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Sterility Protocols During Regional Anaesthesia: An AORA Initiative

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Introduction

The frequency of infection following peripheral nerve block (PNB) is not very clear. The major reason for the paucity of literature is under-reporting of infectious complications. Though rare, the infectious complications associated with peripheral nerve blocks can be devastating and occasionally fatal [1]. A case of necrotising fasciitis following an axillary approach to brachial plexus blockade for carpal tunnel release has been reported where the PNB was directly attributed to the infection. With the increase in the number of peripheral nerve block procedures being performed (both single injection and continuous techniques), it is expected that the infectious complication rate may also increase.

There is no uniform consensus amongst anaesthesiologists across the globe regarding the appropriate sterile technique that should be practised during administration of regional anaesthesia. In a UK and Ireland based survey of obstetric anaesthesiologists, only half of the responders wore a face mask for both neuraxial (spinal and epidural) techniques. One-third of those who did not wear a mask believed that the mask actually increased the risk of infection [2]. It can be easily assumed that a similar attitude is present while performing peripheral nerve blocks.

The aseptic chain starts right from hand washing and ends after the block needle has been taken out from the patient's body (in a single injection technique) or till the perineural catheter is completely removed (in a continuous technique). Any breach in this chain may increase the chances of introducing infection.

Removal of Jewellery

In 2006, the American Society of Regional Anesthesia (ASRA) guidelines recommended removal of jewellery as a part of aseptic technique though there is a scarcity of evidence (Grade B) [3]. The compliance amongst anaesthesiologists is variable. In a 2002 survey of obstetric anaesthesiologists, 86% agreed that removal of their wrist watch was essential prior to epidural blockade, but only 50% agreed that removal of finger rings was necessary [4]. According to Hartley et al in 1999, wearing a wrist watch prevents proper hand washing, resulting in higher bacterial growth and thus, should be removed before any aseptic procedure [5]. A 2005 review on hand hygiene showed that though the skin under jewellery (rings, bracelets and wrist watches) showed a higher microbial load, the evidence was insufficient to say that hand washing was ineffective in ring wearers [6]. In 2013, ASRA proposed a pre-block checklist and conducted a survey to gather feedback. In an internet survey of regional anaesthesia fellowship directors and graduates, only over half of them either strongly agreed or agreed that removal of jewellery before a regional nerve block was appropriate. The rest of them either strongly disagreed, disagreed or stayed neutral [7].

Recommendation- Though the evidence is not compelling, it is a good practice to remove all the jewellery before performing either a single injection or continuous peripheral nerve block to ensure the technique is aseptic.

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Hand Washing

Needless to say, proper hand hygiene is an important and integral component of infection control protocol in any hospital. Contaminated health care workers' hands play a major role in transmission of healthcare associated infections [6, 8]. It has been shown that proper hand hygiene significantly reduces the transmission of infection. Despite emphasizing the importance of hand washing and awareness programmes at regular intervals in many hospitals, the compliance is rarely satisfactory. A tertiary care hospital survey in India showed that the compliance of the anaesthesia providers towards hand washing prior to performing peripheral nerve blocks was only 80%. Whereas, the compliance was 100% for central neuraxial procedures and 93.7% for arterial line placement [9]. Though the infection following peripheral nerve block is rare, it is not zero and every attempt should be made to prevent this complication by taking simple hand washing measures.

Hand wash with soap and water does not kill the organisms and hence is not completely effective. Hand rub with antiseptic solutions or full surgical hand scrub (with reverse osmosis water source) is recommended before attempting any regional anaesthetic procedure. Alcohol based antiseptic solutions are more effective than non-alcoholic antiseptic agents. Even among non-alcoholic based antiseptics, chlorhexidine is superior to povidone iodine for reducing bacterial load for longer duration.8

Various antiseptic agents with different concentrations are available. Some of these are

1. Chlorhexidine (0.3% to 4%w/v)
2. Alcohol 70-75% v/v (used in combination with chlorhexidine and povidone iodine)
3. povidone Iodine (5%-10% w/v)

These agents come in various preparations ranging from creams to solutions as their vehicle. Commonly used agents are Chlorhexidine 4% w/v and povidone iodine 7.5% w/v solution for surgical hand scrub as well as chlorhexidine 0.5% w/v in 70% ethanol solution for hand rub.

