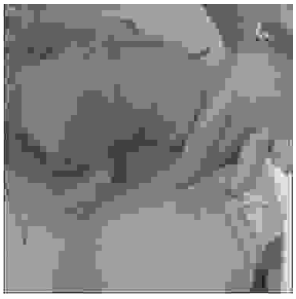
ORIGINAL PROF-1196

# REGIONAL ANESTHESIA;

## BACTERIAL CATHETER COLONIZATION: WHAT ARE THE RISK FACTORS?



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**ABSTRACT...** kavarih@sums.ac.ir , hkavari2000@yahoo.com, hameedchohedri@yahoo.com **Background**: Although several potential risk factors have been discussed, risk factors associated with bacterial colonization or even infection of catheters used for regional anesthesia are not very well investigated. **Design:** The prospective observational trial. **Setting:** Department of Anesthesiology Shaheed Beheshti Hospital Shiraz. **Period:** From April 2003 to April 2004. **Materials & Methods:**, 297 catheters at several anatomical sites where placed using a standardized technique. The site of insertion was then monitored daily for signs of infection (secretion at the insertion site, redness, swelling, or local pain). The catheters were removed when clinically indicated (no or moderate postoperative pain) or when signs of potential infection occurred. After sterile removal they were prospectively analyzed for colonization, defined as > 15 colony forming units. **Results:** 50 (16.7%) of all catheters were colonized, and 27 (9.1%) of these with additional signs of local inflammation. Three of these patients required antibiotic treatment due to superficial infections. Stepwise logistic regression analysis was used to identify factors associated with catheter colonization. Out of 26 potential factors, three came out as statistically significant. Catheter placement in the groin (odds-ratio and 95%-confidence interval: 3.4; 1.5–7.8), and repeated changing of the catheter dressing (odds-ratio: 2.1; 1.4–3.3 per removal) increased the risk for colonization, whereas systemic antibiotics administered postoperatively decreased it (odds ratio: 0.41; 0.12–1.0). **Conclusion** Colonization of peripheral and epidural nerve catheter can only in part be predicted at the time of catheter insertion since two out of three relevant variables that significantly influence the risk can only be recorded postoperatively. Catheter localization in the groin, removal of the dressing and omission of postoperative antibiotics were associated with, but were not necessarily causal for bacterial colonization. These factors might help to identify patients who are at increased risk for catheter colonization.

## INTRODUCTION

Questions about the infection control practices of anaesthesiologists are as old as our specialty and raised as early as 1873 by Skinner[1]. To control infectious complications associated with regional anaesthesia, current recommendations are based on national organizations. Although several risk factors have been discussed, risk factors associated with bacterial colonization or even infection that could guide such recommendations has not been investigated systematically so far or clinical trials had too few patients to draw meaningful conclusions. Among the risk factors

that have been suspected to abet catheter infection are age, pre-existing diseases (e.g. diabetes mellitus, drug abuse, alcoholism), sepsis, and medical treatment compromising the immune response[2-4], site of catheter insertion[2,3,5], technically difficult catheter insertion with development of an asymptomatic haematoma that may later become the focus of bacterial colonization[6], filter changing manoeuvres or disconnecting the system[7] and duration of catheter use[5]. Prophylactic antibiotics, use of local anaesthetic solution with bacteriostatic effect and antimicrobial filters are thought to decrease the risk of infection[8,9].

Thus, the purpose of this observational study was to prospectively determine the incidence of catheter bacterial colonization and infectious complications in postoperative patients having peripheral nerve or epidural catheters at different sites at Hospitals related to Shiraz University of Medical Sciences, Shiraz, Iran and to identify factors associated with bacterial colonization of peripheral or epidural nerve catheters.

## METHODS AND PATIENTS

This prospective study was approved by the local ethics committee and informed consent was obtained from each patient. Consecutive patients scheduled for elective surgery (orthopaedic, cardiac, visceral and urologic surgery) receiving various peripheral or epidural catheters were enrolled in this study over a period of 5 months. All catheters were placed preoperatively in the operating room or in the pre-anaesthetic holding area. No patient for chronic pain therapy was considered.

