

Specific Prevention Against Infection of Local Catheters in Postoperative Pain Management

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Abstract

Background: The guideline for postoperative pain management therapy recommends several obligate measures and permissive provisions keeping catheters hygienic. An organized Pain Nurse is generally regarded as convenient. But some recommendations are still discussed. The guideline is based on only few large studies and the number of catheter-related infections differs from technique and risk profile. However, all recommendations for improvement have to be compared with the guideline. This prospective study was initiated to investigate the influence of catheter fixing, the frequency of changing dressings and the use of bacterium-filters on the rate of inflammation and infection.

Methods: 2545 consecutive patients, who were under treatment of the Pain Nurse, were included in the study. 1624 patients received epidural catheters, 921 patients received continuous peripheral nerve blocks. The catheters were immediately placed and fixed by stitching before performing the operation. A bacterium-filter was always interposed and after some time a second filter was added in tandem circuit. After 4 days the transparent tape was changed. The assessment of the infection severity was oriented towards the criteria of the guideline. The results of the study were statistically compared to the data of the S3-guideline.

Results: 34 (14.4%) of all catheters in the sample were colonized. Catheters placed in the groin were statistically significant more often colonized than epidural catheters (28.1% vs. 6.6%, $p < 0.01$). 5 Catheters (0.2% vs. 4.2%, $p < 0.01$) had signs of local inflammation. Only one fairly serious infection (placement in the groin) (0.04% vs. 2.4% $p < 0.01$) and no severe infection were observed.

Conclusion: Catheter-fixing by stitching and changing catheter-dressing on the first postoperative day to avoid dampness are important measures to prevent catheter related infections. Using consequently bacterium-filters with tandem circuit is supposed to reduce the rate of catheter-related inflammations and infections.

Keywords: Hygiene catheter infection colonization bacterium-filter; Postoperative pain

Introduction

Local catheters in postoperative pain management are progressively popular in anesthesia. However, there is an incertitude concerning the implementation of hygienic measures for prevention against infection. Up till now there is no standardized hygiene policy especially for regional anesthesia catheters so far. Although hygiene deficits could lead to severe consequences for the patient, studies which consider prevention of infection in the context of local catheters in postoperative pain management are rarely.

Background

Peripheral nerve blocks are predicated as safe and highly effective in acute pain management. Specifically, in orthopedic surgeries, the patient benefits from early mobilization [1]. There are only rare severe incidents of pain catheters. But these events may have serious and in some cases life changing impacts (e. g. Mediastinitis [2], necrotizing fasciitis [3]).

Although local anesthesia catheters are frequently deployed in postoperative pain management, there is an incertitude concerning the implementation of hygienic measures for prevention against infection.

Many hygiene precepts for central venous catheters have been adapted analogously to regional anesthesia [4]. A standardized hygiene policy especially for local anesthesia catheters does not exist yet. There are many studies concerning hygienic rules for central venous catheters, but only few studies consider anesthesia catheters in postoperative pain management. It must be remembered that there could exist differences between a venous catheter and a nervous pain catheter. However, an organized pain nurse is regarded as favourable to reduce overlooked catheter infections [5].

The S3 guideline on postoperative pain management, currently being revised, recommends hygienic basic and "optional" measures regarding the management of local anesthesia catheters. Nevertheless, a significant range of variation in the recommendations for action as well as in the infection rate can be observed between the individual centers [6-9]. The scientific working group "Local Anesthesia" assumes that "prevention measures have not been used in the highest possible extent in all centers" [4].

Methods

Definitions and pathophysiology of catheter colonization

The S3 guideline on the “treatment of acute perioperative and posttraumatic pain” describes the following alternatives of catheter colonization (Figure 1).

It is important to differentiate between the terms contamination, colonization and infection (Table 1).

