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# *Infectious Risk of Continuous Peripheral Nerve Blocks*

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CONTINUOUS peripheral nerve block (CPNB) techniques continue to be increasingly used. CPNB catheter infection is an issue that has received little attention to date. The frequency of infection associated with peripheral nerve catheters remains poorly defined.[1–4] Although the risk of infection during CPNB is a major issue, the published literature has mainly focused on the conflicting evidence of the frequency of infectious complications associated with epidural anesthesia. Recent studies show that between 23 and 57% of peripheral nerve catheters may become colonized, with 0–3% resulting in localized infection.[1–10] Severe infectious complications recently reported in the literature include psoas abscess complicating continuous femoral nerve blocks,[1,11] axillary abscess and necrotizing fasciitis[5,12] after continuous and single shot axillary nerve blocks, and thigh and interscalene abscesses after continuous popliteal sciatic and interscalene nerve blocks, respectively[6,13] (table 1). An exogenous source of contamination is frequently suspected. The most frequently detected microorganism on the skin surface and in colonized catheter is *Staphylococcus epidermidis*,[1–4] whereas *Staphylococcus aureus* is mainly reported in infections or abscess formation.[1,2,5,11,13] Several risk factors, including appropriate patient selection (intensive care unit or trauma patients),[1,2] catheter site insertion,[1–3] prophylactic antibiotic use,[1,2,5] local anesthetic solution contamination, and catheter duration,[1,2] have been suspected to modify the risk of infection related to CPNB. The current recommendations to control infectious complications associated with CPNB are based on existing literature and guidelines for the prevention of epidural or intravascular catheter-related infection. The American Society for Regional Anesthesia and Pain Medicine guidelines on this topic have been published in Regional Anesthesia and Pain Medicine.[14] These recommendations highlighted the importance of asepsis during regional anesthesia needle and catheter insertion, including handwashing, use of protective barriers (mask, gloves, gowns, and drapes), and skin disinfectants. The role of subcutaneous tunneling and of bacterial filters is still controversial.[14] Guidelines for practice improvement must be built according to specific actual risk applied to each procedure and certainly cannot be extrapolated without some restrictions.[15] CPNBs are increasing in popularity, and the incidence of infection associated with CPNB is thankfully rare. However, infectious complications will become undoubtedly more common. This review is to tell the reader what is actually known about risk factors specific to CPNBs.

## Sources of Catheter Colonization and Infection

The incidence of inflammation and infection associated with CPNB is low. Exogenous pathogens are suspected as the most likely sources of infection. The skin area surrounding the perineural catheter insertion site is the reported origin of the greater majority of colonizing microorganisms.[1–4,16] The predominance of coagulase-negative *Staphylococcus* at the perineural catheter tip is not surprising. This represents colonization of the skin at the catheter insertion site and the subsequent contamination of the catheter on removal despite aseptic conditions.[1] This hypothesis is supported in the study by Capdevila *et al.*,[1] who showed that 44% of the catheters were colonized if signs of local inflammation were present *versus* 19% when no evidence of inflammation existed. Some authors[14,16] suggest that *S. aureus* is more resistant to nonalcoholic disinfectants than other bacteria and that hair follicles and the orifices of sebaceous glands protect the organism as a result of the lipid covering of the stratum corneum. The American Society of Regional Anesthesia and Pain Medicine recommends the routine use of antiseptic solutions with an alcohol base for skin disinfection before peripheral regional techniques due to their penetration of the stratum corneum and their rapid and prolonged effect.[14]

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**Table 1. Characteristics of the Reported Cases of Continuous Peripheral Nerve Blocks-related Abscesses**

| Study | Number of cases | Catheter location | Microorganism | Underlying disease |
|---|---|---|---|---|
| Bergman *et al.*[5] | 1 | Axillary | *S. Aureus* | NR |
| Neuburger *et al.*[2] | 20 | Different locations | *S. Aureus* | NR |
| Adam *et al.*[11] | 1 | Femoral | *S. Aureus* | NR |
| Compère *et al.*[13] | 1 | Popliteal | *S. Aureus* | NR |
| Capdevila *et al.*[1] | 1 | Femoral | *S. Aureus* | Diabetes |
| Borgeat *et al.*[6] | 1 | Interscalene | *S. Aureus* | Diabetes |
| Nseir *et al.*[12]* | 1 | Axillary | *S. Pyogenes* | Diabetes |

* Single shot axillary plexus block.
NR = not reported.

