Asian Biomedicine Vol. 8 No. 3 June 2014; 345 - 351 DOI: 10.5372/1905-7415.0802.298

Original article

Nurse-controlled analgesia for postoperative pain in pediatric patients: effects on nurses' attitudes and patient care

Suwannee Suraseranivongse[a], Parichart Wattanaamornkiet[b], Vimolluck Sanansilp[a], Napamas Srikwan[b], Somluck Termtor[b], Umaporn Kaewchinda[b], Saovanee Chianvichai[b]

[a]Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand, [b]Division of Nursing, Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand

Background: Because of the limited number of patient-controlled analgesia (PCA) pumps in our developing country, we proposed a technique of modified nurse-controlled analgesia (NCA) to relieve postoperative pain in pediatric patients.

Objective: We assessed efficacy, safety, compliance by nurses, and satisfaction including parent satisfaction of a modified NCA protocol compared with fixed-dose analgesia conventionally used for postoperative pain relief in pediatric patients.

Methods: A prospective study design was conducted in pediatric patients who underwent major surgery in a university hospital. In the pre-NCA phase, patients received a conventional fixed-dose opioid after surgery. In the NCA phase, nurses could initiate two additional small doses autonomously, as prescribed, if the initial bolus was inadequate. Outcome measures were the number of moderate to severe pain scores, respiratory depression, compliance by nurses, and parent satisfaction.

Results: There were 117 and 113 patients in the pre-NCA and NCA phases, respectively. Detection of moderate to severe pain ≥2 episodes in 24 h after surgery was significantly higher in the NCA phase especially in moderate to severe pain procedures. Respiratory depression was not found in either phase. The majority of nurses showed positive attitudes to routine use of a modified NCA protocol. Parent satisfaction was high in both groups.

Conclusion: The attitude of nurses toward the modified NCA protocol was positive and it significantly increased detection of episodes of moderate to severe postoperative pain, which accordingly increased patient care and pain relief without severe untoward effects.

Keywords: Nurse-controlled analgesia, nurse attitude, pediatrics, postoperative pain

Inadequate pain assessment and management in pediatric patients results in several untoward and long lasting effects [1, 2]. Nurse-controlled analgesia (NCA) using a patient-controlled analgesia (PCA) pump according to appropriate pain assessment has been reported to be safe and effective for a wide range of ages and types of surgery in pediatric patients [3, 4].

Because of insufficient resources in our developing country, the availability of PCA pumps is limited. We proposed a modified NCA protocol using nurse-initiated analgesia [5, 6] to relieve postoperative pain in pediatric patients.

***Correspondence to*:** Dr. Vimolluck Sanansilp, Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand. E-mail: sivslvim@gmail.com

Traditionally, nurses are acquainted with using fixed-dose analgesia. However, they were not usually permitted to provide additional treatment in case of inadequate pain control. In this study, nurses who used a modified NCA protocol were authorized to make autonomous decisions for additional analgesia. The authors aimed to assess efficacy, safety, attitude of nurses, and parent satisfaction of a modified NCA protocol compared with routinely used fixed-dose analgesia.

Materials and methods

This quasi-experimental study was approved by our Institutional Review Board, and registered on ClinicalTrials.gov as NCT01325077. The pre-NCA phase was conducted in July to December 2010 and the NCA phase was conducted in April to September 2011 in a Thai University hospital.

Pediatric patients, aged between 1 month and 15 years, who underwent major surgery, were included except those with cardiac surgery, and neurosurgery with impaired consciousness. Written informed consent was obtained from the guardians of all patients, and informed assent was also obtained from patients of age 7 years old or more.

