Adequacy of Postoperative Pain Control During and After Continuous Epidural Infusion

By
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Abstract

Background/Aims:

To evaluate rates of epidural failure, reasons why epidurals fail, and how well pain at rest and with motion is controlled during epidural infusion and for 48 hours after the epidural catheter has been removed in a prospective observational cohort study following postoperative patients with epidurals at UNC Hospitals.

Methods:

Patient-generated pain assessment was obtained on all postoperative days with the epidural, and at 8-12 hours, 24 hours, and 48 hours after epidural removal, for pain at rest and with motion using the numerical rating scale (NRS) (0= no pain; 10= worst possible pain imaginable). When an epidural failed, the care team noted the cause of failure from a standard list. Data were also obtained about preoperative narcotic use, preoperative pain scores, type of operation, epidural catheter placement and all narcotic medications received postoperatively.

Results

Epidural failure rates were approximately 24 -31%. The three most common reasons for epidural failure were hypotension, pain occurring outside of the area of intended coverage, and unknown reasons why pain is not relieved despite appropriate epidural management. Failure rates were significantly higher among patients whose preoperative pain score was ≥5 and among patients who were using narcotics preoperatively. After removal of the epidural, pain scores increased and remained elevated for at least 48 hours. The increase was seen only in patients having lower extremity or abdominal epidurals, patients not taking preoperative narcotics, patients without severe preoperative pain, and patients who did not experience a failure in epidural analgesia. Patients with thoracic epidurals, on preoperative narcotics, with high
preoperative pain scores and with epidural failure did not show an increase in pain scores after removal of the epidural catheter, but instead had higher pain scores at baseline that remained elevated.

**Conclusion:**

This study identified groups of patients with specific characteristics that are more likely to experience severe pain with an epidural, epidural failure, and significant increases in pain scores after removal of the epidural during the postoperative period. The reason(s) why pain scores increased after catheter removal in specific groups of patients is unclear; however since patients are transferred to another service immediately after the epidural is removed, the increase in pain scores may reflect a problem with communication between teams during transfer from the Acute Pain Service to the Surgical Service, ultimately leading to an analgesic gap.

**Introduction**

Evidence published over the past 30 years indicates that suboptimal pain control is a problem experienced by a variety of patient populations, including medical and surgical inpatients, seriously ill hospitalized patients, minority and elderly patients with cancer, and children at the end of life. One population of patients expected to encounter pain consists of the millions of people who undergo surgical procedures every year. The CDC estimates that about 27 million surgical procedures are performed each year in the United States. Many efforts have been made over the last few decades to improve the management of postoperative pain. Such efforts include pharmaceutical research and development of new analgesic therapies, new technology in how analgesic drugs are delivered, and the establishment of acute pain services. However, despite these efforts, undertreatment of postoperative pain still
occurs. Overall, eighty percent of surgical patients experience acute postoperative pain, ranging from mild to severe\textsuperscript{12}.

Historically, pain has not been considered a high priority when treating a patient postoperatively; and patients have merely accepted the idea that postoperative pain should be expected during their hospital stay. However, in May 1999, JCAHO announced that evidence-based standards pertaining to pain assessment and treatment would be used as part of institutional assessments\textsuperscript{13}. These standards emphasize a collaborative and interdisciplinary approach to pain management, appropriate assessment and frequent reassessment of pain, individualized pain management plans, and a formal approach to treating pain\textsuperscript{14}. Following JCAHO's announcement, in 2000, Congress passed into law a provision declaring the decade beginning January 1, 2001 as the "Decade of Pain Control and Research"\textsuperscript{15}. The American Pain Society (APS) actively supports the Decade of Pain Control and Research, working to develop new programs and policies to advance awareness and treatment of pain\textsuperscript{15}. Due to the work of the APS, as well as other professional organizations, clinicians, and the government, there has recently been increasing attention given to acute postoperative pain management within the healthcare system. The APS now encourages health professionals to think of pain as "the fifth vital sign"\textsuperscript{12}.

To understand the importance of providing quality pain management, adverse outcomes that result from the undertreatment of postoperative pain must be examined. Postoperative pain can result in the avoidance of ambulation leading to increased thromboembolic and pulmonary complications, increased time spent in the intensive care unit (ICU), hospital readmission for additional pain management, and the development of chronic pain\textsuperscript{16}. Acute postoperative pain does not only compromise a person's functional mobility, but also impacts emotional well-being,
health-related quality of life, and overall recovery after an operation\textsuperscript{17,18}. Poorly managed pain also contributes to negative patient perceptions and low satisfaction with a hospitalization\textsuperscript{11}.