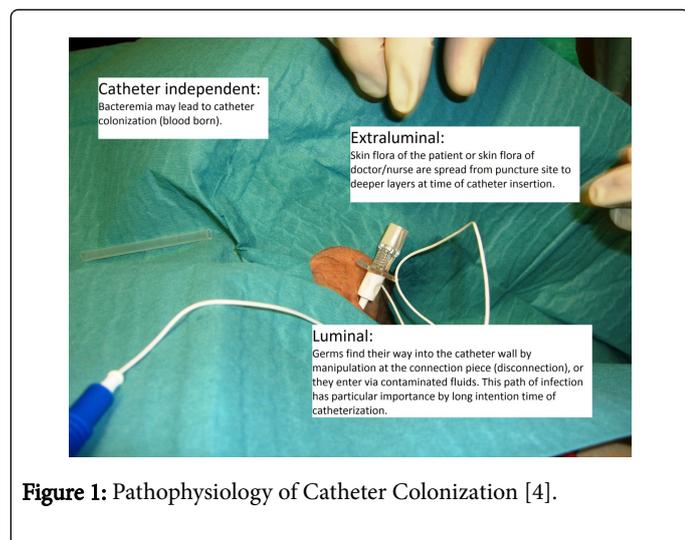


Figure 1: Pathophysiology of Catheter Colonization [4].

Open questions in hygiene management

There are only few and often several opinions concerning bandaging techniques, frequency of changing dressings, fixing catheters securely and the management of bacteria filters. Therefore, a prospective study should evaluate all these mentioned aspects in relation to occurrence, frequency and severity of infections.

Study design and test methods

The observational study lasted three years (January 1st, 2010-January 1st, 2013) and is part of the multicentric, interdisciplinary

benchmark project: “Quality Control in Postoperative Pain Management” (QCPOPM).

Contamination	Colonization	Infection
Germ count <15 colony-forming units (CFU)	Germ count > 15 CFU without clinical signs of infection	Slight: flush, swelling, tenderness on palpation (two criteria at least) Moderately severe: purulence at puncture site, increasing inflammation parameters, temperature, required systemic antibiotic therapy (two criteria at least) Severe: surgical intervention required (abscess incision)

Table 1: Definitions.

An affirmative vote by the ethical review committee of Jena University Hospital is available.

The study included 2,545 consecutive patients undergoing regional anesthesia of the Klink Bayreuth. 1,624 patients had local catheters inserted close to the spinal cord, 921 patients received peripheral nerve blocks. The catheter was inserted immediately preoperative, following a standardized operating procedure (SOP) (Table 2).

The severity of infection was categorized according to the S3 guideline criteria and compared with literature incidence. There are already some well proposed studies in literature, which formed the S3 guideline.

In the following study, we eschewed attentively the control group, but matched the studies in literature of the S3 guideline (control group) against our clinical SOP group (intervention group).

The intervention is shown in Table 2. You can find three interventions regarding the bacteria filter management, dressing and fixing. These three interventions distinguish the clinical SOP group from the control group.

The study design was apart from that similar to the studies in literature (control group). The high significant lower infection rates in our study didn't allow installing a control group afterwards. It wouldn't be ethical to refuse the control group the sensationally effective hygienic procedures.

Hygiene plan
Insertion of the catheter in the preparation room.
Number of persons limited to the required minimum.
No wearing of watches or jewelry.
No routine shaving. Haired body sites are getting shaved immediately before the puncture.
No routine degreasing and cleansing of the skin; cleansing only in the case of visible contamination.
Hand disinfection according to the standards of the Robert Koch Institute.
Skin disinfection: centrifugal spray-and-wipe-and-spray disinfection with alcohol-based disinfectant and an exposure time of 1-10 minutes. Excess disinfectant absorbed by sterile compress immediately before the procedure.
Surgical mask, headgear, sterile gown.
Medical cover sheeting: large self-adhesive fenestrated drapes and spacious sterile work surfaces in order to avoid contaminations.

Medications and material: standards of the DGAI (German Society for Anesthesiology and Intensive-care Medicine) were observed.
Bacteria filter management: By inserting the catheter, a bacteria filter is interposed. After a defined time interval an additional filter is added in tandem circuit. (epidural catheter: 48 hours, peripheral nerve blocks: 96 hours). The second filter is replaced regularly, while the first filter remains until removal of the catheter. S3 guideline: A bacteria filter should be included, but you should abdicate a filter changing.
Dressing: Puncture site is covered with Curapor® Band-Aid, which will be exchanged with a transparent dressing after 24 hours. Renewal of the dressing after 4 days. S3 guideline: Changing dressings only if it is unavoidable.
Fixing: After the puncture, the catheter is fixed by stitching and additionally by pasting. S3 guideline: The catheter has to be fixed safely by pasting.
Daily supervision by the pain nurse.
Indication is verified every day.

