Anesthesia Provider's Preception on Preserving Asepsis at the Epidural Catheter Hub

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Abstract

Epidural catheter infections occur despite best practice guidance. The incidence of positive infectious cultures obtained from epidural catheters is approximately 23%. While most infections are superficial, the incidence of infection within the deeper epidural space can result in permanent and irriversable neurologic damage. The epidural catheter hub is a potential route of contamination that can occur with repeated injections. There is very little literature focusing on the epidural catheter hub and the contamination with repeated injections. The objectives of this scholarly project is to examine the current practice of anesthesia providers and to evaluate whether the current evidence-based best-practice standards, regarding epidural hub mainenance are being applied consistently. Further investigation is needed and will be conducted by surveying providers to determine if there are inconsistencies among practice. The survey findings may suggest the need for further education regarding need for consistent evidence-based best-practice standards to help reduce the risks for epidural catheter infections.

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Anesthesia Provider's Preception on Preserving Asepsis at the Epidural Catheter Hub

Epidural anesthesia is being utilized more frequently because of its ability to provide analgesia during surgery, and throughout the post-operative period, without compromising the patient's airway (Harde et al., 2016). One of the biggest risks of an epidural catheter is infection, which can cause life-threatening and sometimes irreversible harm to the patient as well as delay medical discharge (Yuan et al., 2008). The intent of this scholarly project is to determine if certified registered nurse anesthetists and anesthesiologists follow standard practice for preserving asepsis at the epidural catheter hub and whether the established methods for preventing epidural catheter infections from hub contamination are being systematically and consistently practiced.

Significance & Background of Identified Problem

Providers may be unaware of the most updated facility guidelines concerning the management of the epidural catheter hub. The lack of knowledge about practice guidelines results in differences in practice management of epidural catheter hub contaminations. Limited studies have been completed exploring these differences, but a 2011 survey conducted by McKenzie and Darragh suggests that clinicians may not be uniformly adhering to current best practices. This national survey in the United Kingdom concluded that out of 164 respondents, 128 providers stated after a brief period of separation at the catheter hub from the infusing line, they would clean the catheter with an antiseptic technique, then allow time for the hub to completely dry. While using aseptic techniques, they would then cut off 10-12 cm of the proximal portion with a sterile instrument prior to reconnecting a new hub. While these 128 providers adhered to uniform best practices, 21 providers responded that they did not follow any of these best practice guidelines, and 15 providers abstained from responding to the question.

The differences in provider practices widened when respondents were asked about their methodology if a longer period of time in disconnection from the hub occurred (McKenzie & Darragh, 2011). Out of the 164 providers, 109 answered that they would remove the epidural catheter and either

place another epidural at a different site or evaluate the appropriateness of leaving it out (McKenzie & Darragh, 2011). Another 31 providers answered that they would not do either of these interventions and 24 providers abstained from answering the question on the survey (McKenzie & Darragh, 2011).

While the McKenzie and Darragh (2011) survey cannot be generalized, it suggests that there may be an inconsistent application of best practices to epidural catheter hub management. Therefore, it is important to establish what the current practice is for maintaining asepsis by anesthesia clinicians. This project will identify the knowledge providers have on maintaining aseptic conditions at the catheter hub. In addition, this project will explore the practice among providers when an epidural hub needs to be reconnected or re-dosed. This scholarly project will establish if diversity in current practice might suggest the need for a continuing education module for standardizing management of preserving epidural hub asepsis.

PICOT Search Format Questions

The use of PICOT formatted questions has assisted in a systematic review of the literature. The first question focuses on the thought process behind keeping epidural hubs aseptic: Among anesthesia providers (P), what is the perceived best practice (I) for maintaining asepsis when redosing (C) an epidural with a bolus injection through the epidural port to optimize prevention of infection in the epidural space (O) for the duration of the epidural anesthetic (T)? The second question addresses the actions taken by anesthesiologists and nurse anesthetists: How do anesthesia providers (P) prevent the introduction of an organism at the epidural hub (I) through preserving the hub's asepsis with each re-dose (C) for the purpose of preventing epidural catheter associated infections (O) for the duration of the epidural anesthesia (T)?

Search Strategy/Results

The search strategy employed multiple reference lists including CINAHL, Google Scholar, EBSCO host, and PubMed. Key search terms and MESH combinations used included: *Infection*, AND *epidural,*

AND *epidural hub*, AND *prevention of infection*, AND *analgesia epidural*, AND *microbial*, AND *bacterial*, AND *equipment contamination*, AND *cross infection*, AND *epidural abscess*, AND *abscess*, AND *catheter-related*, AND *epidural port*, AND *epidural connection port*, AND *colonization*. MESH terms included: *epidural analgesia, analgesia epidural, catheterization, microbial, bacterial, colonization*, and *infection prevention*. The search limits were: English language, laboratory research, and human subjects. Inclusion criteria included the following: epidural catheter associated infections whose cause was unknown or of origins other than the site of entry, intracatheter infections, and infections resulting from catheter hub disconnections. Exclusion criteria included: epidural catheter associated infections that were determined to originate from the site of entry. The search originally returned 42 articles using the search terms. Of the original 42 articles, 12 met inclusion criteria.