The procedure for catheter insertion was standardized and carried out with a standardized aseptic technique, according to the guidelines of the German Robert-Koch-Institution. In short these included wearing a surgical hood, face mask, sterile gloves after hand disinfection, a sterile coat, and using a large sterile drape covering the insertion site. The skin was disinfected for at least one minute by wiping or by spraying (at the anaesthetist's discretion) with Cutisept (contains in 100 g: 2-Propanol 63 g, benzalkoniumchlorid 0,025 g, cleaned water and dyestuff). This disinfectant is suitable for all sites and recommended by the DGHM (Deutsche Gesellschaft für Hygiene und Mikrobiologie = German Society for Hygiene and Microbiology).

Bacterial filters provided with the sets were attached to all catheters in a sterile manner. The catheter insertion sites were covered with a sterile transparent dressing that permits the escape of moisture from beneath the dressing (Tegaderm®, consisting of polyurethan). In case of blood sequestration on the insertion site, sterile gauze was placed under the dressing. No antimicrobial prophylaxis was administered specifically for the nerve catheter insertion, but nearly all patients received a single-shot perioperative antibiotic prophylaxis after catheter placement before surgery. In orthopaedic and cardiac surgery, cefuroxim 1.5 g, and in visceral and urologic surgery a fix combination of 2 g ampicillin + 1 g sulbactam was administered intravenously.

An initial bolus dose of a local anaesthetic was injected preoperatively. Patients with a peripheral regional catheter received a mixture of 20 ml prilocaine 1% and 20 ml ropivacaine 0.75%, and patients with an epidural catheter had 10 ml of ropivacaine 0.5–0.75% after an initial test dose of 2–3 ml bupivacaine 0.5%. Then a continuous infusion of ropivacaine 0.2% (5–15 ml/h for peripheral regional anaesthesia and 4–10 ml/h for epidural anaesthesia) was started in the postanaesthesia holding area and continued on the ward.

The catheter management postoperatively was standardized and carried out by the acute pain service by one of the authors (A.M.M.). The catheters were kept in place as long as clinically indicated, depending on a daily evaluation of the intensity of pain (aiming at a pain level of 3 cm or less on a 10 cm visual analogue scale) and the evaluation of the insertion site. For these purposes the patients were visited twice a day and the dressing was inspected and palpated. The dressings were changed only if necessary. This was defined as follows: first the site of catheter insertion was contaminated with blood, second there was a wet chamber under the dressing, or third the dressing was about to peel away. The algorithm of care used after unintentional dressing removal as well as for intended replacements was disinfection of the skin by spraying on the insertion site

with Cutisept®, cleaning the insertion site with sterile compresses and let dry for at least one minute, then fixing a new dressing. If a catheter was obviously disconnected for a short time (less than 30 minutes), it was cleaned and disinfected about 10 cm distant from the catheter end, cut with sterile scissors and reconnected using a new sterile connector and a new bacterial filter. If the time period since disconnection was unclear, the catheter was removed. Otherwise no filter change was performed, even if the catheter was in place for a longer time.

Measurements of body temperature and a neurological examination were performed at least once a day as long as the catheter was in situ and again two days after its removal.

The catheters were removed under aseptic conditions. To prevent bacterial contamination of catheter tips, the skin was disinfected with Cutisept® for one minute. Only when the skin had dried completely the catheter was removed to avoid direct contact of the catheter tip with the disinfectant agent. The distal catheter tip was cut with sterile scissors, placed in a sterile transport medium and transferred immediately to the microbiology laboratory.

Semi-quantitative culture techniques were used as described by Maki et al[10]. The catheter segment was rolled several times across the surface of an agar plate and incubated overnight at 35˚C under aerobic conditions. Then, the same catheter segment was immersed in 5 ml thioglycolate broth. After overnight incubation at 35˚C aliquots of the broth were transferred to a 5% sheep blood agar plate and a MacConcey agar plate (Becton Dickinson, Heidelberg, Germany) and again incubated at 35˚C for 24 h. Colony forming units (CFU) were counted and identified by standard microbiological methods. The presence of more than 15 CFU of a single organism per catheter was considered colonization, and if accompanied by signs of local inflammation (redness, swelling, and pain with pressure or tapping on the insertion site) it was defined as local infection.