Table 2: SOP of hygiene practices (Differences between the recommendations of the S3 guideline and the own clinical SOP is marked. 3 Interventions were different from the S3 guideline: Bacteria filter management, dressing and fixing)).

Data analysis

Incidents were indicated as numerical value with related population. In order to gain comparability, results were converted into percentage frequencies with their 95% confidence intervals. The own examination was defined as study group, the underlying works of the S3 guideline served as control group. Statistical comparisons were performed employing the Chi² test, using bilateral testing. Clinical significance was defined at p<0.05.

Results

Duration of catheterization

The mean duration of catheterization by thoracic epidural catheters lasted 5.4 days and by lumbar epidural catheters 1.8 days. The duration on the average of catheterization by femoral catheters took 5 days,

while the catheters for the ischia nerve remained for 3.3 days and the catheters for the Interskalenar plexus blockade were left for 3.5 days.

Rate of colonization and infection

34 catheters (14.4%) of a random sample (236) were colonized. Femoral catheters were colonized more frequently than epidural catheters (28.1% vs. 6.6%, p<0.01). A coagulase negative staphylococcus, that means a germ of the normal skin flora, was the most frequent germ in the sample.

Slight infections (flush) occurred in 5 patients (0.2% vs. 4.2%, p<0.01), a single moderately severe infection was observed in a femoral catheter (0.04% vs. 2.4% p<0.01). No severe infections were observed.

Rate of colonization and infections in the patients were shown by following Tables 3,4,5 and 6.

	Own study (n)	Own study (%)	Morin (n)	Morin (%)	Capdevila (n)	Capdevila (%)
No colonization	202	85.6%	151	76.3%	691	71.3%
Colonization	34	14.4%	47	23.7%	278	28.7%
Divided						
One pathogen per catheter	24	70.6%	31	66.0%	242	87.1%
Two or more pathogens per catheter	10	29.4%	16	34.0%	36	12.9%
Pathogen total	45	100.0%	66	100.0%	310	100%
Normal skin microbiota						
Coagulase-neg. Staphylococcen	25	55.6%	40	60.4%	195	62.9%
Bacillus spezieis	2	4.4%	9	13.6%		
Enterococcus spezieis	6	13.3%	3	4.5%	21	6.8%
Facultative pathogen						
<i>Bacillus cereus</i> (gram positive)	4	8.9%	0	0.0%	4	1.3%

Escherichia coli	0	0.0%	5	7.8%	15	4.8%
Enterobacter spezies	1	2.0%	3	4.5%	11	3.5%
Klebsiella spezies	3	6.7%	3	4.5%	8	2.6%
<i>Morganella morganii</i>	1	2.0%	1	1.5%		
Nonfermenter spezies	0	0.0%	1	1.5%		
<i>Pseudomonas aeruginosa</i>	1	2.0%	1	1.5%	9	2.9%
Acinetobacter	0	0.0%	0	0.0%	7	2.3%
<i>Proteus mirabilis</i>	1	2.0%	0	0.0%	8	2.6%
Citrobacter	1	2.0%	0	0.0%	4	1.3%
Serratia	0	0.0%	0	0.0%	3	1.0%
<i>Staphylococcus aureus</i>	0	0.0%	0	0.0%	15	4.8%
others	0	0.0%	0	0.0%	10	3.2%
N=236						

Table 3: Comparison between the colonization rates in the own study and the control groups of the S3 guideline:

	Colonization (%)	95% VB	Chi ²	Significance level	OR
Own study	14.4	[10.19-19.54]			
Morin	23.7	[17.99-30.28]	4.92	p<0.05	1.8
Capdevila	28.7	[25.86-31.65]	11.96	p<0.01	2.4

Table 4: Evaluation of the comparison between the colonization rates in the own study and the control groups of the S3 guideline.

	Colonization (%)	95% VB	Chi ²	Significance level	OR
Epidural catheter	6.6	[3.07-12.19]			
Femoral catheter	28.1	[17.58-40.75]	12.18	p<0.01	5.5

Table 5: Evaluation of the comparison between the colonization rates of epidural catheters and femoral catheters in the own study.