GRADE Criteria

The GRADE criteria were used for the rating of the research on epidural catheter hub asepsis and its contribution as a route of contamination. Overall, the level of evidence is very low. The initial rating of the evidence was high, because the literature predominately describes research that involved randomized control trials and systematic reviews. However, due to indirectness in each of the studies the score assigned based on the GRADE criteria is decreased -2, to low. The strength of the evidence is further decreased by 1, to very low due to the following factors a high rate of bias, focus on infections originating from the skin, and inconsistencies in practices. There was only one study that focused directly on contamination originating from the hub, and because of this there is insufficient evidence to recommend a change in practice.

Literature Review and Synthesis of Evidence

There is a high prevalence of epidural catheter use for analgesia because it provides several distinct advantages over general anesthesia such as mitigating side effects associated with general anesthesia and shortening the duration of hospital stay while providing improving patient safety

(Holladay & Sage, 2021). Because of these advantages, epidural catheters are utilized in active labor and delivery, for post-operative pain management, chronic pain management, cancer pain management, lower extremity vascular insufficiency, and for providing interoperative analgesia in a large variety of thoracic, orthopedic, and abdominal cases (James et al., 1976; Nagelhout & Elisha, 2018; Scholle et al., 2013; Sethna et al., 2010). Though providers often employ epidural catheters, research suggests that there are some dangers associated with their use. One of the most dangerous complications associated with an epidural catheter is infection of the epidural space. Epidural catheter-associated infections can occur along a spectrum from mild, characterized by a skin level cellulitis at the entry site, to severe, which is an infection of the epidural space or meninges resulting in an abscess that can cause permanent neurologic deficits and if untreated can progress to death (Grewal et al., 2006; Sethna et al., 2010; Yuan et al., 2008).

There are three main routes by which infection can occur from an epidural catheter. The first proposed, and theorized most common, route of infection is from colonization of the skin at the site of entry. This allows for the bacteriologic agent to spread down the external surface of the catheter into the epidural space (Harde et al., 2016; Holt et al., 1995; Sethna et al., 2010; Yuan et al., 2008). The second source of infection is from hematologic spread. This can occur in patients who have a blood stream infection. The passing of the needle and catheter though the infected blood can pull infected blood into the epidural space. Similarly, bacterial growth can occur along the section of the catheter exposed to the infected blood thereby allowing spread along its external surface into the epidural space (Holt et al., 1995; Harde, 2016; Sethna et al., 2010; Yuan et al., 2008). The third and final route of contamination is via intraluminal spread. This can occur from contamination at the epidural hub, hub disconnection, or contamination of the infusates administered to the epidural (Holt et al., 1995; Langevin et al., 1996; Yuan et al., 2008). The incidence of positive hub contamination cited in the literature ranges from 0.5% to 8.8% (De Cicco et al., 1995; Hunt et al., 1977; Yuan et al., 2008), while the

incidence of positive contamination of the infusates ranges from 1% to 8.9% (De Cicco et al., 1995; Hunt et al., 1977; Yuan et al., 2008). One study that compared the type of bacterial growth between the hub cultures and infusate cultures found that out of 19 positive hub cultures, 16 matched the organisms grown from the contaminated infusates (De Cicco et al., 1995).

Many measures are being taken to prevent infections associated with epidural catheter placement. These measures include: placing the catheter under sterile conditions that are created by cleaning the skin with either 2.5% iodine, 10% povidone iodine, or 2% chlorhexidine, using sterile drapes, having the anesthesia provider wear sterile gloves and gown, and wearing a facemask with a surgical cap (Hunt et al., 1977; James et al., 1976; Sethna et al., 2010). Once the catheter is placed, a sterile, clear dressing or paper tape is applied over the catheter with or without sterile gauze to stabilize the catheter. This dressing typically remains in place unless it becomes visibly soiled or its integrity is compromised (Hunt et al., 1977; James et al., 1976; Sethna et al., 2010). The goal of the dressing is to maintain aseptic conditions at the epidural catheter where it enters the skin and minimize the colonization of bacteria at the site of skin penetration.

Even with these preventive measures being taken, epidural catheter infections can still occur. There are multiple factors that affect the frequency with which infections occur. In many of the studies, the epidural catheters were swabbed for positive microbial growth even if the patient was not showing clinical indication of infection. The rate of positive bacterial growth from the epidural catheters cited in the literature ranged from 8.8% to 53% with the average across studies being 23.6% of the cultures tested being positive (De Cicco et al., 1995; Harde et al., 2016; Holt et al., 1995; Hunt et al., 1977; van Samkar et al., 2020). However, many of the positive cultures were not associated with clinical signs of infection. From the research, between 4.5-10% of positive cultures resulted in significant clinical signs of infection (Hunt et al., 1977; Sethna et al., 2010; van Samkar et al., 2020), while one outlier showed that 75% of their positive cultures displayed signs and symptoms of clinical infection (Holt et al., 1995).

Applicability to Practice/Contribution to Professional Growth

In a study completed by Sethna et al. (2013), epidural catheters were submerged in a bacterial solution, so all catheters were equally contaminated. Disinfecting the epidural catheter solely at the distal portion reduced the frequency of bacterial growth from 100% to 50%. However, when practitioners removed 20 mm of the catheter distal to the exposure site, the reduction of bacterial growth was 100%. In comparison, in-vitro studies suggested that the main bacteria species for contamination was staphylococcus (Langevin et al., 1996; Scholle et al., 2013). When bacterial growth is present along the epidural catheter due to a prolonged time of disconnection of the catheter at the hub, it can be reconnected more than 20 mm distal to the growth, or it can be cut off then reconnected (Langevin et al., 1996; Scholle et al., 2013).