In the pre-NCA phase, all patients were routinely assessed for pain using age-specific tools at regular intervals for 72 hours after surgery. Appropriate pain assessment tools included the Neonatal Infant Pain Scale (NIPS) for neonates and infants [7], Children's Hospital of Eastern Ontario Pain Scale (CHEOPS) for preschoolers (1–6 years) [8] and a Numerical Rating Scale (NRS) for older children [9]. These age-specific pain scales had been routinely used for several years and nurses were regularly trained to use them. Pain scores and sedation scores were routinely assessed by trained nurses at 1-hour intervals for 4 times, then 2-hour intervals for 4 times, and 4-hour intervals until 72 hours after surgery. Continuous pulse oximetry was used for patients of less than 6 months old. Cut-off points of pain scales for moderate to severe pain (NIPS ≥4, CHEOPS ≥8, NRS ≥5) were used by nurses to provide analgesics once after pain assessment as necessary (pro re nata or PRN). Preprinted pain treatment order sheets consisted of proper age-specific orders for monitoring, criteria for respiratory depression, analgesic doses for intravenous (IV) infusion and intermittent bolus with an appropriate dosing interval of each opioid for each age group, as well as treatments for side effects of opioids such as respiratory depression, nausea or vomiting, and pruritus. The dose of opioid routinely used in our hospital was one-half of the usual recommended dose [10].

The modified NCA protocol in the NCA phase implied the PRN regimen described above, combined with nurse-initiated analgesia, such that nurses could autonomously initiate two small extra doses, at 30-minute intervals, if they found inadequate pain relief, i.e., the pain scores were still above the cut-off points on the pain scales. In the intermittent regimen, each extra dose was half of the initial bolus dose; whereas in the infusion regimen, it was the same amount as the amount infused per hour. If the two extra doses were not effective, they would call the responsible doctor (**Table 1**). This NCA protocol's preprinted order had an additional regime, to the routine preprinted order in pre-NCA phase. All nurses were trained to provide incremental doses of opioids in case of pain scores above the cut-off point, after a 30-minute interval between bolus doses, including how to monitor deep sedation and respiratory depression.

Table 1. Protocol for opioid prescription in the pre-NCA (prescription A or prescription C), and the NCA (prescription A+B, or prescription C+D) phases

Prescription A:	Intermittent IV bolus:		
	Fentanyl	0.5–1 mcg/kg	prn every 2 h
	Pethidine	0.5 mg/kg	prn every 2–3 h
	Morphine	0.05 mg/kg	prn every 2–4 h
Prescription B:	In case of inadequate pain relief,[1] add □ of initial bolus dose PRN every 30 min. If additional doses were given twice without improvement, call doctor.		
Prescription C:	IV infusion:		
	Fentanyl	0.5–1	mcg/kg/h
	Morphine	10–30	mcg/kg/h
Prescription D:	In case of inadequate pain relief, add the same volume of opioid, which was currently infused per hour, at 30-minute interval.		
If additional doses were given twice without improvement, increase infusion rate as ordered.			
If sedation score was ≥2, decrease infusion rate as ordered.			
If there is no improvement, call doctor.			

NCA= nurse-controlled analgesia, [1]Inadequate pain relief = NIPS ≥4, CHEOPS ≥8, NRS ≥5, PRN = pro re nata or as necessary

Research nurses collected data prospectively in both the pre-NCA and the NCA phase. Demographic data (including age and type of surgery), pain scores, frequency of moderate to severe pain, frequency of pain assessment, frequency of analgesic given, occurrence of respiratory depression, and proportion of preprinted protocol prescribed were recorded. Nurses' opinions of NCA and parent satisfaction of pain management were evaluated by anonymous questionnaires.

Prevalence of moderate to severe pain in this study was defined as the proportion of patients with at least 2 episodes of moderate to severe pain (pain scores above the cut-off points).

Statistical analyses

Based on our previous experience of incidence of moderate to severe postoperative pain in pediatric patients of 50% [11], a modified NCA was predicted to detect the difference of pain incidents of 30%. Using the power = 0.8, type 1 error = 0.05, drop out = 20%, estimated sample was 103 patients per group.

All statistical analyses were calculated using SPSS version 10 (SPSS, Chicago, IL USA). Data were analyzed using descriptive statistics. Nonparametric continuous data were compared by using a Mann–Whitney *U* test. Parametric continuous data were compared using a Student's *t* test. Categorical data were compared using Chi-squared and Fisher's exact tests. $P < 0.05$ was considered statistically significant.

