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Risk of catheter-associated infection in young hematology/oncology patients receiving long-term peripheral nerve blocks

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Abstract

Background—Continuous peripheral nerve blocks (CPNBs) are increasingly used to control postoperative and chronic pain. At our pediatric oncology institution, the duration of CPNBs is often prolonged. The risk of catheter-associated infection with prolonged CPNBs has not been previously investigated.

Aim—We analyzed the incidence of CPNB-related infection and its relation to catheter duration, catheter site, intensive care stay, and antibiotic coverage.

Methods—All CPNBs placed at our institution between August 1, 2005 and October 31, 2010 were studied. Primary diagnosis and the site, indication, duration, and infectious adverse effects of CPNBs were obtained from our Pain Service QI database. Patients' age and sex, antibiotic administration, and number of days in intensive care were collected from patients' medical records.

Results—The use of 179 catheters in 116 patients was evaluated. Mean age at CPNB placement was 15.1 years (median 14.8, range 0.4–26.9). The most frequent indication for CPNB was surgery (89.4%), most commonly orthopedic (78.8%). Mean CPNB duration was 7.2 days (median 5.0, range 1–81 days). Two cases (1.12%) of CPNBs developed signs of infection, both associated with femoral catheters. The infections were mild and necessitated catheter removal at days 10 and 13, respectively.

Conclusion—Nerve block catheter-associated infections are infrequent at our institution despite prolonged CPNB use. Both patients with infection had femoral catheters and prolonged catheter (10 days) use.

Keywords

Peripheral nerve block; infection; oncology; pain

Introduction

Continuous peripheral nerve blocks (CPNBs) are increasingly used in children (1, 2) and adults (3-8) for postoperative analgesia after orthopedic or general surgery and are typically required for only a few days. Continuous nerve blocks have also been reported for control of chronic pain at the end of life in young adults and children with cancer (9, 10).

At our pediatric oncology center, CPNBs are often maintained for longer periods than those reported in the literature. Our Pain Service uses prolonged CPNBs to optimize pain control after complex surgical procedures or in patients who experience tumor-related pain incompletely controlled by noninvasive medication therapy, including in the end-of-life setting. Therefore, the evaluation of the risk of local or systemic infection associated with the prolonged use of CPNB in our practice is warranted. Furthermore, investigations of CPNB in children reporting the associated infectious risks are few and they usually report on the short-term use of CPNB catheters (1, 2).

The purpose of this review was to assess the incidence of CPNB-related infections as well as the relationship of infections to the duration of catheter use, intensive care stay, catheter site, and prophylactic administration of antibiotics before and after placement of the CPNB at our pediatric oncology center.

Materials and Methods

After approval of this retrospective study by the St. Jude Children's Research Hospital Institutional Review Board, we identified all patients treated with CPNBs between August 1, 2005 and October 31, 2010 by searching our Pain Service database which is maintained for quality improvement (QI) purposes. The primary diagnosis, the site of block, indication, duration of CPNB catheter use, and CPNB-related infectious complications were obtained from the Pain Service QI database. Any data for these variables that were not available in the database were obtained from the patients' medical records. Patient sex, age at CPNB placement, pre- and post-block administration of prophylactic antibiotics, and number of days in intensive care, inpatient, and outpatient settings were obtained from patients' medical records. Temperature (the highest recorded temperature during any 24-hour period) and absolute neutrophil count (ANC; the lowest recorded ANC during any 24-hour period) were obtained from medical records. At our institution, an oral temperature $\geq 38.3^{\circ}$ (38.0° axillary) is considered to indicate fever, and an $\text{ANC} < 500/\text{mm}^3$ defines neutropenia. It is standard institutional practice to administer prophylactic antibiotics for most surgical procedures; nevertheless, for non-surgical indications, the administration of prophylactic antibiotics is left at the discretion of the anesthesiologist who places the CPNB catheter. We collected data on the timing of antibiotic administration in relation to the time of catheter placement and on the duration of antibiotic treatment. Antibiotics used for *Pneumocystis carinii* prophylaxis were excluded.

Infection was diagnosed by clinical signs and/or laboratory findings. Daily pain service progress notes for CPNB-days were reviewed for documentation of local signs of inflammation or infection (e.g., erythema, induration, edema, pus) and for generalized signs

and symptoms of infection (e.g., fever or leukocytosis). Dressings for CPNBs are changed routinely every 7 days, but extenuating circumstances (soiling, surgical dressing change schedule) may alter the usual routine.