Hand rub with antiseptic agents- This includes the World Health Organisation (WHO) approach for the standard six steps of hand washing and an additional two steps for rubbing the forearm. Approximately 15 ml of the antiseptic solution is required depending on the size of the hands which should be wet with the solution during the procedure. This takes about a minute and has to be repeated for up to three times (to make up the total duration to approximately 3 minutes) [8].

Surgical hand antisepsis- This includes scrubbing of hands as well as forearms with water and antiseptic solution as recommended by the WHO for a duration of 2-5 minutes. Longer scrub duration is not necessary as it does not provide any additional advantage. Since the hand scrub needs utilization of tap water, it needs regular monitoring of the taps and faucets. If the quality of water is not assured (water treated by reverse osmosis), it is recommended to do a second step of hand rub with an antiseptic agent before donning sterile gloves. Precaution has to be taken to completely dry the hands before the application of hand rub solution [8].

These above mentioned recommendations by the WHO are for surgical hand asepsis. There is still no uniform opinion as to whether these meticulous hand hygiene steps are needed before performing a peripheral nerve block procedure. The reason for this non uniformity is that the peripheral nerve block procedures are less invasive and brief in duration as compared to surgical procedures. The peripheral nerve blocks are considered as clean/aseptic procedures and according to the WHO, this is one among the five moments for hand hygiene. There is clear evidence that proper hand washing and application of sterile gloves alone significantly reduces central venous catheter infections [11]. Therefore this should be applied to peripheral nerve blocks also. Considering that the infectious complication following peripheral nerve block is an unacceptable and avoidable complication, there should be no hesitancy in incorporating the good hand hygiene practices.

Recommendation- It is mandatory to perform thorough hand hygiene before performing any peripheral nerve block procedure (both single injection and continuous catheter techniques). We recommend either full surgical hand scrub (with chlorhexidine 4%w/v or povidone iodine 7.5% w/v) or hand rub (with chlorhexidine 0.5% w/v in 70% v/v alcohol).

Wearing a Face Mask

Wearing a face mask in the operating room in preventing infection transmission to and from the patients has always been a subject of debate. There are various case reports of patients developing meningitis following lumbar puncture for spinal anaesthesia where the anaesthesiologists did not wear a face mask [12, 13]. In one of these case reports, the anaesthesiologist was suffering from upper respiratory infection. In several cases of iatrogenic meningitis following spinal anaesthesia, alpha-haemolytic streptococci which is a normal oral commensal was isolated [13, 14]. Many argue that the face mask is effective in preventing meningitis and hence should be used routinely [15, 16, 17].

However, there are studies showing contrasting results where face masks were ineffective in reducing surgical wound infection and removal of the mask reduced the infection rates [18, 19]. Since then, there has been confusion

as to whether the face mask should be worn by anaesthesiologists. Some authors recommend wearing of the mask only if the anaesthesiologist is either suffering from upper respiratory infection or speaking during the procedure and not routinely [20]. This begs the question - Could the anaesthesiologist in the window period or recovery phase of his respiratory infection transmit the infection? In most institutes, the anaesthesiologists speak either to teach the students or to have a verbal contact with the patient during a neuraxial procedure, which necessitates the application of the face mask. Another review implied that plastic face shields offer a higher level of protection to the anaesthesiologists as compared to face masks and hence discouraged routine use of face masks except for some special procedures [21].

It is unknown if the face masks are necessary while performing peripheral nerve blocks. It is also difficult to extrapolate the complications in the spinal anaesthesia case reports to peripheral nerve blocks. Despite this, anaesthesiologists routinely wear facemasks in the operating room environment during surgeries. This should leave little doubt if the mask has to be worn while performing any regional anaesthesia procedure. Application of the face mask needs only a few seconds and its impact on the overall cost is negligible.

Recommendation- We recommend the application of face mask (to cover the mouth and nose completely) during all the peripheral nerve block procedures.

Sterile Gowns

Just like face masks, there is ambiguity about the use of sterile surgical gowns while performing peripheral nerve blocks. Various studies on continuous nerve blocks with catheters have been published. In most of these studies except a few, the catheter was placed by taking all aseptic precautions including a surgical gown. Gharabawy et al [22] experienced 2 infections out of 290 popliteal perineural catheters (0.68%) when surgical gowns were not used whereas Borgeat et al [23] reported 2 out of 1001 popliteal catheters being infected when a sterile gown was used. Though it is inappropriate to compare these different studies where the confounding factors responsible for infection are not avoided, the infection rate was high in the study where the sterile gowns were not used (Table 1). On the contrary, Compere et al [24] reported only 1 case of infection out of 400 popliteal catheters (0.25%) that were placed without a sterile gown being worn. Neuberger et al [25, 26] in their prospective studies of perineural catheters at various sites in 2006 and 2007 encountered unusually high infection rates despite the catheters being placed under sterile precaution which also included gowns.

