REGIONAL ANAESTHESIA

Video-assisted structured teaching to improve aseptic technique during neuraxial block†

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Editor’s key points

- Strict adherence to proper aseptic technique is a mandatory component of safe epidural catheterization.
- This study evaluated a teaching video highlighting key steps of a thorough aseptic technique in anaesthesia trainees.
- A scoring system was used to quantify compliance and this indicated marked improvement in aseptic practice after instruction.
- Good habits, taught early in training, are likely to instil a higher level of hygienic practice in our specialty.

Background. Teaching epidural catheter insertion tends to focus on developing manual dexterity rather than improving aseptic technique which usually remains poor despite increasing experience. The aim of this study was to compare epidural aseptic technique performance, by novice operators after a targeted teaching intervention, with operators taught aseptic technique before the intervention was initiated.

Methods. Starting July 2008, two groups of second-year anaesthesia residents (pre- and post-teaching intervention) performing their 4-month obstetric anaesthesia rotation in a university affiliated centre were videotaped three to four times while performing epidural procedures. Trained blinded independent examiners reviewed the procedures. The primary outcome was a comparison of aseptic technique performance scores (0–30 points) graded on a scale task-specific checklist.

Results. A total of 86 sessions by 29 residents were included in the study analysis. The intraclass correlation coefficient for inter-rater reliability for the aseptic technique was 0.90. The median aseptic technique scores for the rotation period were significantly higher in the post-intervention group (27.58, inter-quartile range (IQR) 22.33–29.50 vs 16.56, IQR 13.33–22.00). Similar results were demonstrated when scores were analysed for low, moderate, and high levels of experience throughout the rotation.

Conclusions. Procedure-specific aseptic technique teaching, aided by video assessment and video demonstration, helped significantly improve aseptic practice by novice trainees. Future studies should consider looking at retention over longer periods of time in more senior residents.

Keywords: epidural block; neuraxial aseptic technique; resident assessment; training

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Epidural catheterization is a frequently performed procedure in anaesthesia. The manual skill involves many aspects and is considered to be one of the more difficult to learn procedures in anaesthesia.1 2 Infections secondary to neuraxial anaesthesia were traditionally thought to be rare.3 As a result of these two factors, there is a natural tendency to concentrate on teaching the manual skill with the assumption that the general aseptic principles taught during medical school and residency would be appropriately applied by the learner as the manual skill was acquired.

In a previous study, we have shown this assumption to be incorrect.4 While manual skill significantly improved with experience, aseptic technique performance remained poor even with improved dexterity. The most significant conclusion of the study was that our teaching of the aseptic principles was, as our results clearly demonstrated, insufficient.

Medical students about to start their residency may have significant gaps in formal teaching of aseptic technique, originating from insufficient emphasis in medical school.5 In previous studies, new post-graduate year 1 trainees demonstrated significant gaps and poor aseptic technique performance at the beginning of residency.6 7

As a result of the inadequate aseptic technique observed in our trainees, we have initiated a targeted intervention. Teaching is now highly procedure-specific and includes a step by step demonstration of the application of the general aseptic technique principles to the practicalities of epidural catheter insertion. It includes a video we produced.
which demonstrates common mistakes and how to avoid them.

Aseptic technique has become even more important with the emergence of new data showing infections secondary to neuraxial anaesthesia to be less rare than assumed. The aim of this study was to compare epidural aseptic technique performance by novice operators after a targeted teaching intervention, with operators taught aseptic technique before the intervention was initiated.

**Methods**

**Consent**

The study was approved by the Institutional Research Ethics Board of Mount Sinai Hospital, a University of Toronto teaching hospital, Toronto, ON, Canada.

Starting July 2008, anaesthesia residents in their second year of residency after graduating from medical school performing a 4-month obstetric anaesthesia rotation were recruited consecutively over a 2-year period. All participating residents were at the same stage of their training. Second year residents spend 1–2 days and one to two nights calls a week on the labour floor, where they get the bulk of their epidural anaesthesia training. Written informed consent was obtained from both the residents and the participating parturients.

**Procedures**

All residents filled out a questionnaire regarding their previous experience with epidural anaesthesia. Those who had previously performed epidural procedures were excluded. They attended a 1 h lecture dedicated to aseptic technique principles and their application during epidural anaesthesia performance. In the post-intervention group, as part of the 1 h lesson, residents watched a 17 min video which was produced by the authors (Z.F. and S.D.) and is now a part of an online Continuous Medical Education module on the University of Toronto Anesthesia Department website. The instructional video demonstrates proper aseptic technique and targets common breaches observed when analysing videotaped epidural catheter insertions by residents during a previous study. It contains a demonstration of both a wrong and correct technique, thus emphasizing the key elements of asepsis. It was professionally produced re-enactment and includes annotations, voice overlay, and some visual effects to enhance key points. Only attending physicians and actors participated and no residents or patients were involved in its production.