## Risks Factors for Catheter Infection

There is a great variability in the rate of inflammation and infection across studies (table 2). A careful analysis for the reasons for these differences and of the procedures to minimize infection in the low *versus* high infection rates should be done. Recent studies[1,2,4] report that independent risk factors were associated with catheter colonization and related infection.

A strong risk factor for development of infectious adverse events during CPNB is a stay in the intensive care unit (ICU). In the ICU, most of the patients studied had sustained major trauma. It has been suggested that trauma ICU patients have a greater number of skin bacterial species than other patients and that inadequate and difficult working conditions and environment prevent a total aseptic technique during catheter insertion.[2] Moreover, compromised cellular immunity, which frequently develops in the ICU patients, may contribute to the higher risk of infection. Neuburger *et al.*[2] claimed that the high incidence of local inflammation and infection observed in their study is explained by large number of trauma patients (30%). However, in Capdevila *et al.* study,[1] the stay in ICU is an independent risk factor for local inflammation. This factor is independent from the group of trauma patients. All the catheters in that study were put in before ICU admission in surgical and trauma patients. Anesthesiologists should be aware of the increased risk of catheter-related infection in the subgroup of ICU patients.

Duration of catheter also seems to be an important risk factor of local infectious problems. Capdevila *et al.*[1] reported that CPNB of duration longer than 48 h was an independent risk factor for local inflammation and catheter-related local infection (odds ratio [95% CI], 4.61 [1.57–15.9]). Capdevila *et al.*[1] noted 3% of local inflammation defined by focal pain, redness, and induration, and only one case of systemic infection (psoas muscle abscess). We analyzed the incidences of local inflammation for each period of time in the 1416 patients of Capdevila's study and report them in table 3. Interestingly the incidence of inflammation increased significantly for each studied period, except for the 24-h selected threshold. The longer that the CPNB catheter is still in place, the more the risk of local inflammation is important. In the same study, we calculated the adjusted odds ratio for local inflammation and signs of infection as a function of every 24-h time period. The results are reported in figure 1. After the 48-h period, if we consider odds ratio, the risk of local inflammation and/or infection signs increases for each time period considered. Similarly, Neuburger *et al.*[2] observed a relation between the mean duration of catheter use 5 (range, 2–18) days and the patients having an infection requiring surgical drainage. Noninfected patients had a mean catheter use duration of 4 (range, 1–36) days.

The absence of antibiotic prophylaxis was noted to be an independent risk factor for local inflammation.[1,2,5] In a series of 405 continuous axillary blocks, the only abscess occurred in a patient who had not received antibiotics.[5] That patient was scheduled in a rehabilitation program after a chronic pain syndrome. Eighteen patients did not receive the usual 2 days of antibiotic

**Table 2. Incidence of Catheter Colonization, Local Inflammation and Infection in Continuous Peripheral Nerve Blocks Studies**