To allow comprehensive analysis of potential factors associated with bacterial colonization, a large amount of clinical variables were recorded prospectively. Some of them were pre-processed to reduce the load for the multifactorial statistical analysis. E.g., the patients' weight and height were used to calculate the body-mass-index (BMI). Furthermore, factors that were observed with a low incidence and therefore having no realistic chance to provide statistical significance in the univariate and in the multivariate analysis (history of infectious disease of the skin (n = 8) and infection with other catheter material in the past (n = 3) were analyzed separately and after merging them into an additional dummy variable. The same strategy was used for factors known to provoke surgical wound infection[11]. These were diabetes mellitus (n = 24), chronic steroid medication (n = 9), and cancerous disease (n = 49)[12]. The anatomical site of catheter insertion was grouped using the incidences of catheter colonization in a descriptive univariate analysis. Several attempts to group the different catheter techniques were used but finally the best discriminating power was achieved by summarizing catheters located in the groin (femoral nerve catheters and sciatic nerve catheters inserted by the anterior approach described by Meier et al[13]) against all other techniques.

Twenty six potentially relevant variables were entered into a stepwise backward logistic regression analysis using the maximum likelihood method. The order of removal from the model and the odds-ration and p-value, respectively. The goodness of fit of the regression model was judged using Nagelkerkes's $R^2$. All analyses were performed using JMP 5.1 for Windows (SAS Institute Inc., Cary, NC, USA) and SPSS 11.5 for Windows.

## RESULTS

A total of 300 catheters from 201 patients were initially enrolled in the study. Three catheters were excluded because they were not removed in accordance with the aseptic technique. Thus, 297 catheters from 198 patients could be analyzed

Catheters were removed between day 0 (if a planned extensive surgery was modified intraoperatively into a smaller one not requiring postoperative analgesia via a catheter), and day 31 after an invasive procedure. In

mean, catheters were in use for 3.7 days (standard deviation: 3.0). The median and the $25^{th}$ / $75^{th}$ percentile were: 3;2/5. This time period was not different in colonized catheters (mean: 3.8±2.1 days) and uncolonized catheters (mean: 3.7±3.1 days).

Of 297 catheters analysed, 47(23.7%; 95%-confidence interval: 18–30%) were not sterile. A heterogeneous flora of bacteria could be detected. In most cases (78.7%) these were normal non pathogenic skin flora. Coagulase negative staphylococci were most often detected, and only 21.3% were optional pathogenic microorganisms. In 50 patients (16.7%; 95%-confidence interval: 12–23%) there were more than 15 CFU detectable. According to the different insertion sites, of these patients, 27 showed additional signs of local inflammation, indicating local infection.

The stepwise logistic regression analysis revealed that out of the 26 potentially relevant parameters only three independent factors remained in the final model as statistically significant. Catheter placement in the groin was associated with a significant higher incidence of catheter colonization (p = 0.004). The odds-ratio was 3.4 (95%-confidence interval: 1.5 – 7.8) compared to all other anatomical sites. No other potential risk factor that can be determined preoperatively came out as statistically significant. Postoperatively, removal of the catheter dressing, either intentionally or unintentionally, was associated with an increased risk for colonization. Using the graphical exploratory tools in the JMP 5.1 software, there was an almost linear increase of the rate of colonization with an increasing number of changes of the dressings. Results of the logistic regression analysis revealed that each attempt to change the dressing increased the risk with an odds ratio of 2.1 (95%-CI: 1.4 – 3.3; p = 0.001). There was a maximum number of changing the dressing of five times.

Postoperative administration of an antibiotic drug at least for 24 hours significantly reduced the risk of catheter colonization. The odds-ratio was 0.41 (95%-CI: 0.12 – 1.0; p = 0.05). The constant of the equation of the regression analysis (- 2.63) and the coefficients for each risk factor can be used to calculate a predicted risk for each patient. This theoretical risk can vary between 2.8% (when a catheter is not placed in the groin, no changing of the dressing is performed, and the patients receives postoperative antibiotic treatment) and 91% (in a patients receiving a femoral nerve catheter, with no postoperative antibiotic treatment, and where the dressing was removed five times or more). These calculations are performed for demonstration in the appendix. The goodness of fit was moderate but acceptable (Nagelkerke's $R^2 = 0.20$).