After the lectures, the residents observed five procedures consistent with the manual skills and aseptic techniques taught, and participated in an additional five procedures with a ‘scrubbed’ experienced attending anaesthesiologist. The residents then performed the procedure during five more sessions with an attending anaesthesiologist present in the room. They received verbal feedback during all these sessions. The residents then proceeded to perform the procedure independently with access to immediate assistance from an in-house attending anaesthesiologist.

Over a 4-month period, the residents were videotaped three to four times while independently performing epidural catheter insertion. All procedures were performed in the sitting position between L2 and L4 levels, using the midline approach and a standard 17 gauge epidural needle and catheter. Video recording was only performed during daytime to control for workload and fatigue factors. Each resident maintained a procedural log and each was recorded once when the following number of epidurals had been completed: <30, 30–90, and >90. We strived to capture the performance of epidural procedures number 1, 30, and 91. This however was not always feasible because of the limitations imposed by patient consent, resident scheduling, and recording daytime sessions only. A minimum of 20 procedures were performed between each recorded session.

**Recording and blinding**

Video recording was performed by a research assistant using a Canon ZR400 digital camcorder (Canon, Lake Success, NY, USA) mounted on a tripod. The video-recorded sessions began with the initial preparation and equipment set-up and ended at the time when the catheter was secured. Video recording was done in a manner that ensured masking of the resident’s identity and rotation stage. This was achieved by avoiding videotaping the residents’ faces and removing the date tags from the tapes.

A graded task-specific checklist for proper aseptic technique during epidural anaesthesia procedures which was previously developed by the authors was used to assess the videotaped performance (Appendix 1). It was compiled based on current literature recommendations and the sterility breaches observed during a previous study. This checklist was revised and approved by a panel of obstetric anaesthesiologists using the Delphi technique. The Delphi technique is an iterative process with experts in an area that establishes content validity by consensus through repeated questionnaires. Residents were not given the checklist, however, all its components were covered for both groups during the lecture. The recorded sessions were copied from the camcorder to a digital videodisc in random order according to a computer generated list and were then graded by two examiners, trained by the principal investigators to independently evaluate subjects for aseptic practice. The examiners were blinded to the residents’ identity and level of experience at each session. The sessions were not observed by the residents or the examiners before the end of the study.

**Statistical analysis**

Analysis was performed using a SAS System v.9.1.3 (Cary, NC, USA). Sample size was based on two previous studies of epidural anaesthesia skills assessments performed by the authors. Intraclass correlation coefficients (ICCs) were
calculated to assess the agreement among examiners, where \( P<0.05 \) suggest that agreement is greater than expected by chance alone. The following ranges of kappa (\( \kappa \)) were used to determine the level of agreement: \( \kappa \geq 0.80 \), near perfect agreement; 0.61 < \( \kappa \) < 0.80, substantial agreement; 0.41 < \( \kappa \) < 0.60, moderate agreement; 0.21 < \( \kappa \) < 0.40, fair agreement; 0.00 < \( \kappa \) < 0.20, slight agreement; and, \( \kappa $$<$$ 0.00$$, poor agreement.$^{15}$

The average number of epidurals per subject was calculated in order to obtain a single measure of experience for each study participant, and these values were then compared across the two study groups using a Wilcoxon rank-sum test (a non-parametric equivalent to a two-sample \( t \)-test; appropriate for use here given the relatively small sample size). Aseptic technique scores were averaged across all levels of experience within-subjects in order to derive a single average aseptic technique score per study participant. These scores were compared across groups using an additional Wilcoxon rank-sum test.

Three additional tests were carried out exploring group differences in aseptic technique total scores at low levels of experience (i.e. <30 epidurals), moderate levels of experience (30–90 epidurals), and high levels of experience (>90 epidurals).

### Results

A total of 86 sessions by 29 residents were included in the study analysis (11 residents and 35 sessions, 18 residents, and 51 sessions in the pre- and post-intervention groups, respectively). Five sessions were excluded for technical video-recording reasons (recording stopped prematurely, activity performed outside the recorded frame).

The ICC for the aseptic technique total score was 0.90 suggesting a ‘near perfect agreement’ between the examiners. Accordingly, the examiners’ scores were averaged into a single score per resident per session per scale.