Unfortunately there are no studies comparing infection following perineural catheter placement with and without a surgical gown. Though the ASRA 2006 guidelines [3] consider wearing a face mask and sterile gown as one of the major hygiene practices to prevent infection, Capdevila et al [27] included these measures as unproven potential risk factors for infection. Nevertheless, the German Society for Anaesthesiology and Intensive Care Medicine (DGAI) revised their hygiene guidelines in 2005 after they observed high infection rates during continuous peripheral nerve blocks and subsequently made sterile gown and face mask mandatory for continuous catheters [28]. This practice drastically reduced the infection rates and supports the routine use of sterile surgical gowns while placing perineural catheters.

Recommendation- Routine use of sterile surgical gown is not recommended for single injection peripheral nerve block, but it is mandatory while performing continuous nerve block.

Study	No of catheters	Catheter sites	Local inflammation/ infection	Sterile gown
Borgeat et al[23]	1,001	Popliteal	2/0	Yes
Gharabawy et al [22]	1,059	Supraclavicular (7690/ Popliteal (290)	12/1	No
Cuvillon et al [29]	211	Femoral nerve	3 cases had fever	No details
Neuberger et al [25]	2,285	Various	96/93	Yes
Compere et al [24]	400	Popliteal	1/0	No
Aveline et al [29]	747	Various	72/1	Yes
Capdevila et al [27]	1,416	Various	43/1	Yes
Bergman et al [30]	405	Axillary	1/0	No details
Neuberger et al [26]	3,491	Various sites	146/112	Yes
Wiegel et al [31]	1,398	Various sites	9/3	No details

Skin Antisepsis Before Peripheral Nerve Blockade

An ideal skin antiseptic agent should have a broad spectrum of activity, fast onset, prolonged duration of action and should not be inactivated by blood or other secretions. Additionally, it should have minimal toxic effects on the skin and other tissues [3]. Though povidone iodine is widely used for skin antisepsis before a regional anaesthetic technique, chlorhexidine gluconate has been consistently shown to be superior. Several investigators have shown that chlorhexidine is effective against a wide range of organisms and it effectively reduces colony count compared to povidone iodine [32-36]. It has a fast onset of action and has been shown to provide an extended duration of activity as compared to povidone iodine [37]. Chlorhexidine causes less skin irritation than povidone iodine and is not inactivated in the presence of blood. An in vitro study conducted by Sakuragi et al [38] showed that the growth of both methicillin resistant and sensitive strains of S. aureus was completely inhibited by exposure to 0.5% chlorhexidine in 80% alcohol just for 15 sec. In contrast 10% povidone iodine and 0.5% chlorhexidine inhibited growth only after 120 secs of exposure. Therefore, alcohol based chlorhexidine solution is considered to be superior to plain 0.5% chlorhexidine for skin disinfection.

One of the major concerns of chlorhexidine is its potential neurotoxicity. There are a few case reports of adhesive arachnoiditis following neuraxial anaesthesia and accidental contamination of bupivacaine syringe with chlorhexidine was blamed as the reason [39, 40]. Few animal studies also have proved the chlorhexidine neurotoxicity [40, 41]. This complication, though rare is a catastrophic event and thus it has been recommended that only 0.5% chlorhexidine preparations instead of 2% solution to be used for skin antisepsis [41]. This applies to peripheral nerve blocks as well. Most of the peripheral nerves are superficial and run within a short distance beneath the skin and are as susceptible to neurotoxicity similar to neuraxis [41]. It is advised to use coloured solution of chlorhexidine and not to pour it in the gallipot during the procedure. This is to avoid inadvertent drawing of chlorhexidine into the syringe and injecting instead of local anaesthetic.

Recommendation- Alcohol based 0.5% chlorhexidine solution is recommended for skin antisepsis before the commencement of regional anaesthetic procedure. It is advised to allow sufficient time to ensure that the antiseptic has completely dried before the puncture by block needle.