Results

Patients

We identified 116 patients who received 179 CPNBs. Mean age at CPNB placement was 15.1 years (median 14.7, range 0.4–26.9 years); the broad age range reflects our institution's long-term care of survivors of childhood cancer. Fifty-seven (49.1%) patients were male and 59 (50.9%) were female; osteosarcoma was the most frequent diagnosis. Patients' primary diagnoses and demographics are presented in Table 1. Most commonly, our patients had a diagnosis of solid tumors (86.2%), of which osteosarcoma was the most frequent.

Catheters

The 179 CPNBs observed in this study had a total duration of 1280 days, excluding the day of catheter placement (day 0). Nerve block catheters were maintained for a mean of 7.2 days (median 5.0, range 1–81 days). The indications for placement and the catheter duration (total catheter-days, mean, median and range duration for each indication) are presented in Table 2. Indications for CPNBs were surgical for 89.4% and non-surgical for 10.6% of CPNBs. The most common surgical indications were primary limb-sparing and revisions of limb-sparing, and the CPNB catheters were maintained for a mean of 8 and 4.3 days, respectively; catheters for amputations were maintained for a mean of 8 days. Catheters placed for non-surgical indications such as pathological fractures and tumor-related pain were maintained for longer periods of time (mean duration of 26.1 and 24.6 days, respectively) than those used for management of postoperative pain. The number, site, and duration of catheters at each site are presented in Table 3. The most commonly placed CPNB were at the femoral and sciatic sites, in 48% and 20.7% of catheters, representing 51.7% and 19.8% of catheter-days, respectively. Table 4 (a,b,c) presents the distribution of the number of catheters and the corresponding number of catheter days as these relate to the duration of care in the intensive care unit, as inpatient, and outpatient. Ninety-five catheters (53.1%) were maintained in intensive care for at least 1 day (mean duration in intensive care 2.7 days, median 2.0 days, range 1–8 days). The majority of the CPNB catheters (55.9%) were only cared for in the inpatient setting, representing 35.2% of catheter days, while 44.1% of the CPNB were maintained in the outpatient setting, for 64.8% of the catheter-days.

Antibiotic administration

Antibiotics were given on the day of catheter placement in 93.9% (168 of 179) catheters and at least one antibiotic dose was administered after day 0 of catheter placement for 162 (90.5%) catheters. An antibiotic was administered on 630 (49.2%) of the 1280 total catheter days (excluding day 0). A variety of antibiotics were utilized, depending on clinical status and physician preference. Table 5 presents the timing of antibiotic administration according to surgical and non-surgical indications for CPNB catheters.

Local inflammation/Infection

Clinical signs of local inflammation and infection were noted in two of the 179 CPNBs. One patient complained of pain and tenderness at the femoral catheter site on CPNB day 13; the area showed mild induration. The catheter was removed, and coagulase-negative staphylococci were cultured from the catheter tip. On CPNB day 14, the patient had an ANC of $100/\text{mm}^3$, suggesting immune compromise. On day 15, the patient continued to experience tenderness at the catheter site, and the broad-spectrum antibiotic cefepime was started. By day 16, the site was free of tenderness and induration.

Another patient had erythema around the femoral catheter site on CPNB day 10. The catheter was removed on the same day, but the tip was not cultured. The patient's ANC was $5100/\text{mm}^3$ on CPNB day 8 and $8900/\text{mm}^3$ on day 11. Table 6 summarizes the clinical data for both cases.

Immune Status

Of 1280 catheter-days, the ANCs were documented for 778 days (60.8%). In six patients, catheters were maintained for 19 catheter-days (1.5%) while the ANC was $500/\text{mm}^3$, indicating neutropenia (in one patient ANC was <500 for 14 days); only three of them were given antibiotics on days when they were neutropenic, yet no signs of infection were observed in this subset of patients with neutropenia.

Discussion

Our study is the first to examine the infectious risks of long-term CPNBs in young adults and children and to investigate their use in the unique population of children and young adults with cancer. There is no generally accepted definition of prolonged vs. short-term use of nerve block catheters; nevertheless, most of the current literature reports the use of catheters for postoperative pain control for only a few days (1-8, 11), with the exception of the literature reporting on the use of nerve block catheters for palliative pain control at the end of life (9, 10). The mean and longest duration of catheter use in our study were 7.2 days and 81 days, respectively. Two pediatric studies have reported on the incidence of infection associated with shorter term use of CPNBs. One study in 292 children with 339 CPNB catheters with a mean duration of stay of 61.6 hours (2.6 days) and maximum duration of 264 hours (11 days) described 2 cases (0.59%) of local inflammatory signs and fever, at 24 and 48 hours, respectively, with negative bacterial cultures in both cases (1). Another study in 217 children with 226 CPNB catheters reported a single case of superficial cellulitis (0.44%), which was diagnosed 48 hours after placement of a femoral catheter (2). In adults, a study of 1,416 patients reported a median duration of catheters of 56 hours (5) and the duration of catheters exceeding 48 hours has been identified as a risk factor for catheter-related infection (4).