There is an opportunity to improve patient outcomes by reducing the number of epidural catheter infections. Research currently suggests that additional study surrounding aseptic technique can impact the anesthesia profession by examining best practice guidelines among providers. Some anesthesia clinicians, prior to redosing with a local anesthetic, are disinfecting the epidural hub site using an aseptic technique, while other clinicians choose not to disinfect the site. Identifying variances in approaches to disinfection of the hub may suggest the need for continuing education to consistently apply established best practices and improve patient care.

Project Aims

The aim of this project is to identify what the perceived best practice is in relation to preserving the aseptic conditions of epidural catheter hubs among anesthesiologists and certified registered nurse anesthetists that work for US Anesthesia Partners- Florida (USAP).

The objectives are defined as follows:

1. Assess if there is a discrepancy between provider's practice and established policy.
2. Assess if there is a discrepancy between provider's practices for maintaining asepsis of an

epidural catheter's hub.

3. Assess if there is there a need for an educational module to standardize provider care.

If there are inconsistencies between providers, this research will show any gaps in knowledge that need to be addressed. The project will ask anesthesia providers to assess their current practices. The first improvement outcome would continue to aid in reducing epidural catheter related infections. The second improvement outcome for this project would promote the importance of consistently following evidence-based best-practice guidelines.

Methods

The setting includes anesthesiologists and certified registered nurse anesthetists (CRNAs) that work within the AdventHealth system for USAP. Inclusion criteria include currently licensed and practicing providers. Exclusion criteria include incomplete surveys. Due to the population being sampled, the exclusion of vulnerable populations is not needed. Recruitment will be through email dissemination, asking providers to participate in the study by responding to a survey. A reminder email will be sent two weeks after the initial email. A possible third email can be sent if needed, depending on the response rate. Participants will be provided with a letter of participation that will provide the details of the survey, including its purpose, time frame for completion, and confidentiality.

Each email will contain a link redirecting the provider to a secure and anonymous online survey site. The data will be collected and retrieved from the survey database. There will be no more than three email messages sent to the participants. The benefits of participation include improved patient outcomes. Discomforts of participation may include stating an uncomfortable truth about their current practice.

Permission has been obtained (Appendix B) to use the tool *Prevention of Infection with Epidurals and Spinals – A National Survey of Practice in Obstetric Units* (Appendix A) created by McKenzie and Darragh (2011). The survey consists of ten "yes" or "no" questions. The questions and survey have been

validated by the Obstetric Anesthetists Association (OAA). Using an instrument that has been validated with anesthesia providers will provide consistent data that can be compared with previous studies.

Each answer from the survey will be designated a numerical representation to create a dichotomous data set. The data will then be assessed using descriptive analytics. The data will be compiled, organized, and analyzed using Microsoft Excel. A complete copy of the data will be maintained through AdventHealth University for seven years in accordance with AdventHealth's Institutional Review Board standards. An additional copy of the data will be maintained on a specifically purposed USB drive that will be stored in each student researcher's care.

Using an all-inclusive sample pool will hopefully provide data from Anesthesiologist and CRNAs, clinicians who practice in different specialties, and providers with different educational backgrounds.

Planning and Procedures

Each key player will have a specific role to play. The implementation process will require a great deal of time management. The first step involves formatting the survey using the tool, *Prevention of Infection with Epidurals and Spinals – A National Survey of Practice in Obstetric Units* created by McKenzie and Darragh (2011). The survey tool will be anonymous, user friendly, and can be done online by participants. The tool that is being used is the survey from *Prevention of Infection with Epidurals and Spinals – A National Survey of Practice in Obstetric Units* created by McKenzie and Darragh (2011). The next step is to contact USAP and request that they send the survey link to their providers. With permission, the list of anesthesia providers at USAP will be contacted via email. Approximately 315 providers will be emailed with the survey link. The email that participants receive will include a brief introduction regarding the survey as well as an explanation of the study and its importance. The email will also contain a time frame for completion and the proper instructions to submit the survey. Once the time frame has closed for the participants to complete the survey, the data will be collected.

The objective is to have at least 75 providers complete the survey. The measured outcome will

be to assess the data for a difference of practice among providers for cleaning the epidural catheter hub after the disconnection of a syringe. The outcome will be measured by keeping track of the survey tool answers on an excel spreadsheet. The data will be calculated using the average of each question from the tool. If there are observed inconsistencies within practice guidelines among the anesthesia providers, implementation of a teaching module will be recommended for the participants.

A key factor that will facilitate the successful implementation of the project is the support from anesthesia providers to complete the survey. Other factors include having knowledgeable key players as well as making sure that the surveys are completed in a timely manner. Barriers that may occur include not receiving input from providers and providers not filling out the survey in its entirety. These barriers would limit the collection of data. The strategies that we will implement to minimize these barriers are sending out email reminders to the anesthesia providers and discussing the project with one of the co-chief nurse anesthetists to see if an email could be sent out to the anesthesia providers to encourage them to complete the survey.

Anticipated Limitations

The biggest limitation we foresee with our project will be related to recruitment. There is a concern that not enough providers will take time to fill out the survey. There is also a potential for inaccurate results if providers search their policies and procedures to answer the questions instead of responding based upon their actual methods.