| Study | Number of CA | CA Location | Overall CA Colonization (%) | Local inflammation (%) | Local Infection (%) | Abscesses (%) | Surgery |
|---|---|---|---|---|---|---|---|
| Bergman *et al.*[5] | 405 | **Axillary** | NR | 0.2 | 0.2 | 0.2 | No |
| Cuvillon *et al.*[3] | 208 | **Femoral** | 57 | 4.3 | 0 | 0 | No |
| Borgeat *et al.*[6] | 700 | **Interscal** | NR | 0.7 | 0.1 | 0.1 | Yes |
| Borgeat *et al.*[17] | 1,001 | **Popliteal** | NR | 0.2 | 0 | 0 | No |
| Capdevila *et al.*[1] | 1,416 | **Different** | 28.7 | 3 | 0.1 | 0.1 | No |
| Neuburger *et al.*[2] | 2,285 | **Different** | NR | 4.2 | 3.2 | 0.9 | Yes |
| Neuburger *et al.*[9] | 3,491 | **Different** | NR | 4.2 | 2.4 | 0.8 | Yes |
| Stojadinovic *et al.*[7] | 361 | **Different** | NR | NR | 1.9 | 0 | No |
| Morin *et al.*[4] | 102 | **Different** | 23.7 | 13.7 | 1.9 | 0 | No |
| Swenson *et al.*[10] | 620 | **Different** | NR | 0 | 0 | 0 | No |
| Wiegel *et al.*[26] | 1,398 | **Different** | NR | 0.6 | 0.2 | 0 | No |
| Meier *et al.*[8] | 91 | **Interscal** | NR | 8.7 | 2.1 | 0 | No |

The reported incidences of catheter colonizations in the literature extended from 23.7% to 57%. Those for skin inflammation and local infection extended, respectively, from 0% to 13.7% and from 0% to 3.2%. The percentage of proven systemic infection extended from 0% to 0.9%.

CA = catheter; Interscal = interscalene continuous block; NR = not reported.

therapy. Morin *et al.*[4] reported that the use of an antibiotic in the postoperative period can limit the risk of local infection. However it appears that a single dose of antibiotics injected 30 to 60 min after catheter insertion probably does not provide sufficient protection.[5]

The site of catheter insertion can be another potential risk factor for bacterial colonization. The femoral or axillary sites are associated with a rate of catheter bacterial colonization as high as 37% to 57%,[1,3] whereas the popliteal catheter has a reduced colonization rate of between 0% to 19%.[1,4,17] This finding may be related to the density of sebaceous glands in the groin or the axilla, which has been shown to affect the ability of disinfection to decrease the percentage of microrganisms.[16] We analyzed the incidence of local inflammation for CPNBs at the most common sites of placement as a function of every 24-h time period in the Capdevila *et al.* study.[1] The results are reported in figure 2. As for the catheter colonization, the incidence of local inflammation is related to the duration of the catheter and to the location. The femoral/fascia iliaca compartment and axillary continuous blocks are associated with the higher rate of patients' local inflammation. Morin *et al.*[4] highlighted the fact that catheter placement in the groin can increase the risk of a local inflammation. The authors reported an odd ratio at 3.4 (1.5–7.8) for this parameter in comparison with other catheter locations.

Male sex seems significantly associated with an increased risk of local inflammation.[1] In studies by Capdevila *et al.*[1] and Morin *et al.*,[4] age, underlying disease (diabetes mellitus, cancer, infectious disease, steroid therapy), and technically difficult catheter insertion were not associated with an increased risk of local inflammation or infection. However, these statements were not clearly supported by power analysis.

In the majority of studies investigating the infectious risk of CPNB, the anesthesiologists have worn a hat, surgical mask, gloves and gown and have prepared the

**Table 3. Incidence of Local Inflammation (Focal Pain, Redness, and Induration) for Each Studied Period**

| Studied Periods | < Selected Period [95% CI] | ≥ Selected Period [95% CI] | *P* Value | Studied Pts, n before / n after |
|---|---|---|---|---|
| 24 h | 0% | 4% [2.8-4.9] | NS | 146/1,270 |
| 48 h | 1.5% [0.3-2.5] | 4.5% [3.1-5.7] | <0.05 | 441/975 |
| 72 h | 2% [0.9-2.6] | 7% [4.4-8.7] | <0.05 | 912/504 |
| 96 h | 2.5% [1.4-3.1] | 10% [5.7-13.0] | <0.05 | 1,170/246 |
| 120 h | 3% [1.9-3.7] | 11% [5.5-17.1] | <0.05 | 1,301/115 |

Patients with a perineural catheter at or more than the studied period are compared with patients who have withdrawn the catheter before the studied period. There are significant differences in the incidence of local inflammation for all periods except for the 24-h threshold.