Despite the high rates of catheter colonization and superficial local infection, only two clinical infections occurred.

On the fourth postoperative day (the dressing was changed once on the second postoperative day) a patient with an interscalene plexus catheter developed pain at the insertion site, neuropathic pain of the arm and a reddish swelling of 4 cm in diameter, temperature of 38.6˚Celsius, and a leukocyte count of 16.7 $G \cdot l^{-1}$ within a few hours. Until then, the patient did not receive any prophylactic antibiotic except for the intraoperative single-shot administration of 1.5 g intravenous cefuroxim. The catheter was immediately removed and antibiotic therapy with cefuroxim 1.5 g intravenously three times daily was initiated. All symptoms disappeared within the following two days. Two different species of coagulase negative staphylococci (staphylococcus epidermidis) were found on the catheter tip, both of them with CFU > 15. One kind of staphylococcus epidermidis was resistant to cefuroxim, but since the symptoms resolved quickly, the antibiotic regimen was not changed.

The other patient presenting with an infectious complication had an epidural catheter at T7/8. The dressing was changed three times. Only the perioperative single-shot antibiotic with a fix combination of 2 g ampicillin + 1 g sulbactam had been administered, and no further antibiotic treatment was necessary. On the fifth postoperative night he developed very intensive pain and a dark red swelling of 8 cm in diameter superficially just underneath the skin. Until then, a continuous infusion of 4–6 ml/h ropivacaine 0.2% was infused. Neurological examination was normal, neither were there signs of

systemic reaction like fever or leukocytosis. The catheter was removed and a local disinfectant ointment was applied. Within 36 hours all symptoms had resolved. The bacterium found on the catheter tip was again staphylococcus epidermidis with > 15 CFU.

## DISCUSSION

In this study, catheter colonization occurred with an incidence of almost 17%. More than half of these colonized catheters also presented with local signs of inflammation (9%). In contrast to these high colonization rates real catheter related infections (local complications, bacteriaemia and / or systemic reactions like fever and leukocytosis) are quite rare. Cuvillon found only three out of 208 femoral catheters with transitory bacteriemia likely related to the catheter, and no abscess occurred, despite the high colonization rate of 57%[14]. Steffen et al. reported a low incidence of colonization in a series of 502 epidural catheters. Several large studies reported epidural abscesses with a varying incidence between 0% and 3%[5,15-17].

In our trial only two catheters related local infections occurred. Both resolved completely within two days with only local ointment or intravenous antibiotics. No serious complication occurred at all during our observational period.

Using a multifactorial statistical model, three independent factors could be identified that were associated with bacterial colonization. However, only one factor (anatomical localization of the insertion site) can be used as a "true risk factor" since the other risk factors are "postoperative" variables. E.g., the decision to perform antibiotic therapy is often performed by the surgeon and the number of changing of the dressing is not easy to foresee.

All other potential "true risk factors" that are patient related factors (e.g. gender, age, pre-existing diseases), puncture site and technical details of catheter placement and fixation (e.g. number of attempts until successful placement, catheter tunnelling) were removed as insignificant. This means that it is not possible to discriminate which patient will or will not develop catheter colonization preoperatively. This result highlights the need for a close postoperative evaluation of every patient even if no factor is present that has been described as a risk factor in previous reports.

Age, preexisting diseases or medical treatment which compromise the immune response have been discussed as potential risk factors and in part are proven risk factors for surgical wound infection[18]. In our trial, neither age nor preexisting diabetes mellitus, cancer disease, infectious disease, abscess in the past, infection with other catheter material in the past, prolonged corticosteroid therapy or short term corticosteroid therapy perioperatively were indicators for an increased risk. Furthermore, combining disease states that occurred too infrequent to have a realistic change to achieve statistical significance did also not lead to variables with significant impact.

The site of catheter insertion is another potential influencing factor in previous studies. The femoral site was associated with a rate of bacterial colonization as high as 57%[14], whereas the popliteal insertion site had a very small bacterial colonization rate of 7.5%[19]. Epidural catheters revealed catheter colonization in 6 to 35%[2,20]. One possible explanation for these differing results might be the great variations with respect to the density of sebaceous glands in the different insertion sites that has been shown to impact the ability of local disinfectants to reduce the number of microorganisms[21].