Timeline

The collection of data will be initiated by September of 2021. The initial email is sent on a Tuesday with a reminder email sent on Friday. The second week the email will be sent on Monday with a follow-up on Wednesday. No emails will be sent in the third week. If needed during the fourth week, additional emails can be sent if there are an inadequate number of replies. The goal is to have the surveys completed within a five-week time frame. Post-implementation data will be organized and

analyzed after five weeks of gathering the data. This analysis phase will take approximately two weeks to complete.

Distribution Plan

An email providing a letter of participation that will explain the details of the survey, including its purpose, time frame for completion, and details concerning its confidentiality, will be sent to a list of potential participants. The formulated plan is to receive approval from USAP about sending the email to all their employee regarding surveying for the project. The intent is to have the email sent out twice, with the second reminder sent two weeks after the initial email. If a desired sample size of 75 completed survey is not reached, then a possible third email will be sent out with the survey.

Budget/Grant

There is no foreseeable budget needed for the completion of this phase of the project.

Results and Findings

The survey was sent out to approximately 314 anesthesiologists and certified registered nurse anesthetist via email. We received a total of 49 responses to the survey culminating in a 15.6% response rate. Out of the 49 surveys that were received, two providers abstained from answering the questions regarding provider practice of utilizing epidural top up doses (question 5a part i.), because of this they were excluded. Additionally, there were 7 providers who responded that they did utilize epidural top-up, however they abstained from answering whether they cleaned the port with alcohol prior to injecting medication through it (question 7a). These surveys were also excluded, this resulted in 40 completed surveys.

Of the 40 anesthesia providers surveyed only one responded that they did not re-bolus medication through an epidural port. This results in 97% of providers responding that they will re-bolus through an epidural port (Appendix C, Chart 1). The sole provider who responded that they do not utilize epidural re-boluses also responded that they did not wipe the injection port prior to injecting. Because

of their negative response to utilizing epidural re-boluses their survey was excluded moving forward. This results in 39 completed surveys of providers who utilize epidural re-boluses. Of these 39 providers 8 of them (20.5%) do not clean the epidural port prior to re-bolusing while the remaining 31 (79.5%) responded that they cleaned the hub with alcohol (Appendix C, Chart 2).

Discussion and Implications

This research project coincided with the previous research we had found that there are multiple practices within anesthesia practitioners. This study found that there is a large divide in provider practice that shows a need for further education to provide a higher standard of care between providers regarding redosing an epidural.

In the clinical setting there is some debate as to whether cleansing the epidural port with alcohol prior to re-bolusing can cause nerve damage versus not cleaning the hub and risking contaminants to get into the epidural space and cause an infection. The findings of this study show that there is a divide between practitioners and their current practice. There is currently limited research with very little being completed in the last couple of decades on the effects of using alcohol to clean an epidural port. This lack of research has created a lack of knowledge that is being addressed by each individual provider.

The innovation PICOT question that was created to assist in the review of literature for this research addressed how anesthesia providers prevent the introduction of an organism at the epidural hub. The survey showed that there is a divide in how anesthesia providers preserve the aseptic status of the epidural hub. While this study shows that it is not an even split, the majority of providers will utilize an alcohol wipe. Of the three aims of this research, the first is to determine if there is a discrepancy between provider's practice and an established policy. There are no established policies or recommendations from the manufacturers, hospitals, anesthesia provider groups, or organizations. Instead, practice is based on evidence-based literature. However, the review of literature shows that

there is minimal research out evaluating the effectiveness of using alcohol to clean the epidural hup vs any potential harm from its inherit neurotoxic properties. The second aim of this research was to evaluate if there is a discrepancy between each provider's practice. The survey results showed that there is a division between individual practice. This leads to the third aim, if there is a need for additional education to standardize the practice amongst providers.

Based on the results, the current recommendation is that further evidence-based research based on using alcohol on the epidural catheter port is detrimental or not to patients. More evidence-based research on the topic would then lead to an informative decision on what is the best practice. A set standard of care should be created so that providers are able to follow a set practice guideline based on research. With sustainability to practice, over time new implementation strategies may develop to provide a standardization of care. The practice may evolve to adjust to evidence-based practice that could be beneficial to individuals receiving care.

The research project has the potential to make an impact on the profession by providing education regarding the practice gap among anesthesia providers. This realization may make providers aware of the implications of using alcohol on the epidural hub. Also, practitioners might decide to change or adapt to different practice methods based on the project.

Limitations

The project was limited by a single setting used for conducting the survey. The survey was distributed within one anesthesia provider group. As there are dozens if not hundreds of anesthesia groups that use neuraxial anesthesia within their practice, surveys were not sent out to multiple groups to see what their standards may be. Implementing multiple settings could have presented different results with survey findings. Other limitations included not being able to alter or remove any survey questions. The length of the survey could have limited the amount of anesthesia providers that decided to participate and answer the survey questions.

The project study utilized a small sample size. The survey was distributed among 314 anesthesiologists and certified registered nurse anesthetist and 49 survey responses were received. Of those received surveys, only 39 could be included within the sample size. The limitation of a smaller sample size could decrease the influence of the study on whether providing education or creating a set standard practice is beneficial. It does not provide much of a margin of error and therefore can decrease the value of the research project survey results.