We observed local inflammation and infection in 2 of 179 (1.12%) CPNB catheters. Our infection rate is only slightly higher than rates reported in pediatric studies by Dadure et al. (0.59%) (1) and Ganesh et al. (0.44%), and it is lower than that reported by Capdevila et al., whose retrospective multicenter study of 1,416 patients showed local inflammatory signs in

3% of catheters (5), while examining adverse events associated with CPNBs within 5 days after nerve catheter placement and surgery (5).

Regarding the duration of use of CPNBs, we found no infections associated with CPNBs lasting < 10 days. In the 2 cases of local inflammation and infection, signs of local inflammation were noted on days 10 and 13, respectively. This finding suggests that the risk of infection increases beyond day 10; however, only 2 of 40 CPNB (5%) maintained for 10 days or more resulted in infection. Both catheters were removed when signs of infection were observed, and neither patient had severe infectious complications. The small number of infections observed precluded meaningful statistical analysis.

Published reports in adults have described acute neck cellulitis and mediastinitis complicating a continuous interscalene block used for 2 days (11) and a psoas muscle abscess complicating a femoral nerve block of unspecified duration in a patient with diabetes (5). The reported risk of CPNB catheter-related infection in adults varies greatly, depending on the method of catheter insertion. Compere et al. reported a bacterial colonization rate of 6.22% for tunneled catheters maintained for a mean duration of 48 hours, and no patients developed signs of infection (6). Studies of non-tunneled catheters found a bacterial colonization rate of 17%-57%; nevertheless, signs of infection were rare (5, 7, 8); one multicenter study of 1,416 patients reported a 28.7% colonization rate and a 3% frequency of local inflammatory signs (5), while another reported a 57% bacterial colonization rate and a 1.5% frequency of bacteremia in 208 patients having femoral catheters removed at 48 hours (7). Capdevila et al. suggested that the high rates of colonization reflected contamination of the catheter tips by skin flora when the catheters were removed for culture, despite aseptic removal technique (5). This hypothesis is supported by studies which identified coagulase-negative *Staphylococcus epidermidis* on the majority of colonized catheter tips (5, 7, 8). Our practice of not culturing all CPNB catheter tips systematically is based on evidence from the literature that this practice does not add reliable, useful information about infectious source due to the high likelihood of local contamination during catheter removal (7). Similarly, the routine culture of catheter tips is not recommended for epidural catheters, as it is not a good predictor of epidural space infection (12, 13). Our current recommendation is to culture catheter tips from all CPNBs with local inflammatory and/or infection signs.

Several independent risk factors for CPNB catheter-associated local inflammation or infection were identified in a large multicenter study in adults, including intensive care stay, duration of catheter use > 48 hours, male sex, and the absence of prophylactic antibiotics, with odds ratios of 5.07, 4.61, 2.1 and 1.92, respectively (5). For all CPNBs placed perioperatively for surgery-related pain, it has been our standard to administer prophylactic antibiotics as reflected in the results of this study (99.4%, Table 5). Our current recommendation for clinical practice includes prophylactic administration of antibiotics for all CPNB including those placed for non-surgical indications (which was not the standard practice during the study period).

Other risk factors cited in the literature are axillary or femoral location and frequent dressing changes, with odds ratios of 3.39 and 2.12, respectively (10). In a study of 198 CPNB

catheters in adults, Morin reported odds ratios of 3.4 for femoral catheters and 2.1 for each postoperative dressing change, while the postoperative administration of an antibiotic for at least 24 hours significantly reduced the risk of catheter colonization, with an odds ratio of 0.41 (8). In our study, signs of local infection were observed in 2 of 86 (2.33%) femoral catheters; both patients received perioperative antibiotics, and only one had an ICU stay. In a prospective study of femoral nerve block catheters, Cuvillion et al. found a 1.5% incidence of bacteremia after a 48-hour catheter duration (7). Thus, while our findings are consistent with previous reports on the risk associated with femoral catheter site, our small number of cases precludes definitive conclusions.