Studied Pts = patients studied at the selected periods. At Hour 0, 1,416 patients participated in the trial.

skin with disinfectants and sterile drapes. This fact probably partially explains the very low incidence of infection during CPNB.

Table 4 describes the risk factors for peripheral nerve block catheter inflammation based on clear evidence in the literature, unproved factors, and those that are proven not to be a risk factor.

## Different Aspects of Aseptic Techniques

Studies show that both equipment and local anesthetic solutions can become contaminated.[18]

Rituals and myths regarding aseptic technique performed by anesthesiologists abound in the operating room. Woodhead *et al.*[18] reported that only 12% of

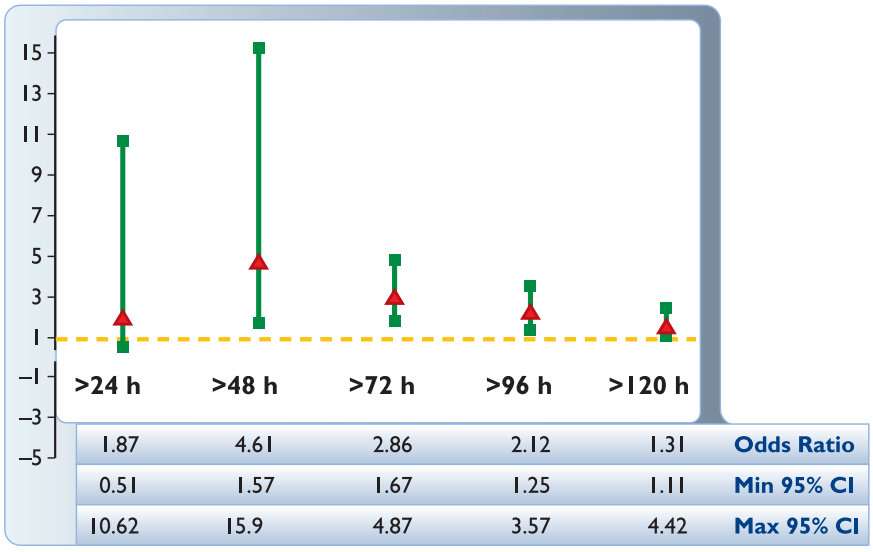


**Fig. 1. Odds ratio for local inflammation and/or signs of infection as a function of every 24-h time period for all the continuous peripheral nerve block catheters. From Capdevila *et al.*[1]**