	Slight infection (%)	95% VB	Chi ²	Significance level	OR
Own study	0.2	[0.06-0.46]	95.6	p<0.01	22.1
Neuburger 2006	4.2	[3.54-4.90]			
	Moderate severe infection (%)	95% VB	Chi ²	Significance level	OR
Own study	0.04	[0.01-0.22]	58,6	p<0.01	62
Neuburger 2006	2.4	[1.90-2.94]			
	Severe infection (%)	95% VB	Chi ²	Significance level	OR
Own study	0				
Neuburger 2006	0.8	[0.56-1.20]			

Table 6: Evaluation and comparison between infection rate in the own study and the control group in the S3 guideline.

Discussion

As compared to literature, the present study shows a very low infection rate (Figure 2).

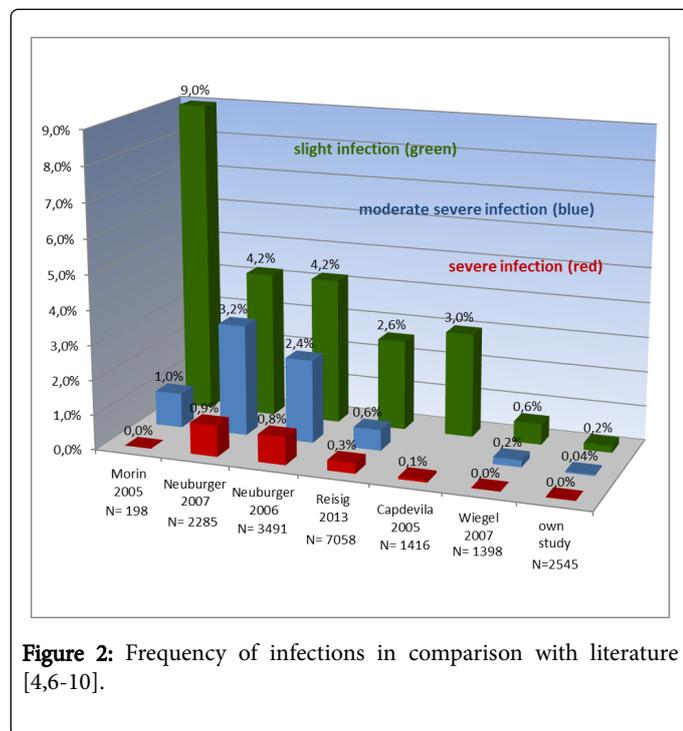


Figure 2: Frequency of infections in comparison with literature [4,6-10].

We observed a colonization rate of 14.4%. The contamination of coagulase-negative staphylococci (55.6%) was most frequent. These results confirm the observations of the control studies by Morin [11] and Capdevila [6]. Clinical signs of slight infections were observed in only 0.2% of catheterizations (Figure 3).

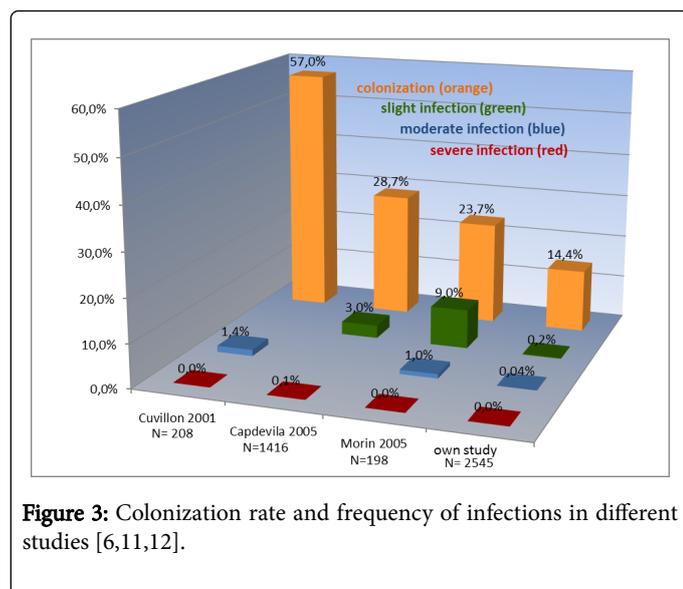


Figure 3: Colonization rate and frequency of infections in different studies [6,11,12].

Safe catheter fixing

“Catheter and connectors must be fixed safely” [4]. In the S3 guideline, it is recommended to paste the catheter with connector and

plugged in filter tightly on to the skin [4]. But sole pasting with Tagaderm® can't be the best fixing of catheters, because a study, which considered the problem of well fixing catheters of pain management, showed a migration of catheters after only two days [13].