Bacterial Filters for Continuous Perineural Catheters

Catheter hub contamination is an important risk factor for catheter colonisation and catheter infection [3]. It is a general practice to use bacterial filters provided by the manufacturers during continuous epidural analgesia or peripheral nerve block. These filters are considered to provide protection against 1) the small particulate micro debris which are produced after breaking of the glass ampoules and 2) the bacteria in the perfusing solution [42]. ASRA guidelines do not recommend routine use of bacterial filters for shorter duration of epidural / perineural infusions (hours to days) [3]. This is somewhat surprising and we feel this needs to be reconsidered. There are a few case reports where epidural infection occurred despite the use of bacterial filters. Saady [43] reported a case of epidural abscess on the fourth post-operative day following thoracic epidural catheter. In this case the catheter was removed on second postoperative day itself. The author of this report suspected a possible epidural hematoma following the needle placement or the catheter which acted as a culture medium for haematogenous spread of bacteria. Similarly, Borum et al [44] reported a case of labour epidural analgesia which was complicated by epidural abscess. The author in this case suspected spread of skin contaminant (S. aureus) into the epidural space via the catheter. Bacterial filters offer protection against catheter related infection provided that the microorganisms originate at catheter hub. Apart from the hub, the catheter can be contaminated from other routes like haematogenous spread and skin at the catheter insertion site [42]. Bacterial filters does not prevent contamination from these sources. Several authors have confirmed the efficacy of the bacterial filters by various in vitro studies. Kaushal et al [45] conducted an in-vitro study where bacterial solutions were infused through epidural filters and compared with the infusions without filters (controls). All filters (100%) in the study group effectively prevented bacterial growth. Morris et al [46] cultured the filtrates after flushing 100 bacterial filters used for labour analgesia with solution containing S. epidermidis and found that the organisms failed to grow. All the filters successfully prevented bacteria from passing through the membranes. In a study conducted by De Cicco et al, [42] the bacterial filters containing nylon filtering membrane were highly efficacious for a longer duration of time (60 days) and yielded no growth compared to cellulose acetate membranes.

Recommendation- Bacterial filters are highly effective in preventing microbial contamination and hence their use in all perineural catheters is recommended.

Tunnelling of Perineural Catheters

Tunnelling of catheters which are intended to be kept for a longer duration (dialysis catheters) has shown to reduce the

infection [47]. Similarly many institutes practice tunnelling of the epidural and perineural catheters in an attempt to reduce the catheter migration and infections. Up to 50% of the epidural catheters tend to migrate either inwards or outwards [48]. Similarly a volunteer study showed that the overall dislocation rates of non-tunnelled peripheral nerve catheters was 25% [49]. Burstal et al [50] in a prospective study compared the migration tendency of 100 tunnelled with 113 non-tunnelled catheters. The study showed that the tunnelled epidural catheters demonstrated less inward as well as outward movement compared to the non-tunnelled catheters. Similarly, Bougher et al [51] in a comparative study analysed the effect of tunnelling in 81 patients who received epidural analgesia either via tunnelled or non-tunnelled catheters. This study showed that the inward movement was decreased by more than 20% with tunnelled catheters than the non-tunnelled catheters. 62% of tunnelled catheters remained within 0.5cm of their original position. Sellmann et al [52] also showed in his comparative study that the tunnelled catheter migrated less. Though there are no clinical studies on tunnelling of perineural catheters, there are few cadaver and animal model experiments to evaluate the stability of tunnelled catheters. Byren et al [53] compared the force required to dislodge the tunnelled and non-tunnelled catheters on porcine models. Their study showed that the force required to dislodge the tunnelled catheter was 5 times more than the non-tunnelled catheter. From the above studies, it appears that the tunnelling helps in stabilising the catheters.

Similarly the tunnelling also helps in reducing the bacterial colonisation and subsequent infection. Bomberg et al [54] analysed 22,411 thoracic catheters that were inserted over a period of 8 years and found that tunnelled catheters had significantly lower incidence of any grade of infection compared to non-tunnelled catheters (4.5% for tunnelled vs. 5.5% for non-tunnelled catheters). Tunnelling was an independent factor in reducing infection rate in this study. Similarly Sellmann et al [52] also noted less bacterial contamination with tunnelled catheters (8 out of 59) than the non-tunnelled ones (14 out of 54) in their prospective study. Compere et al [55] prospectively studied colonisation rate of 402 tunnelled perineural catheters at various sites. They found that the catheter colonisation was significantly less (6.22%) compared to other previous studies. These studies show that the tunnelling the perineural catheter is beneficial in reducing both dislodgement as well as microbial contamination.