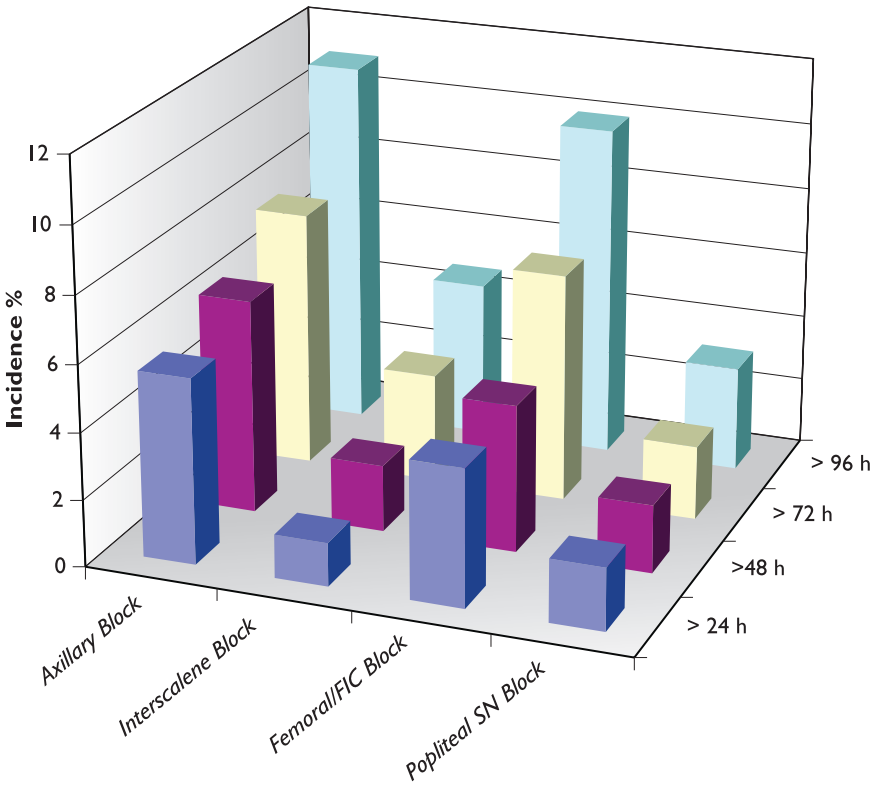


**Fig. 2. Incidences of local inflammation as a function of every 24-h time period at four selected sites of continuous peripheral nerve block catheters. The incidences increase if we consider axillary and femoral/fascia iliaca compartment (FIC) locations. From Capdevila *et al.*[1] SN = sciatic nerve.**

physicians based infection control practice in the operating room on evidence-based medicine data.

There is good evidence that the risk of central venous catheter infection is reduced by the use of a technique involving surgical type aseptic conditions compared with hand washing and sterile gloves alone.[19,20] Therefore, this method should be applied to CPNB techniques.

The American Society for Regional Anesthesia and Pain Medicine recommendations[14] discuss hand cleansing, jewelry, gloves, gowns, masks, bacterial filter, antiseptic prep solutions and methods of applying them, and

**Table 4. Risk Factors for Catheter Local Inflammation and Signs of Infection When Using Continuous Peripheral Nerve Blocks**

| Reported Risk Factors Odds Ratio [95% Confidence Interval] | Unproved Potential Risk Factors | Proven to Be Unimportant |
|---|---|---|
| Stay in an intensive care unit[1,2,4,8] 5.07 [0.33–18.1] | Male sex[1,2] | Age of the patient[1,2,4] |
| Duration of catheter use > 48 h[1–4] 4.61 [1.57–15.9] | Diabetes mellitus[1,6,12] | Preexisting disease (except of diabetes)[1,2,4] |
| Absence of antibiotic prophylaxis[1,4,5] 1.92 [1.03–3.9] | Absence of tunelling of the catheter[6,17] | Technical aspects of the catheter[1,2,4] |
| Axillary or femoral location[1–3] 3.39 [1.48–7.79] | Mobility of the head and neck[1,2] | Fixation of the catheter (except tunelling)[1,2,4] |
| Frequent changings of the dressings[1,4] 2.12 [1.37–3.29] | No sterile gloves, masks, hats, and gowns[14,18] | Local anesthetic infused[1,2,4] |

**Table 5. Important Components of Aseptic Technique That Could Be Related to Continuous Peripheral Nerve Blocks***

| Major | Minor |
|---|---|
| Removal of watches and jewelry | Proper use of bacterial filters during long-term catheterization |
| Preprocedural hand cleansing with hydro-alcoholic solution | Prevention of catheter, hub, and site violations or repetitive injections |
| Protective barriers: gowns | Catheter tunneling? |
| Surgical hat and mask | |
| Sterile gloves | |
| Appropriate selection and application of skin disinfectant: alcoholic antiseptic or chlorhexidine gluconate | |
| Proper sterile draping technique(s) | |
| Maintenance of a sterile field | |
| Appropriate dressing techniques | |

* From American Society of Regional Anesthesia Guidelines. Reg Anesth Pain Med Vol. 31 No. 4 July–August 2006.[14]

drapes or dressings at the catheters sites. They are reported in table 5. These are generic recommendations regarding single shot and continuous regional anesthetic techniques, and the authors commented that little is known regarding CPNBs. However, it seems reasonable to apply these recommendations to CPNB techniques.

