https://doi.org/ 10.1097/BRS.0b013e318263165c
42. Rullander AC, Jonsson H, Lundström M, Lindh V. Young people's experiences with scoliosis surgery: a survey of pain, nausea, and global satisfaction. *Orthop Nurs* 2013;32(6):327(33):334-5. https://doi.org/10.1097/NOR.0000000000000007
43. Connelly M, Fulmer RD, Prohaska J, Anson L, Dryer L, Thomas V, et al. Predictors of postoperative pain trajectories in adolescent idiopathic scoliosis. *Spine (Phila Pa 1976)* 2014;39(3):E174-81. https://doi.org/10.1097/BRS.0000000000000099
44. Mayell A, Srinivasan I, Campbell F, Peliowski A. Analgesic effects of gabapentin after scoliosis surgery in children: a randomized controlled trial. *Paediatr Anaesth* 2014;24(12):1239-44. https://doi.org/10.1111/pan.12524