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Appendix: Matrix Tables

Holt, H. M., Andersen, S. S., Andersen, O., Gahrn-Hansen, B., & Siboni, K. (1995). Infections following epidural catheterization. *The Journal of hospital infection*, *30*(4), 253-260. https://doi.org/10.1016/0195-6701(95)90259-7

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Purpose	**Variables**	**Setting/Subjects**	**Measurement and Instruments**	**Results**	**Evidence Quality**
Study one: To describe infection types associated with ECs and their frequency. **Study two:** To evaluate the incidence of EC infections during or after continued infusions.	**Study one:** <u>Primary:</u> Identifying infectious organism involved in EC infection. <u>Secondary:</u> Provide an estimate of the incidence of infection. <u>Tertiary:</u> Describe the clinical and microbiological features of each infection. **Study two:** <u>Primary:</u> Frequency of infection with ECs.	**Study one:** <u>Setting:</u> Odense University Hospital <u>Subjects:</u> All EC tips that were sent for microbiological investigation during the study. Of 147 tips sent 78 grew positive cultures. **Study two:** <u>Setting:</u> Children's hospital Boston. <u>Subjects:</u> 7,792 children from newborn to 18 years of age. Between 1993-2009.	**Study one:** Negative vs positive growth culture. Positive cultures divided into <10 cfu, 10-100 cfu, or >100 cfu. **Study two:** Infection of soft tissue or epidural space that had been confirmed by blood culture or skin purulent discharge culture.	**Study one:** By way of administrating a drug ($t=0.98$, $0.2<P<0.4$). **Study two:** Skin colonization and propagation of microorganisms along the external surface prime cause infection.	*Methodological flaws:* **Study one:** Infusates were not cultured on every patient, only asymptomatic patients that were not included in the original study. **Study two:** No injection ports were cultured. *Inconsistency:* *Indirectness*: *Imprecision:* **Study one:** No injection ports cultured. *Publication bias*
Design **Study one:** Microbiologic survey **Study two:** Retrospective evaluation				**Implications** **Study one and two:** No relation between symptoms, microorganisms cultured and the way of administering the drug.	

Hunt, J. R., Rigor, Sr B. M., & Collins, J. R. (1977). The potential for contamination of continuous epidural catheters. *Anesthesia and analgesia*, *56*(2), 222-225. https://doi.org/10.1213/00000539-197703000-00012

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Purpose	**Variables**	**Setting/Subjects**	**Measurement and Instruments**	**Results**	**Evidence Quality**
Study one: Route of contamination for epidural associated infections. **Study two:** To determine how far bacterial contamination can advance long the internal catheter.	**Study one:** Primary: Frequency of epidural associated infections. Secondary: Source of infection. **Study two:** Primary: Bacterial species, Staph aureus, E coli, and P. aeruginosa. Secondary: Static vs fluid displacement with bacterial spread. Tertiary: Vertical vs horizontal bacterial spread.	**Study one:** Setting: US Naval hospital, Portsmouth, VA Subjects**:** L&D and surgical patients selected at random. **Study two:** Setting: in vitro Subjects: None	**Study one:** Cultures were taken from hub, skin, catheter contents, and catheter tip. Assessed for positive or negative culture. **Study two:** Rate of bacterial spread along epidural catheters.	**Study one:** + hub cultures 9 out of 109 cultures. Same number of positive hub cultures as tip cultures. **Study two:** E. coli and P. aeruginosa advanced as much as 35 in along the catheter with fluid displacement. S. Aureus advanced 8in. Vertical position had no difference.	*Methodological flaws:* **Study two:** Bacterial growth accelerated with ideal temp and conditions. *Inconsistency:* **Study one:** Majority of infections came from hospital prepared reusable epidural trays. *Indirectness:* *Imprecision:* **Study one:** No quantity measurement for bacterial growth. *Publication bias:*
Design				**Implications**	
Study one: Microbiologic survey. **Study two:** Post-test-only, equivalent group design.				**Study one:** Hubs can be potential source of infection. **Study two:** Bacterial contamination at the hub can advance to the epidural space.	

James, F. M., George, R. H., Naiem, H., & White, G. J. (1976). Bacteriologic aspects of epidural analgesia. *Anesthesia and analgesia*, *55*(2), 187-190. https://doi.org/10.1213/00000539-197603000-00013

De Cicco, M., Matovic, M., Castellani, G. T., Basaglia, G., Santini, G., Del Pup, C., Fantin, D., & Testa, V. (1995). Time-dependent efficacy of bacterial filters and infection risk in long-term epidural catheterization. *Anesthesiology*, *82*(3), 765-771. https://doi.org/10.1097/00000542-199503000-00019

Purpose	**Variables**	**Setting/Subjects**	**Measurement and Instruments**	**Results**	**Evidence Quality**
Study one: Incidence of contamination of syringes and catheters. **Study two:** To determine the effectiveness of bacterial filters placed on epidural catheters.	**Study one:** Primary: Frequency of infection on catheter hubs. Secondary: Effectiveness of bacterial filters on EC. Tertiary: Does 0.25% bupivacaine have bactericidal traits? **Study two:** Primary: To determine the route of infection. Secondary: Does a filter lose its antimicrobial efficacy with prolonged use? Tertiary: Is infection from direct contamination during the filter changing process thereby bypassing the filter?	**Study one:** Setting: Birmingham (England) Maternity Hospital. Subjects: 101 women using epidural analgesia during labor. **Study two:** Setting: Department of anesthesiology and pain management. Aviano, Italy. Subjects: 47 patients with advanced cancer who had subcutaneously tunneled epidural catheters.	**Study one:** Cultures were taken from syringes and catheters after delivery. **Study two:** Cultures were taken from skin around the catheter insertion site, of the filtrate, the inside surface of the catheter hub, and the catheter tip when the epidural was removed.	**Study one:** 5 out of 101 syringes cultured positive. 3 were original syringes used throughout the life of EC, 2 were changed once or more. **Study two:** Of the 828 cultures performed 19 of the catheters were removed for positive hub cultures. Of the 25 positive filtrate cultures 16 matched the microorganism colonizing the skin. In 2 cases the source was unidentifiable.	*Methodological flaws:* **Study one:** Multiplication may have occurred during the handling process. *Inconsistency:* *Indirectness:* *Imprecision:* *Publication bias:*
Design				**Implications**	
Study one: Microbiologic survey **Study two:** Microbiologic survey				**Study one:** Syringe contamination most like occurred from hands of injecting personnel. **Study two:** Positive correlation between positive hub cultures and positive filtrate cultures. Filter changes present major risk of causing hub contamination and colonization.	