No differences in experience were detected across the study groups (\( P=0.48 \)). Accordingly, aseptic technique scores were averaged across all levels of experience within-subjects in order to derive a single average aseptic technique score per study participant.

When the results across the different levels of experience were pooled together, the median aseptic technique total scores for the duration of the rotation were significantly higher in the post-intervention group compared with the pre-intervention study group (\( P=0.0001 \)). These results are summarized in Table 1.

Similar to our initial study, in order to assess the effect of experience and retention, the scores for aseptic technique were categorized into early (low level of experience, <30 epidural procedures performed), middle (moderate level of experience, 30–90 epidural procedures performed), or late (high level of experience, >90 epidural procedures performed) rotation. Median aseptic technique scores were significantly higher in the post-intervention group than in the pre-intervention group at low, moderate, and high levels of experience (\( P=0.0005, P=0.0002 \), and \( P=0.0002 \), respectively). These results are summarized in Table 2.

### Discussion

Our previous study has shown that what is effective for teaching the epidural manual skill, namely instruction followed by practice, is not adequate for the teaching of aseptic technique.$^4$ The results from the current study demonstrated a significant improvement in aseptic technique after a teaching intervention which included video assessment and demonstration. Similar to the pre-intervention group, performance remained very close to the initial baseline throughout the 4 months of observation. This may be a strong indicator that the aseptic practice that trainees adhere to when starting their training persists throughout their residency and likely for the rest of their professional career.

Video recording has been shown to be a valuable tool in assessing performance and teaching epidural anaesthesia.$^{16−18}$ The novelty of the current study was the creation of an instructional video that was squarely based on common mistakes observed through repeated video recording of residents performing neuraxial procedures. Although this video was professionally produced, lower fidelity videos may achieve the same effect. Video recording may also be used to provide feedback based on the assessment tool in a quiet environment after the procedure. Access to the video recordings also enables learners to review their own performance.

Lack of proper aseptic practice is mainly our fault as teachers. Practical instruction tends to concentrate more on the technical aspects, which are easier to notice and comment on. Aseptic technique principles are less tangible and more difficult to assimilate and translate to the actual procedure. Accordingly our teaching is now highly procedure-specific and demonstrates the application of the aseptic principles to the performance of the procedure. For instance, the principle states that ‘the edges of a sterile enclosure are considered unsterile’.$^{12}$ Frequent breaches of this principle were observed. In many patients, the edges of the plastic drape which are not considered sterile folded back onto the back

### Table 1

<table>
<thead>
<tr>
<th>Study group</th>
<th>Aseptic technique total score</th>
</tr>
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<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Pre-intervention group (n=11)</td>
<td>16.4</td>
</tr>
<tr>
<td>Post-intervention group (n=18)</td>
<td>27.1</td>
</tr>
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</table>
of anaesthesiologist’s gloves during land-marking or were accidentally touched during placement onto the back. Such scenarios are now discussed in detail and demonstrated in the instructional video.

During residency, the teaching of technical skills lacks uniformity in both content and instructional strategies and often, in regards to aseptic technique, is done in an unstructured ‘learn as you go’ manner.5, 19 20 As we as teachers usually judge our teaching by the learner’s ability to independently perform a successful procedure, we do not pick up on these aseptic deficiencies unless we specifically look for them. Contributing to the problem of non standardized teaching is the controversy over what is ‘essential’ for aseptic technique in regional anaesthesia.21

This study has several limitations that warrant comment. Ideally, this study’s subjects would have been randomized into two groups, one receiving the teaching intervention and one control group. This of course was not ethically or educationally acceptable once we observed the breaches in aseptic technique performed before the teaching intervention. As a result, the examiners were not blinded to group allocation and may have been biased. We were not able to mix the recordings of the pre- and post-intervention group and reassess all of them as the video recordings are erased after their grading in order to maintain full confidentiality and only the reviewers’ results and analysis are kept. This is promised to the residents in order to secure their participation as they are sensitive about being observed and recorded. The time gap between groups could have also affected the results. However, during that time there were no changes in policy, staff or equipment that would have affected performance. Residents were all from the same cohort and to the best of our knowledge there have been no changes in teaching asepsis in medical school. Also, because of logistical issues, the examiners for the post-intervention group were not the same as those for the pre-intervention group, which again could have created a bias. However, the examiners all have similar experience and were trained by the same authors. This is further substantiated by the high ICC.