Recommendation- Tunnelling of the perineural catheters can be beneficial as it reduces catheter migration and infection and is highly recommended.

Antiseptic Impregnated Dressing

Another major source for catheter infection is the skin entry site. Attempts have been made to reduce the skin entry site colonisation by application of antiseptic impregnated dressings. Mann et al [56] conducted a randomised study where 55 female patients received continuous postoperative epidural analgesia either with biopatch (chlorhexidine impregnated dressing) or with plain tegaderm dressing. The study revealed that 11 out of 26 (42.3%) patients from the plain dressing group developed microbial colonisation whereas only 1 out of 29 patients in biopatch group showed bacterial colony (3.45%). In a 2006 meta-analysis, again the chlorhexidine dressing showed lesser colonisation than the placebo dressing (3.6% vs. 35%) [57]. Kerwat et al [58] prospectively analysed the patients receiving either epidural or peripheral nerve catheter for postoperative analgesia with medicated and non medicated dressings. 167 out of 337catheters had medicated dressing and the rest 170 had conventional dressings. The study showed that both epidural as well as peripheral nerve catheters in the medicated dressing group showed less colonisation both at the catheter tip as well as at the insertion site as compared to the non-medicated control group. However, in a study by Schroeder et al [59] where femoral nerve catheters for postoperative analgesia with or without a biopatch dressing was compared, there was no difference in the catheter colonisation rates between the groups.

Recommendation- Although it appears that overall catheter contamination can be reduced by antiseptic impregnated dressing, the cost effectiveness of this strategy needs to be proven. It may not be economical to use these expensive dressings routinely and thus decision has to be individualised. Patients at risk of infection (diabetic, obese etc) can be considered for these types of dressings. It is also wise to use a transparent dressing which can aid in daily inspection of the catheter insertion site for local redness and swelling.

Antibiotic Prophylaxis Before a Peripheral Nerve Block

It is well established that the antibiotic prophylaxis before skin incision reduces the incidence of surgical site infection. But it is unclear whether single dose antibiotic reduces the perineural catheter infection. Almost all patients who receive regional anaesthesia via continuous catheter also receive single dose antibiotic as a part of pre-operative prophylaxis except for a few clean surgical cases. So it is difficult and probably unethical to conduct a randomised trial between patients receiving and not receiving antibiotic prophylaxis. However, Bomberg et al [60] in a retrospective registry analysis evaluated 40,362 patients who received

regional anaesthesia. After propensity matching, 11,307 patients who received single dose antibiotic were compared with 11,307 controls who did not receive any antibiotic. The infection rate was significantly less in matched patients who received the antibiotic (1.1%) as compared to the control group (2.4%). The timing of antibiotic (either before or after the catheter insertion) did not influence the infection rate. German Society of Anesthesiology and Intensive Care Medicine (DGAI) and the Association of German Anesthesiologists (BDA) also recommend the use of prophylactic antibiotic for perineural catheters even if it is not indicated for surgical procedure alone.61

Recommendation- Though the evidence is weak due to lack of studies confirming the efficacy of antibiotic prophylaxis, it may be beneficial to administer a single dose antibiotic during continuous peripheral nerve block procedure at least in patients who are at risk of infection (obesity, diabetic, multiple comorbids, axillary or femoral catheters). Single injection techniques need not follow antibiotic prophylaxis.

Summary

Following are the recommendations that needs to be observed before performing a peripheral nerve block (either single injection or continuous catheter technique)

1. All jewellery, wrist watch, bracelets, finger rings have to be removed.
2. Proper hand washing with appropriate antiseptic agent (4% w/v chlorhexidine or 7.5% w/v povidone iodine for hand scrub and 0.5%w/v chlorhexidine in 70%v/v alcohol for hand rub) is mandatory.
3. Wearing a surgical cap and face mask to cover the nose and mouth completely.
4. Sterile surgical gowns are to be worn while performing a continuous catheter technique.
5. Block site skin antisepsis with 0.5% chlorhexidine in 70% alcohol is recommended. Do not pour the antiseptic agent into the gallipot to avoid antiseptic splash and possible contamination of syringes.
6. Always use bacterial filters for perineural catheters.
7. Tunneling of the perineural catheters is preferred to reduce displacement and bacterial colonisation.
8. Routine application of antiseptic impregnated dressing is not recommended. However it can be considered in high risk cases (diabetic, obese patients, axillary and femoral nerve catheters).
9. Single dose antibiotic prophylaxis for a perineural catheter placement is recommended.

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