Our pediatric patient population has unique characteristics. Firstly, our cancer patients undergo complex orthopedic and general surgical procedures and/or experience long-term tumor-related pain; therefore, it is often necessary to maintain the CPNB catheters for several days or weeks; this practice is in contrast to the shorter durations reported by other studies. In one patient in our study, the CPNB remained in place for 81 days without infection, with one day in the outpatient setting. Secondly, due to the nature of our population, we provide long term care to cancer survivors; this explains the range of ages in our patient population and the inclusion of young adults in addition to children and adolescents. Thirdly, the immunocompromised status of some of our patients also contributes to the uniqueness of our patient population. We evaluated the immune status based on ANC values rather than time relationship with administration of chemotherapy because the individual immune response to chemotherapy is highly variable among patients and across treatment regimens.

The retrospective design of this study has inherent limitations. The technique of CPNB catheter placement during the studied time period varied among physicians and clinical practice was adjusted according to individual clinical scenarios; therefore, we were not able to evaluate the consistency in our practice. While we know that all CPNB catheter placement procedures are performed under sterile conditions in our institution (cap, gloves, mask, and sterile preparation of the site with chlorhexidine gluconate), other elements are variable (the use of a sterile gown, the location of the procedure in a sterile operating room vs. a nonsterile procedure room, the use of a nerve stimulating technique vs. an ultrasound technique vs. a combined technique, the tunneling of the catheters, the number of attempts and duration of the CPNB catheter placement procedure) and their documentation in the medical record may be incomplete. Another variable in our practice is the routine of dressing changes at the block site. Morin et al. reported that the risk of infection in patients with nerve blocks increases in proportion to the number of dressing changes (8). At our institution, dressing changes are usually performed weekly or when soiled or wet. However, we were unable to analyze this factor retrospectively, as information about dressing changes could not reliably be found in the medical records. The clinical procedure for a suspected catheter-associated infection was not standardized regarding the requirement to perform a culture of the catheter tip during the time of the study. After the completion of this study, we developed a set of recommendations for clinical practice, in an attempt to standardize the following variables: systematic use of prophylactic antibiotics, CPNB placement only in a sterile environment (operating room), use of strict aseptic technique, use of silver-impregnated dressing and dressing change every 7 days using sterile technique. The choice

of insertion technique, with nerve stimulator, ultrasound, or both, is left to the discretion of the anesthesiologist.

Prospective investigations of the analgesic efficacy of CPNBs in children, concurrent use of other analgesic methods, and associated risks are needed to shed light over the risk benefit ratio of long-term use of CPNB catheters, especially in subsets of patients at risk, such as the pediatric oncology population.

The low incidence and severity of infection in our study indicate that CPNB is a safe method of pain control that carries a limited infection risk, even in the setting of prolonged catheter use and in a potentially immunocompromised patient population.

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Table 1

Demographics and diagnoses of 116 patients receiving continuous peripheral nerve blocks

Sex	N=116 (%)
Male	57 (49.1)
Female	59 (50.9)
Age (years) at CPNB Placement	N=179 ¹
Mean	15.1
Median	14.7
Range	0.4-26.9
Primary diagnosis	N=116 (%)
Solid tumor	100 (86.2)
Osteosarcoma	64
Ewing sarcoma	13
Sarcoma	13
Other ²	10
Hematologic	14 (12.1)
Acute lymphoblastic leukemia	9
Other ³	5
Infection/rule out cancer	2 (1.7)
Osteomyelitis	2

¹ Some patients had multiple catheters.

² Other solid tumors: angiomatoid fibrous histiocyoma, chondroblastoma, chondromyxoid fibroma, desmoid tumor, giant cell tumor, malignant peripheral nerve sheath tumor

³ Other hematologic diagnosis: acute or chronic myeloid leukemia, Burkitt lymphoma, myelodysplastic syndrome, sickle cell disease

Table 2

Indications for 179 continuous peripheral nerve blocks and duration of blocks

Indication	Catheters, N (%)	Catheter days, N (%)	Catheter duration, mean; median (range)
<u>Surgical</u>	160 (89.4)	901 (70.4)	N=160
Orthopedic surgery			
Amputation	21	168	8.0; 8 (1-15)
Primary limb-sparing	49	393	8.0; 8 (1-29)
Limb-sparing revision	44	190	4.3; 4 (1-11)
Other ¹	27	95	3.5; 4 (1-7)
General surgery			
Tumor resection	17	51	3.0; 3 (1-10)
Other ²	2	4	2.0; 2 (2.0)
<u>Non-Surgical</u>	19 (10.6)	379 (29.6)	
Pathological fracture-related pain	7	183	26.1; 26 (12-41)
Tumor-related pain	7	172	24.6; 15 (3-81)
Closed manipulation	4	13	3.3; 4 (1-4)
Other ³	1	11	11.0; 11 (11.0)

¹ Other orthopedic surgical indications: hip arthroplasty, hip resurfacing, open manipulation, others.