Other specific parameters like catheter tunneling, specific dressing, and infusate contamination can be discussed separately. The dressing around a CPNB catheter minimizes the risk of premature displacement and allows inspection of the catheter skin entry point (local inflammation) if transparent. Visible local inflammation, even without pus, is associated with an increase in catheter colonization.[1,2] However, we have seen that high catheter colonization rates are not related to deep infection or abscesses.[1–3] In contrast, the absence of skin inflammation does not mean that there is no bacterial catheter colonization. The transparent dressing is impermeable, resulting in the underlying skin becoming moist and allowing the growth of organisms. On the other hand, a totally porous dressing can maximize the site access to bacteria. Another way of decreasing skin colonization is to place antiseptic around the puncture site or to use antiseptic dressings. The rationale of this practice is to prevent the regeneration of skin microorganisms in the hours after the initial antiseptic application. Iodine-based powders or creams can be used, but they tend to reduce dressing adhesion. Catheter tunneling has the theoretical advantage of decreased catheter movement and decreased spread of infection. There are several techniques for tunneling CPNB catheters using 17- to 18-gauge tuohy or 18-gauge IV needles with or without a plastic cannula.[21,22] Borgeat *et al.*[6,21] used a lateral modified approach for continuous interscalene blocks and tunneled the interscalene catheter. They reported no catheter dislodgement in 700 patients and 1% of patients with signs and symptoms of local infection. Capdevila *et al.*[1] in 1416 CPNB did not tunnel the catheters and reported 11% of catheter accidental withdrawal and 3% of local inflammation signs. A recent study in 402 patients with CPNBs highlighted the interest of catheter tunneling.[23] The authors reported a colonization incidence of 6.22% (3.8–8.5%), with a microbiologic analysis of the catheter tip cultures revealing coagulase negative *Staphylococcus* in 72%. Therefore, it appears that subcutaneous tunneling seems beneficial in reducing clinically relevant movements of the catheters and perhaps in providing an extra benefit regarding the development of CPNB catheter site colonization. The infusate can be the source of infection, although it is thought to be the least important because the solutions of local anesthetics have some antibacterial activity.[24] The risks of infusate contamination may increase with frequent changes of the catheter hub, with syringes repeatedly changed in surgical ward by nurses without masks, hats, and gloves and in long-term continuous

regional blocks.[18] Kirschke *et al.*[25] reported *S. aureus* joint and soft-tissue infections occurring in outpatients after therapeutic intraarticular injections. In 17 patients, 3 were subsequently hospitalized for infections. All of these patients received triamcinolone-lidocaine solutions. The multiple-dose vial of lidocaine was contaminated with *S. aureus*. It seems reasonable to use large volume bags of regional block infusate prepared by the pharmacy or reputable supplier/industrial firm and to be aware of the infusate preparation conditions in the operating theaters, postanesthetic care units, or surgical wards.

## Conclusion

Risk factors are perfectly demonstrated to be related to local inflammation or infection during CPNB techniques. There are duration of the continuous infusion more than 48 h, the absence of antibiotic prophylaxy, the stay in ICU for a patient, and axillary or femoral location of the catheter. The coagulase-negative *Staphylococcus* is predominantly noted at the perineural catheter tip. Although definitive proof is lacking, there is strong evidence that the maximal sterile precautions used for epidural insertion can be recommended to anesthesiologists for CPNB. The American Society of Regional Anesthesia recommendations are based on clinical evidence for some and theoretical rationale for others. Caregivers should be aware of risk factors for inflammation and possibly for infection with CPNB.

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