Freise, H., Kipp, F., Reich, A., Scholle D. (2013). Influence of protective measures after epidural catheter disconnection on catheter lumen colonization: an in vitro study. *Journal of Hospital Infection, 86*(2014), 133-137. http://dx.doi.org/10.1016/j.jhin.2013.12.001

Van Samkar, G., Balraadjsing, P., Hermanns, H., Hoogendijk, I. V., Hollmann, M. W., Zaat, S., & Stevens, M. F. (2020). Microbiological and scanning electron microscopic evaluation of epidural catheters. *Regional anesthesia and pain medicine, 45*(5), 381–385. https://doi.org/10.1136/rapm-2019-101180

Purpose	**Variables**	**Setting/Subjects**	**Measurement and Instruments**	**Results**	**Evidence Quality**
Study one: Examination of the in vitro effects of clinically applied safety measures after epidural catheter disconnection and submerging the catheter in a bacteria suspension. **Study two:** To investigate the patterns of bacterial growth on epidural catheters by utilizing quantitative bacterial culture and scanning electron microscopy (SEM).	**Study one:** Primary outcome: Is bacteria present after cutting off the exposed proximal end of the epidural catheter with sterile scissors 20 mm distal to the level of the bacteria suspension? Secondary outcome: Is the epidural catheter end contaminated with bacteria after spray–wipe disinfection with disinfectant with 3 cycles of spray, 30s incubation and wiping with sterile gauze? Tertiary outcome: Presence of bacteria after continuing epidural infusion with local anesthetics (ropivacaine 0.75%). **Study two:** Primary outcome: Whether bacteria present on or in the skin is the primary source of colonization of the epidural catheter along the outer catheter surface towards the tip & into its lumen. Secondary outcome: Does bacteria colonization on epidural catheter occur from a distant source or by contaminated infusion fluid or delivery systems?	**Study one:** Setting: In-vitro Subjects: No human subjects. Contaminated epidural catheters **Study two:** Setting: Operating Room in hospital Subjects: 28 patients undergoing major abdominal surgery with thoracic epidurals (treatment ≥72 hours)	**Study one:** Fisher's exact test by Sigmaplot 11.0 **Study two:** Bacterial growth was quantified in colony-forming units (CFU) per catheter segment based on the numbers of CFU recovered and the respective dilution. Instrument: Matrix-Assisted Laser Desorption/Ionization Time-of-Flight Mass Spectrometry measured the species of retrieved bacteria.	**Study one:** Cutting the catheters distal to the visible contamination showed no bacterial growth. Disinfection of the catheters reduced the rate of bacterial growth from 100% to 50% ($P < 0.05$). Using disinfection, only 6 of 40 infections were prevented ($P < 0.37$). Combining ropivacaine & disinfection had no protective effect ($P = 0.14$). **Study two:** 27 of the 28 catheters were used. The percentages of positive cultures were skin swab 29.6%, extracorporeal segments 11.1%, subcutaneous segments 14.8%, and tip segments 33.3%. One patient diagnosed with a catheter-associated infection.	Methodological flaws: **Study one:** Preventive measures were applied shortly after experimental contamination **Study two:** Small number of patients and catheters investigated Inconsistency: Indirectness: Imprecision **Study one:** No quantity measurement for bacterial growth. Publication bias None
Design				**Implications**	
Study one: Non-randomized controlled before-and-after study Untreated control was used as the control group for the single intervention groups I, II and III, whereas the dual interventions were compared to the respective single treatment groups. **Study two:** Microbiologic survey Prospective Observational Study				**Study one:** Disinfecting the epidural catheter is better than not disinfecting and injecting the catheter with ropivacaine or sterile water once the catheter is exposed to bacteria. **Study two:** The skin is a primary source of bacterial infection that develops from the skin to the epidural catheter.	

Harde, M., Bhadade, R., Iyer, H., Jatale, A., & Tiwatne, S. (2016). A comparative study of epidural catheter colonization and infection in Intensive Care Unit and wards in a Tertiary Care Public Hospital. *Indian Journal of Critical Care Medicine: peer-reviewed, official publication of Indian Society of Critical Care Medicine*, *20*(2), 109–113. https://doi.org/10.4103/0972-5229.175943

Yuan, H. , Zuo, Z. , Yu, K. , Lin, W. , Lee, H. & Chan, K. (2008). Bacterial Colonization of Epidural Catheters Used for Short-term Postoperative Analgesia. Anesthesiology, 108(1), 130-137. doi: 10.1097/01.anes.0000296066.79547.f3.