Results

Two hundred and fifty patients were enrolled, 7 and 13 patients were dropouts in the pre-NCA phase and NCA phase, respectively. One hundred seventeen patients in the pre NCA phase and 113 patients in the NCA phase remained (**Figure 1**).

Demographic data, including age and body weight, and types of surgery were not different between groups (**Table 2**). The number of upper abdominal surgeries in the NCA phase was greater than in the pre-NCA phase, but this difference was not significant.

We found that nurses could determine whether patients had moderate to severe pain ≥2 times as well as the total episodes of moderate to severe pain following surgery in the NCA phase, using the modified NCA protocol, more frequently than in the pre-NCA phase (**Table 3**). Therefore the prevalence of pain was significantly higher in the NCA phase than in the pre-NCA phase.

Although the episodes of giving IV opioid were not different between the two phases (**Table 3**), when a subgroup analysis was performed for the patients who underwent moderate to severely painful procedures, the number of patients who had ≥2 episodes of moderate to severe pain in 24 hours and the number of patients who received ≥2 doses of IV opioid in 24 and 72 hours in the NCA phase were significantly higher than in the pre-NCA phase (**Table 4**).

The response rate of nurses to the NCA practicality survey was 100%. The majority of nurses showed positive attitudes to routine use of the modified NCA protocol. Nurses did not find any opposition from parents, surgical residents or staff in using this protocol. Although most nurses did not consider the modified NCA protocol as a difficult task or a burden, about one quater of all nurses did (**Table 5**). During an in-depth interview, they complained of the confusing format of the modified NCA protocol prescription and their concern for the responsibility to initiate the extra doses autonomously.

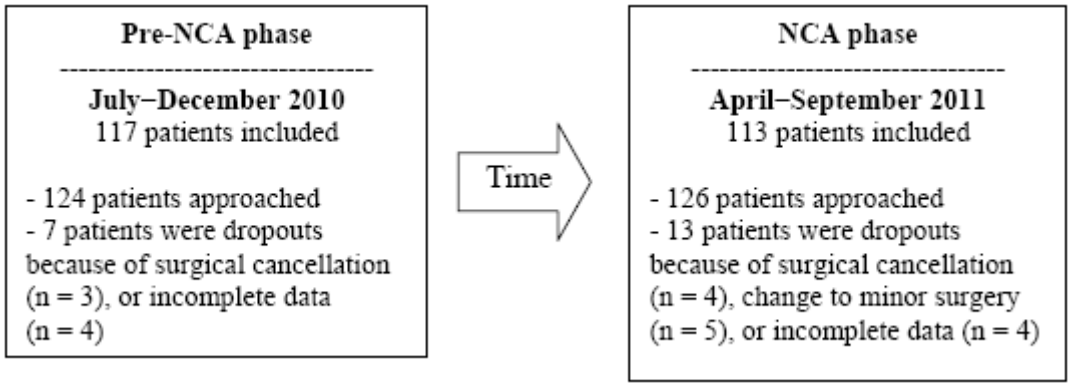

Figure 1. Description of the different phases in the interventional study

Table 2. Demographic data and type of surgery in the pre-NCA and NCA phases

	Pre NCA (n = 117)	NCA (n = 113)	*P*
Age group			0.52
Infant	22 (18.8)	15 (13.4)	
Preschooler	54 (46.2)	57 (50.9)	
Children	41 (35.0)	40 (35.7)	
Missing	0	1	
Age (years)	4 (1 to 11) [0.003, 15]	4 (1 to 10) [0.083, 16]	0.66
Body weight (kg)	15 (8.8 to 33.0) [1.8, 77]	14.9 (10.3 to 31.2) [3, 87]	0.55
Sites of surgery			0.23
Thoracic	1 (0.9)	1 (0.9)	
Upper abdomen and kidney	28 (23.9)	36 (31.9)	
Lower abdomen	24 (20.5)	17 (15.0)	
Spine	4 (3.4)	4 (3.5)	
Extremity and bone	7 (6.0)	13 (11.5)	
Head and neck	10 (8.5)	8 (7.1)	
Maxillofacial	9 (7.7)	1 (0.9)	
Groin and perineum	25 (21.4)	25 (22.1)	
Superficial	9 (7.7)	8 (7.1)	