Safe catheter fixing will minimize the risk of flaw in catheters with following colonization and infection, especially if we have to change strappings frequently. Stitching the catheter for fixing is considered as satisfactory, especially if the catheter is left for less than four days [14]. An Increasing appearance of infections caused by stitching the catheter was not be observed in our own study. Conformable to the study of Bormann [15], an atraumatic insertion of the catheter and fixing the catheter by stitching is postulated to prevent infection.

Bacteria filter management

The “optional” advices of the DGAI recommend the application of a bacteria filter, “though a filter change should not be performed routinely” [4]. Studies showed that a frequent filter change increases the colonization of catheters with skin pathogens [16]. But most manufacturers claim a change of the filter after 24-72 hours. In our study, we had to face the quandary.

The DGAI recommendation does not insist of using a bacteria filter, while reducing colonization is not evidenced by documents [4]. Capdevila and associates [6] consider a bacteria filter only necessary if the catheter is left for long-term. But a Japanese study recommends already the use of microbial filters from 24 hours resting the catheter [17].

In our study, bacteria filters were always used for all the catheters in postoperative pain management. Furthermore, we educated a special bacteria filter management to guarantee the manufacturer's warranty. After a period of time (Epidural catheter: 48 hours, peripheral nerve block: 96 hours), an additional bacteria filter was added in tandem circuit. Here, we had to pay attention not to interrupt the continuity of the preoperatively added microbial filter to the catheter. A closed system was minded and the caution of De Cicco et al. was observed [16]. The second filter of the tandem circuit was changed regularly (Epidural catheter: after 48 hours, peripheral nerve block after 96 hours), while remaining the first filter in place until the catheter was removed. In case of disconnecting accidentally the first bacteria filter of the tandem circuit, the catheter was removed if possible. If it was not possible to remove the catheter, the catheter was disinfected thoroughly with an alcohol-containing antiseptic and dried according to a recommendation by Langevin [18]. Thus the proximal catheter end was cut off with a sterile instrument and then reconnected.

Dressing management

The S3 guideline [19] says: “It is assumed but not ensured that there is a positive correlation of incidence of infections with duration of catheterization, the frequency of dressing changes and catheter disconnections as well as dependence of the localization of the catheter insertion site (interskalenar, groin, caudal region)”. Thus, the scientific working group “Local Anesthesia” recommends only changing strappings if it is absolutely essential. Therefore, they say: “Dressing remains as long as possible, the first dressing is the ‘most abacterial!’” [4].

In Morin's study (the control group of our study) [11], three risk factors were statistically significant:

- placement in the groin,

- repetitive dressing changes and
- absence of a postoperative antibiotic prophylaxis

These risk factors, showed in our control group, were indeed associated with an increased infection rate, but they were not necessarily observed in every case of infection during Morin's study. We assume that not changing dressings by itself caused the high infection rate in the study of Morin and fellows, but the reason why. So could have leaded the reason why it was necessary to change the dressing to more bacterial growth, for example a moisture penetration of the strapping with blood or the patient's heavy perspiration. These could be the "real" risk factors [11]. To avoid a moisture penetration of the dressing we changed the strapping frequently (Table 2). It must be remembered that the most frequent germ in the colonization sample was a coagulase negative staphylococcus, a germ of the normal skin flora. We hypothesize that the significant lower infection rates in our study are due to the specific dressing management. Furthermore, we detected a higher colonization rate in femoral catheters and confirm the risk factor "location in the groin". The patient's perspiration could be the reason for this risk factor.

Conclusion for Clinical Practice

A standardized hygiene plan is necessary to minimize the risk of catheter-related infections. We conclude, that stitching the catheter for safety fixing and changing dressings on the first postoperative day in order to avoid a moisture penetration of the strapping reduce infections significantly. We recommend a strict postoperative dressing management performed by a pain nurse. Furthermore, we favor using microbial filters independent of the catheter's resting time. A special postoperative bacteria filter management (tandem circuit) with the second microbial filter being changed after a fixed period of time is profitable to reduce infections.

Conflict of Interest

The authors declared that there is no conflict of interest.

Adherence to Ethical Guidelines

All examinations on humans described were carried out upon approval by the responsible ethical review committee, in accordance with national legislation and according to the Declaration of Helsinki in 1975 (in the current, revised version). Informed consents of all patients involved are available.

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