To assess performance, we used a quantitative task-specific checklist which was previously described.4 We tried to improve its qualitative capability by introducing a 3-scale feature enabling observers to judge performances more accurately. Another drawback is the fact that all stages are weighted equally. In theory a high grade may be achieved, even though crucial stages are neglected. However, this may be less true for aseptic technique in which we consider all stages equally necessary. Alternatively, a pass/fail component can be introduced to allow for consideration of crucial mistakes. Although developed based on current literature and a Delphi technique, it is still highly region specific and not independently validated. However, it is easily adjustable to comply with different practices.

Blinding may not have been perfect in our study as subjects could sometimes still be identified despite videotaping the epidural field and hands only. We do not feel this resulted in bias attributable to the large number of sessions that were graded in random order and at a time distant from the actual procedures. As with all video-recorded procedures, the study may have suffered from a possible Hawthorne effect, a phenomenon which describes a change in participant performance due solely to their conscious participation in a study.22 This however would have been similar for all the subjects in the study.

One might argue it would be obvious to expect improvement when the primary outcome examines the same parameters that are being taught during an intervention. Our teaching however has only changed in method and emphasis, not in content. The residents in both groups were not given the task-specific checklist but its content was covered during the lecture. This was still not effective enough to achieve adequate aseptic technique in the pre-intervention group.

In our opinion, there were two key factors which contributed to the success of the intervention. The first was the ability to identify common mistakes with the use of video analysis. The second was the emphasis on the application of general aseptic principles to the specifics of the epidural procedure and the description of commonly observed breaches, in combination with the visual aid of the instructional video.

In conclusion, we have demonstrated that procedure-specific aseptic technique teaching, aided by video assessment and video demonstration, helped to significantly improve aseptic practice by novice trainees. Future studies should look at retention over longer periods of time in more senior residents.

<table>
<thead>
<tr>
<th>Study group</th>
<th>Level of experience</th>
<th>Aseptic technique total score</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>(Min, Max)</th>
<th>IQR</th>
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<tr>
<td>Pre-intervention group (n=11)</td>
<td>Low (&lt;30 epidurals)</td>
<td>14.2</td>
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<td>14.0</td>
<td>(11.3, 16.7)</td>
<td>(12.7, 16.3)</td>
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<td></td>
<td>Moderate (30–90 epidurals)</td>
<td>17.2</td>
<td>2.9</td>
<td>17.3</td>
<td>(12.3, 22.3)</td>
<td>(15.7, 18.7)</td>
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</tr>
<tr>
<td></td>
<td>High (&gt;90 epidurals)</td>
<td>16.9</td>
<td>2.4</td>
<td>16.3</td>
<td>(13.7, 22.7)</td>
<td>(15.8, 17.3)</td>
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<td>Post-intervention group (n=18)</td>
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<td>26.0</td>
<td>3.4</td>
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<td>(17.0, 29.5)</td>
<td>(24.8, 28.3)</td>
<td></td>
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<tr>
<td></td>
<td>Moderate (30–90 epidurals)</td>
<td>27.6</td>
<td>2.2</td>
<td>27.5</td>
<td>(22.0, 29.5)</td>
<td>(27.5, 29.0)</td>
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<tr>
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<td>High (&gt;90 epidurals)</td>
<td>27.8</td>
<td>1.8</td>
<td>28.0</td>
<td>(25.0, 30.0)</td>
<td>(26.0, 29.5)</td>
<td></td>
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Declaration of interest
None declared.

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Appendix 1: examiner’s checklist for Aseptic Technique

(1) Removes rings and watches.
(2) Washes hands and arms upon entering the room.
(3) Wears a hat and puts on a fresh face-mask.
(4) Opens the epidural tray in the correct manner and sequence (top flap opened away from operator).
(5) Washes hands with alcohol gel and air dries.
(6) Dons gloves in a sterile fashion.
(7) Prepares the skin aseptically, and waits for the solution to dry.
(8) Applies the drape in a cuffed and sterile manner.
(9) Works in a manner that minimizes crossing of bare forearms over the sterile field/equipment.
(10) Holds the anaesthetic receptacle away from the sterile area to allow assistant to pour in required solutions.
(11) Keeps all epidural equipment on the sterile tray when not in use.
(12) Maintains control over the catheter tip to avoid contamination.
(13) Dries the entry site of the epidural catheter and covers it with a sterile dressing while maintaining sterility (this requires keeping one hand sterile over the catheter insertion site, while partially removing the drape with the other hand in order to allow the nurse to apply the dressing).
(14) Further removal of any residual antiseptic or blood in the surrounding area is completed only after the entry site itself is protected by the sterile dressing.
(15) Maintains vigilance over all sterile fields and equipment and notes any potential breaks in technique.

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