NCA = nurse-controlled analgesia, Data presented as n (%) or median (interquartile range) [min–max]

Table 3. Analgesic prescription, mode of IV opioid, number of patients with more than one episode of moderate to severe pain. The episodes of moderate to severe pain and of giving IV opioid in the pre-NCA and NCA phases

	Pre NCA (n = 117)	NCA (n = 113)	*P*
Mode of IV opioid prescription			**0.005**
Continuous infusion	16 (13.7)	35 (31.0)	
Intermittent bolus	98 (83.8)	77 (68.1)	
Patients with moderate to severe pain ≥2 times			
Day 1	28 (23.9)	46 (40.7)	**0.006**
Day 2	22 (18.8)	24 (21.2)	0.64
Day 3	7 (6.3)	8 (7.9)	0.63
Episodes of moderate to severe pain			
Day 1	137, 1 (0 to 2) [0, 8]	175, 1 (0 to 2) [0, 10]	**0.046**
Day 2	77, 0 (0 to 1) [0, 7]	94, 0 (0 to 1) [0, 7]	0.12
Day 3	33, 0 (0 to 0) [0, 4]	41, 0 (0 to 0) [0, 5]	0.36
Episodes of giving IV injection of opioid			
Day 1	117, 0 (0 to 1) [0, 8]	148, 1 (0 to 2) [0, 6]	0.19
Day 2	69, 0 (0 to 1) [0, 7]	79, 0 (0 to 1) [0, 7]	0.53
Day 3	30, 0 (0 to 0) [0, 4]	33, 0 (0 to 0) [0, 6]	0.39

NCA = nurse-controlled analgesia, Data presented as n (%); or number of episode, median (interquartile range) [min–max]

Table 4. Subgroup analysis for moderate to severely painful procedures shows the number of patients with moderate to severe pain and receiving IV injection of opioid in the pre-NCA and NCA phases

	Pre NCA (n = 73)	NCA (n = 71)	*P*
No. of patients with moderate to severe pain in 24 h			**0.03**
0–1 episode	46 (63)	32 (45)	
≥2 episodes	27 (37)	39 (55)	
No. of patients receiving IV injection of opioid in 24 h			**0.03**
0–1 dose	51 (70)	37 (52)	
≥2 doses	22 (30)	34 (48)	
No. of patients with moderate to severe pain in 72 h			0.06
0–1 episode	38 (52)	26 (37)	
≥2 episodes	35 (48)	45 (63)	
No. of patients receiving IV injection of opioid in 72 h			**0.04**
0–1 dose	40 (55)	27 (38)	
≥2 doses	33 (45)	44 (62)	

NCA = nurse-controlled analgesia, Data presented as n (%)

Table 5. Opinion of nurses after using NCA protocol (n = 45)

Items	Least	Few	Moderate	Much	Most
Surgical staff resistance	14 (31)	30 (67)	1 (2)	–	–
Resident resistance	13 (29)	31 (69)	1 (2)	–	–
Parental resistance	10 (22)	32 (71)	3 (7)	–	–
Burden of NCA	7 (16)	25 (56)	13 (29)	–	–
Difficulty in using NCA	2 (4)	31 (69)	11 (24)	–	1 (2)
Willing to continue to use this protocol in routine practice	–	–	8 (18)	26 (58)	11 (24)

NCA = nurse-controlled analgesia, Data presented as n (%)

However, the mean (SD) [min, max] for global satisfaction score on the modified NCA protocol was 8.3 (1.1) [7, 10]. Nurses favored the flexibility to provide additional opioids for inadequate analgesia autonomously. There was no occurrence of respiratory depression in NCA period.

Positive feelings of parent satisfaction regarding postoperative pain management in the pre-NCA and NCA phases were not significantly different: satisfied 39.3% and most satisfied 60.7% in the pre-NCA phase compared with 32.5% and 67.5%, respectively, in the NCA phase ($P = 0.363$).