Purpose	**Variables**	**Setting/Subjects**	**Measurement and Instruments**	**Results**	**Evidence Quality**
Study one: To compare the incidence of colonization of epidural catheters retained for short duration (48 hrs) operative analgesia. **Study two:** To determine the incidence, potential routes, and risk factors of microbial colonization of epidural catheter used for postoperative pain control. **Design** **Study one:** Prospective observational study **Study two:** Prospective, nonrandomized study	**Study one:** <u>Primary outcome</u> Presence of bacterial colonization on the epidural catheter tip and the entry point of the catheter. <u>Secondary outcome</u> Find if bacteria migrate along epidural catheter track from the surrounding skin leading to colonization of epidural catheter tip. **Study two:** <u>Primary outcome</u> Identify where does contamination from microbial colonization occur. <u>Secondary outcome</u> Identify the incidence of microbial colonization of epidural catheters	**Study one:** <u>Setting</u> PACU and general wards of a tertiary care teaching public hospital <u>Subject</u> 400 patients underwent abdominal, urological, orthopedic, and gynecological procedures (elective and emergency). 200 belonged to PACU and 200 to the ward. **Study two:** <u>Setting</u> Taipei-Veterans General Hospital <u>Subject</u> 205 patients – 102 male, 103 female, including 25 parturient.	**Study one:** Fisher's exact test. Data was analyzed using statistical software (GraphPad Software Inc.) **Study two:** Fisher's exact test for categorical variables and two-sample T test or Mann– Whitney U test, and SPSS 14.0.	**Study one:** Of 400 tips sent for culture, 6% (24) showed positive culture, of them 14 (7%) were from PACU and 10 (5%) from wards. Two -sided P value is 0.5285. Skin swab culture, 38% (150) showed positive culture, of them 80 (20%) from PACU and 70 (18%) from wards. P value is 0.3526. 24 patients with positive tip culture had positive skin swab culture of the same microorganisms which is extremely significant with two-sided $P < 0.0001$ 95% CI of that fraction: 0.1053–0.2289 **Study two:** The positive culture rates for the subcutaneous and tip segments of the catheter were 10.5% and 12.2%. The most common organism in the culture was coagulase-negative staphylococcus **Implications** **Study one:** Bacteria migrate along epidural catheter track from the surrounding skin leading to colonization of epidural catheter tip. Disinfection of the skin is what reduced bacteria colonization. **Study two:** Bacterial migration along the epidural catheter track is the most common route of epidural catheter colonization. Maintaining sterile skin around the catheter insertion site will reduce colonization of the epidural catheter tip.	Methodological flaws: **Study one:** No injection ports where cultured or swabbed. **Study two**: no unified antibiotic protocol for the patients was used in the study Inconsistency: None Indirectness: **Study one:** None **Study two:** Study failed to find infection in other locations, the absence of a bacterial filter, and fever to be predicators for the catheter tip colonization. Imprecision **Both: s**mall sample size Publication bias None

Appendix A

In your maternity unit:

1. Do you have hand washing facilities with surgical scrub solution available in every labor room?		
2. When inserting an epidural, what aseptic precautions are taken?		
a. Cap		
b. Gown		
c. Mask		
d. Gloves		
e. Insistence that assistant wears a cap and mask		
g. Any other precautions (Specify _____)		
3. Is a micropore filter always attached to the epidural catheter at the time of insertion?		
4. Describe your protocol of management in the event of the microspore filter becoming detached from the epidural catheter.		
a. If brief period of disconnection longer: allow to dry and cut off 10-12 cm with a sterile instrument, then re-connect.		
b. If period of disconnection longer: remove the catheter and either resite or abandon.		
c. Decision to salvage the epidural depends on level and movement of meniscus in catheter. (Explain _____)		
d. Regardless of period of disconnection, it is mandatory to remove the catheter and either resite or abandon.		
5. Do you use?		
a. Epidural top-ups		
i. by anesthetists		
ii. by midwives		
b. Epidural infusions		
c. Patient-controlled epidural analgesia		

6. If you use top-ups of premixed epidural solution, what is the source of the top-ups?

a. Drawn from bag by multiple puncture If "yes", where is bag stored between uses (_____)		
b. Single-use small volume		
i. Prepared by pharmacy (Specify drugs and concentration) (_____)		
ii. Commercial preparation (Specify drug and concentration) (_____)		
c. Bag via infusion pump		

7. If top-ups are drawn from a premixed bag, do the staff?:

a. Wipe the injection port with alcohol swab		
b. Attach a dispensing pin to the injection port		
c. Attach a filter device to the injection port		
d. Label the syringe before use		

8. When performing a spinal with diamorphine added to the local anesthetic, what is the source of the diamorphine?

a. Sterile volume prepared by pharmacy		
b. Drawn from non-sterile-wrapped ampoule		

9. If opioid for a spinal is drawn from a non-sterile-wrapped ampoule, state the precautions taken.

a. Ampoule neck wiped with alcohol swab		
b. Use of micropore filter		

10. Have you identified any cases of sepsis relating to epidural or spinal insertion in obstetrics?

Please give details
(_____
_____)

Appendix B

amckenzie.has20 <amckenzie.has20@btinternet.com> Thu, Jun 24, 7:20 AM

to me

Dear Travis Barcelow,

I was immediately happy to grant permission for you and Kindra Dominique to use the questionnaire in the survey, which was published in *Anaesthesia* 2011; **66**: 497-502.