For example Steffen et al.reported a higher incidence of colonized catheters in patients where the epidural catheters were placed at a thoracic level compared to the lumbar route. However, a variable that should distinguish between potentially more contaminated and clean puncture sites based on the latter hypothesis was early removed as insignificant in our analysis. Catheter placement in the groin (femoral nerve catheters and sciatic catheters advanced via the anterior approach) was associated with a significantly higher incidence of colonization than all other anatomical landmarks.

Technically difficult catheter insertion may cause asymptomatic haematoma that may later become the focus of bacterial colonization [6]. However, this theory was

not supported by other authors[5]. In our trial the numbers of skin perforations with the needle during catheter placement did not increase the occurrence of catheter colonization.

The repetitive administration of antibiotics during the postoperative period reduced the incidence of catheter colonization. Reports from the literature support the view that antibiotic therapy during the peri-operative period lowers the risk for infectious catheter complications. A relatively high rate of epidural abscess occurred in a population that apparently did not receive perioperative antibiotics routinely[5]. Furthermore, in a series of 405 axillary catheters, the only abscess occurred in a patient who had not received an antibiotic[22]. It is interesting to notice that intraoperative single dose antibiotic treatment did not provide sufficient protection. However, this single shot treatment was usually administered 30–60 minutes after the insertion of the epidural or peripheral nerve catheter. Thus, we can not answer the question, whether antibiotic prophylaxis before catheter placement might be able to reduce the incidence of colonization.

Concerning the possible routes for catheter colonization, Hunt et al. demonstrated that the catheter hub represented the main route for catheter colonization[11]. Therefore disconnection of the closed system or filter changing maneuvers should be avoided if possible[11,23]. We analyzed the situations where catheters were accidentally disconnected assuming that the unprotected end was open for an indefinite time and could let microorganisms pass through. In the multifactorial analysis, accidental disconnection of the catheter was removed at a late stage of the stepwise logistic regression procedure. Thus, this potential risk factor was insignificant but is a candidate for further investigations.

Local anaesthetic solutions with bacteriostatic effect like bupivacaine, prilocaine, lidocaine and tetracaine[24] have shown to decrease the risk of infection[8,9]. In our trial, only ropivacaine 0.2% was used postoperatively for continuous administration and thus this potential influencing factor could not be included in the statistical model.

Duration of catheter use has been found to increase the risk of infectious complications in a Danish study with epidural catheters[5]. No epidural abscess was found with use of catheters $\leq$ 2 days, but one third of the abscesses were found in patients who had the catheter in situ for three days only. This implicates that even a short catheterization time of three days does not eliminate the risk of infection. In another observational trial, there was a very strong correlation between duration of catheter use and infectious complications in patients with perfusion disorders, but not in the other subgroups[25,26]. In our own trial we could not observe a statistically significant time dependency, but the variable was late removed at step 21 of 23. In our trial catheters were removed between day 0 and day 31. The decision to withdraw a catheter was primarily based on the daily pain evaluation by the patient. However, also local signs of the insertion site influenced the decision to remove the catheter. Thus, it is important to notice that duration of catheter use is not a risk factor only under the strict assumption that the site of insertion is evaluated at least once a day and the catheter is immediately removed if there are any signs of local redness, swelling or pain at the insertion site. This is in agreement with a recent study showing that the duration of use of an epidural catheter was not different in colonization and in sterile catheters. Attention should be paid to the fact that duration of catheter placement has some correlation with the number of removal of catheter dressing (Pearson correlation coefficient r = 0.50; Spearman correlation coefficient rho = 0.35). Only the latter factor remained statistical significant in the final model, and thus some of the predictive information provided by the duration of catheter placement was virtually transferred. This phenomenon of co-linearity is discussed in more detail in the following paragraph.

## CONCLUSION

Summarizing the present results, three independent risk factors could be detected applying a stepwise logistic regression procedure to a great number of potential risk factors for bacterial catheter colonization. Catheter localization in the groin, removal of the dressing and omission of postoperative antibiotics were associated but not necessarily causal for postoperative catheter

colonization.

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