Discussion

Our results indicated that nurses could detect more patients with moderate to severe pain in the 24 hours following surgery in the NCA phase (40.7%) more readily than in the pre-NCA phase (23.9%), and these numbers were far greater than when using NCA with pump in a previous study (1.8%) [3].

We found that whenever the patients received IV opioids, although the doses we used were smaller than the usual recommended dose [10], they could sleep, but within the duration of the analgesia provided. After the analgesic wore off, some patients woke up and cried because of pain. Nurses' responses were different between the two phases. In the pre-NCA phase, when the patients cried because of pain before the scheduled time for the next dose, nurses usually applied non-pharmacological techniques to calm the patients, and made a note in the nursing record. By contrast, in the NCA phase nurses usually measured the pain scores at that time and gave the additional doses if the pain scores were above the cut-off point. We thought that the authority given to nurses to give analgesics after assessment, according to the modified

NCA protocol, might be an important motivation for better pain assessment in the NCA phase than in the pre-NCA phase.

That more patients in the NCA phase received continuous IV infusion than in the pre-NCA phase despite similar types of surgery might be because surgeons had learned that certain types of surgery were painful and believed that intermittent IV boluses were not adequate. Despite using continuous IV infusion in more cases in the NCA phase, we found that a greater number of painful episodes were identified in the NCA phase on the first day after surgery. This greater recognition could also be explained by the permission for nurses to make an autonomous decision to initiate additional IV opioid whenever pain control was inadequate.

Therefore, nurses' awareness and enthusiasm to assess pain and provide analgesic were increased. These findings were similar to those in a study that found that physicians, who could make decisions to treat pain, assessed pain 4-fold more frequently than nurses [12]. The greater flexibility of pain assessment and treatment gives the modified NCA protocol advantages over the conventional PRN regime.

Apart from better detection, another explanation for the higher prevalence of moderate to severe pain in the NCA phase might be that the opioid dose was small in both phases. As we weighed the effectiveness of pain control against the risk of respiratory depression, we avoided the latter. Thus, the initial dose of opioid in protocol was designated as one-half of the usual recommended dose [10], which was the same dose used in the pre-NCA phase, and then each additional dose of one-quater of the usual recommended dose and could be given twice. Therefore, the total number of doses was rather less than what was usually recommended.

We did not find any untoward effect of the protocols on respiratory depression. Therefore, a survey of nurses' opinions after using NCA showed that majority of nurses had positive attitudes to NCA and that they were willing to continue using this regimen in routine practice, although about one-quater of them expressed some concern about the difficulty and burden of the new protocol.

From this study, we suggest the use of this protocol with high compliance by nurses as a practical treatment for postoperative pain in children in any institution that has insufficient resources including the availability of PCA pumps. To improve the efficiency of pain control we suggest that the initial bolus dose should be increased to a recommended high limit instead of using only half the dose. Pain after thoracic surgery and upper abdominal surgery should be treated with continuous epidural analgesia if possible, because we found inadequate pain relief after systemic analgesia. A list of painful procedures would be proposed to our surgeons. They could prescribe the modified NCA protocol in the infusion regimen, but with an adjusted dose. Whenever this regimen was ineffective to control pain, surgeons should consult physicians in the Acute Pain Service.

In our setting, there is a strong possibility of successful implementation of the modified NCA protocol for quality improvement in pediatric pain following surgery. This intervention is not only clinically applicable to produce better care, a safer outcome, and practical, with no extra expense for special equipment, but also trusted by our surgeons and nurses [13]. Leaders at all levels were approached to participate in the research process from the beginning. A few barriers occurred from inappropriate prescription in the modified NCA protocol because of frequent resident rotations. Nevertheless, this problem might be solved by hospital endorsement of its regular use. Further study should be conducted to compare NCA with an increased dose or with NCA that use a PCA pump.