As the survey was done under the auspices of the Obstetric Anaesthetists' Association (OAA), I had first to put your request to the OAA Secretariat - I am pleased to say that the Committee

approved. I also checked with my co-author Dr Karen Darragh, and again she approved. So, you may proceed to use the questionnaire and just acknowledge/reference the source.

Best Wishes,

Alistair McKenzie FRCA

•••

Thank you so much! Thank you very much! Thank you very much.

Appendix C

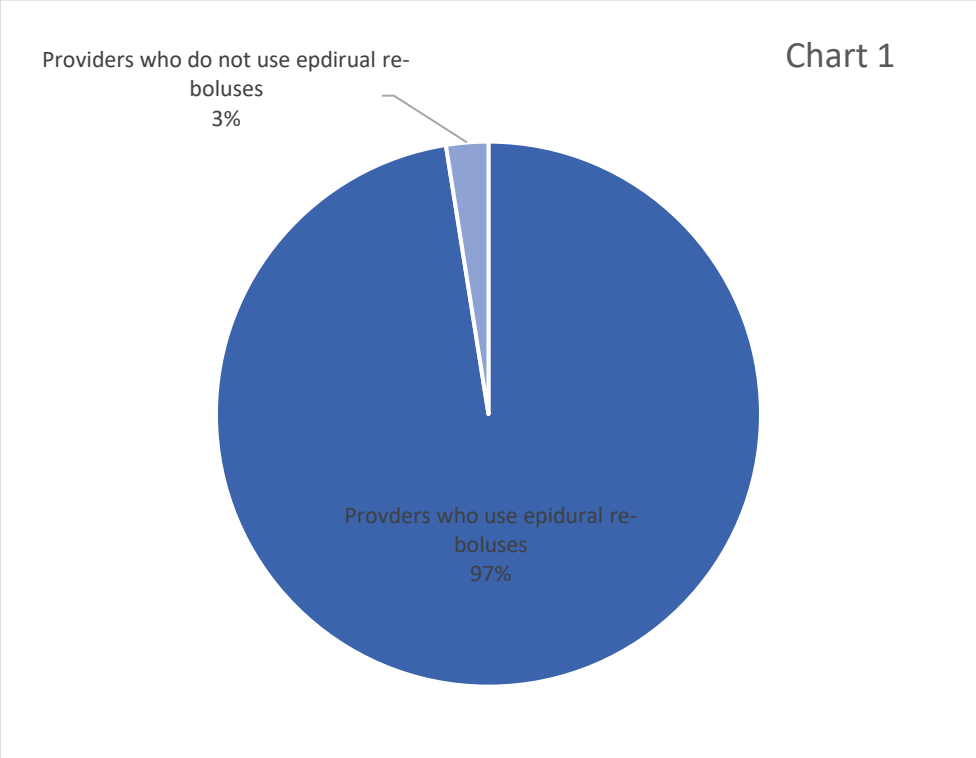
Chart 1
Providers who do not use epdirual re-boluses
3%
Provders who use epidural re-boluses
97%

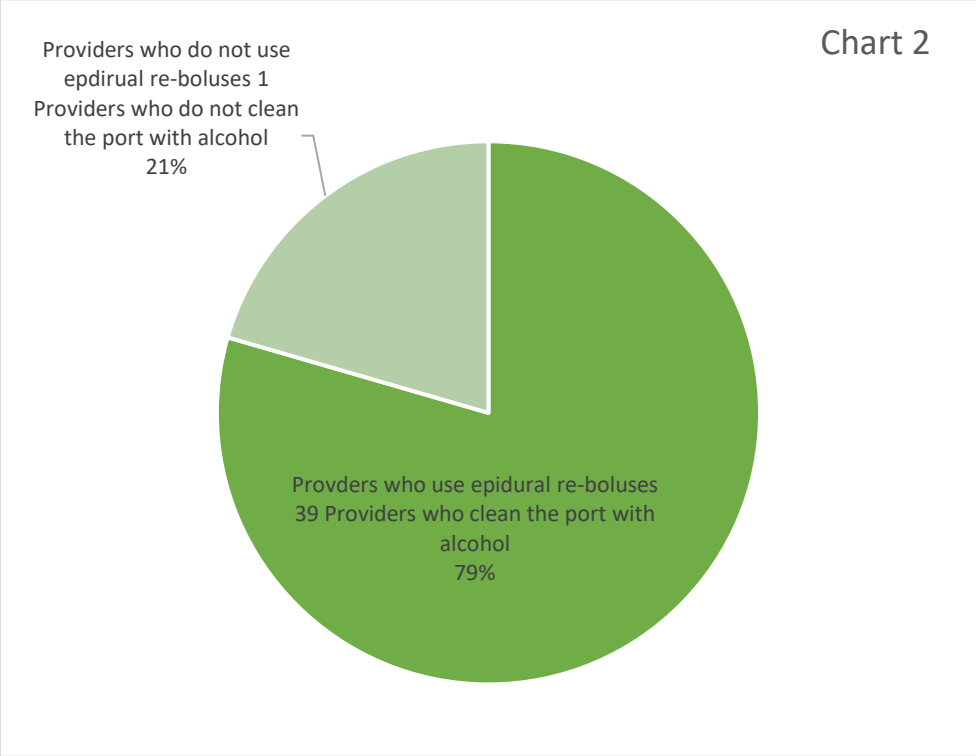
Chart 2
Providers who do not use epdirual re-boluses 1
Providers who do not clean the port with alcohol
21%
Provders who use epidural re-boluses
39 Providers who clean the port with alcohol
79%