² Other general surgery indications: wound repair, excision of pubic rami muscle

³ Other nonsurgical indications: infection-related pain

Table 3

Site and duration of 179 continuous peripheral nerve block in 116 patients

Catheter site		Catheter duration				
	Catheters, N (%)	Catheter days, N (%)	1-3 days	4-6 days	7-9 days	10 days
Femoral	86 (48.0)	662 (51.7)	24	31	11	20
Sciatic	37 (20.7)	253 (19.8)	11	14	3	9
Brachial	27 (15.1)	238 (18.6)	7	5	6	9
Lumbar	27 (15.1)	120 (9.4)	12	8	5	2
Popliteal	1 (0.56)	1 (0.1)	1	0	0	0
Tibial/Peroneal	1 (0.56)	6 (0.5)	0	1	0	0
Total catheters, N (%)	179	-	55 (30.7)	59 (33.0)	25 (14.0)	40 (22.3)
Total catheter days, N (%)	-	1280	112 (8.8)	275 (21.5)	195 (15.2)	698 (54.5)

Table 4

Relation of 179 continuous peripheral nerve blocks to location of care: a) Intensive Care Unit; b) Inpatient unit; c) Outpatient

a		
ICU duration (days)	Catheters N (%)	Total catheter days N (%)
0	84 (46.9)	1020 (79.7)
1-2	48 (26.8)	76 (5.9)
3-4	36 (20.1)	126 (9.5)
8-6	10 (5.6)	50 (3.9)
7-8	1 (0.56)	30 (0.6)
9	0 (0)	0 (0)
Total	179	1280

b		
Inpatient duration (days)	Catheters N (%)	Total catheter days N (%)
0	4 (2.2)	11 (0.9)
1-2	43 (24.0)	98 (7.7)
3-4	72 (40.2)	370 (28.9)
5-6	33 (18.4)	276 (21.6)
7-8	13 (7.3)	161 (12.6)
9	14 (7.8)	364 (28.4)
Total	179	1280

c		
Outpatient duration (days)	Catheters N (%)	Total catheter days N (%)
0	100 (55.9)	450 (35.2)
1-2	22 (12.3)	206 (16.1)
3-4	29 (16.2)	219 (17.1)
5-6	11 (6.1)	115 (9.0)
7-8	9 (5.0)	110 (8.6)
9	8 (4.5)	180 (14.1)
Total	179	1280

Table 5

Antibiotic administration during 179 continuous peripheral nerve blocks

Time of antibiotic administration	Surgical indication (n=160)	Non-surgical indication (n=19)	Total (n=179)
Administration on Day 0 ^I N (%)	159 (99.4)	9 (47.4)	168 (93.9)
Administration after Day 0 N (%)	148 (92.5)	14 (73.7)	162 (90.5)

^I Any antibiotic (excluding three-times-a-week trimethoprim-sulfamethoxazole for *Pneumocystis carinii* prophylaxis) administered on the day of CPNB catheter insertion

Table 6
Selected clinical data for two patients with signs of infection after prolonged continuous peripheral nerve blocks

Case	Primary diagnosis	Age (years)	Pain source	Block site	ICU days/ catheter duration (days)	Antibiotic coverage	Signs of infection (day of diagnosis)	Temperature at time of CPNB removal
1	Osteosarcoma	18.0	Pathological fracture	Femoral	0/13	On Day 0, after catheter insertion	Induration and coagulase-negative staphylococci on catheter tip (Day 13)	37.5°C
2	Osteosarcoma	18.3	Primary limb-sparing surgery	Femoral	3/10	Before and after catheter insertion on Day 0 and on Days 1 – 8 (ceftriaxone, cefuroxime, gentamicin, vancomycin)	Erythema around catheter site (Day 10)	Unknown

ICU, intensive care unit; CPNB, continuous peripheral nerve block