There are some limitations to this study. First, the design of this study was not as good as a randomized controlled trial (RCT) to demonstrate the effects of interventions; but the quasi-experimental design can be practical and better generalized in routine practice. Second, surgeon prescriptions of postoperative pain management were not controlled. Therefore continuous IV infusion of opioid was ordered in the NCA phase more frequently than in the pre-NCA phase. Third, nurses were not blinded to the NCA protocol. There might be some bias in this study because nurses provide both assessment and interventions. Fourth, time to adequate pain control, i.e., stable pain scores below the cut-off point, in both phases was not recorded in this study. Therefore, we could not demonstrate whether the modified NCA protocol could provide adequate pain relief faster, because moderate to severe pain could be detected quickly, and treated earlier.

Conclusion

A modified nurse-controlled analgesia protocol using no pump provided improvement in pediatric patient assessment and management following surgery. It is clinically applicable with better care by increasing the detection of pain incidents as well as management following surgery, high compliance by nurses, practical, with a safe outcome, and has no extra expense on special equipment. This protocol may be an alternative to PCA pumps and can be generalized in developing countries in case of limited resources.

Acknowledgements

We wish to thank Siriraj "Routine to Research" Development Fund for financial support and Dr. Akarin Nimmannit for his invaluable suggestion. The authors declare no conflicts of interest to this study.

References

1. Weisman SJ, Bernstein B, Schecter NL. Consequences of inadequate analgesia during painful procedures in children. Arch Pediatr Adolesc Med. 1998; 152:147-9.
2. Johnston CC, Stevens BJ. Experience in a neonatal intensive care unit affects pain response. Pediatrics. 1996; 98:925-30.
3. Howard RF, Lloyd-Thomas A, Thomas M, Williams DG, Saul R, Bruce E, et al. Nurse-controlled analgesia (NCA) following major surgery in 10 000 patients in a children's hospital. Pediatr Anesth. 2010; 20:126-34.
4. Czarnecki ML, Salamon KS, Mano KEJ, Ferrise AS, Sharp M, Weisman SJ. A preliminary report of parent/nurse controlled analgesia (PCNA) in infants and preschoolers. Clin J Pain. 2011; 27:102-7.
5. Muntlin A, Carlsson M, Safwenberg U, Gunningberg L. Outcomes of a nurse-initiated intravenous analgesic protocol for abdominal pain in an emergency department: A quasi-experimental study. Int J Nurs Stud. 2011; 48:13-23.
6. Kelly AM. Nurse-initiated analgesia improves patients' pain experience: time for change? Evidence-Based Nurs. 2011; 14:115-6.
7. Suraseranivongse S, Kaosaard R, Intakong P, Pornsiriprasert S, Karnchana Y, Kaopinpruck J, et al. A comparison of postoperative pain scales in neonates. Br J Anaesth. 2006; 97:540-4.
8. Suraseranivongse S, Santawat U, Kraiprasit K, Petcharatana S, Prakkamodom S, Muntraporn N. Cross-validation of a composite pain scale for preschool children within 24 hours of surgery. Br J Anaesth. 2001; 87:400-5.
9. Suraseranivongse S, Montapaneewat T, Manon J, Chainchop P, Petcharatana S, Kraiprasit K. Cross-validation of a self-report scale for postoperative pain in school-aged children. J Med Assoc Thai. 2005; 88: 412-28.
10. Weisman SJ, Rusy LM. Pain management in infants and children. In: Motoyama EK, Davis PJ, editors. Smith's anesthesia for infants and children 7th ed. Philadelphia: Mosby Elsevier; 2006. p. 436-58.
11. Suraseranivongse S, Khuvichitsuwan P, Sriverachai P, Boonthitikul S, Homchan W. Quality assessment and risk factors of postoperative pain in children. Thai J Anesthesiol. 2006; 32:261-8.
12. Taylor BJ, Robbins JM, Gold JI, Logsdon TR, Bird TM, Anand KJS. Assessing postoperative pain in neonates: a multicenter observational study. Pediatrics. 2006; 118: e992-e1000.
13. Price M, Fitzgerald L, Kinsman L. Quality improvement: the divergent views of managers and clinicians. J Nurs Manag. 2007; 15:43-50.