Pain is not the same for every patient and should be managed on an individual basis; however, some standardization must be put into place when assessing, documenting, and treating acute postoperative pain. Guidelines for managing postoperative pain have been established by organizations such as the Agency for Health Care Policy and Research (AHCPR), now the Agency for Healthcare Research and Quality (AHRQ), and the American Society of Anesthesiologists (ASA). However, in a national survey of acute pain program directors, conducted 6 years after the publication of the AHCPR guidelines and 3 years after the ASA guidelines, only one third of the responding institutions reported that their acute pain practices were influenced by such guidelines\textsuperscript{11}.

In order to improve quality in the management of post-operative pain, we must identify the root causes of failure and determine new methods for improvement. There are several stages at which the system can break down when managing postoperative pain. Karlsten et al., experts on health care quality and safety, note that health care should include quality systems for the planning, performance, evaluation, and improvement of care, and all staff should be involved in this work\textsuperscript{19}. Postoperative pain management should be a multidisciplinary process that involves anesthesiologists, surgeons, nurses, pharmacists, and physical therapists. In order to develop a successful system to manage and improve postoperative pain, an integrated approach must be put into place. Since different people place the orders, fill the orders, administer the medications, and monitor the effects of the pain medications, communication must be emphasized among all team members. Standardized training and education is necessary for all personnel involved in
the management of a patient’s postoperative pain, and it is important that all health care providers be comfortable with pain management techniques.\textsuperscript{13}

One issue that exists due to system-related events is the analgesic gap, which is an interruption in analgesic delivery.\textsuperscript{20} Despite increased efforts and new technology used to improve pain care, there are also challenges that exist in combining treatment approaches, finding the most effective analgesic therapy for each individual patient, and transitioning patients from one treatment to another.\textsuperscript{11} The period of transition between treatment modalities is one factor that often presents a major obstacle in the hospital setting when patients must rely on others to administer their medication. In order to avoid analgesic gaps, there must be communication among all members caring for a patient, regarding the timing of discontinuing one mode of analgesia, the use of equianalgesic conversions to another mode, and the time that must be allowed for a different treatment to take effect before the previous one is stopped.\textsuperscript{11}

Anesthesiology-based acute pain services manage postoperative pain using techniques such as intravenous patient-controlled analgesia (i.v. PCA), peripheral nerve blocks, intramuscular (i.m.) analgesia, oral analgesia, and epidural analgesia. The first acute pain services were introduced in the United States and Germany in 1985.\textsuperscript{21,22} Since then, Anesthesiologist-led acute pain services have been established in Canada, Australia, New Zealand, and other European and Asian countries.\textsuperscript{23-28} In the UK and Canada, around 90\% of hospitals now have an acute pain service.\textsuperscript{29,30} Guidelines put out by the International Association for the Study of Pain (IASP) recommended that acute pain services be established in all hospitals with pain nurses and anesthesiologists who are able to implement various techniques to manage acute pain.\textsuperscript{30}
The activities of the acute pain service also include induction of postoperative analgesia in the recovery unit, clinical rounds including all patients receiving regional analgesia, epidural analgesia or patient-controlled analgesia (PCA), additional consultations on postoperative pain management for other patients on request, assessment and documentation of the clinical status of each patient, the quality of analgesia and side effects, and written orders for further treatment. The implementation of an acute pain service has been shown to improve postoperative pain relief.

Two specialized techniques commonly used by the acute pain service include epidural analgesia and intravenous PCA (iv PCA). These techniques are considered the “gold standard” for the management of pain after an operation. For an iv PCA, PCA pumps are set to administer a small bolus dose of analgesic medication through the intravenous catheter at specified time intervals when the patient presses a button. A PCA device allows patients to control when they get their anesthetic. Postoperative pain is also often managed with epidural analgesia. Two types of epidural analgesia include patient-controlled epidural analgesia (PCEA) and continuous epidural infusion. PCEA is similar to iv PCA in that patients are able to control when they receive their analgesic medication, but the infusion is through an epidural catheter rather than an iv catheter. Continuous epidural analgesia is a continuous infusion of anesthetic through the epidural catheter. In most cases, the analgesic medication infused through an epidural catheter is a local anesthetic and/or opioid-based analgesic regimen.

When formulating an individualized plan for a patient’s postoperative pain management and the type of analgesia that the patient will receive, several variables must be considered. These variables include the type of surgery, expected severity of postoperative pain, existing medical conditions, prior narcotic use, the risk-benefit ratio for the available analgesic options,
and the patient’s preferences. Dolin et al. performed a meta-analysis on data assessing three analgesic techniques (i.m. analgesia, i.v. PCA, and epidural analgesia) on the incidence of moderate-severe and severe postoperative pain. A total of 165 studies were analyzed, including nearly 20,000 patients. Pain was assessed by visual analogue or verbal rating scale. Stratification of the data according to the route of administration showed that the proportion of patients having the highest pain scores were those receiving i.m. opioids and proportion having the lowest pain scores were those receiving epidural opioids. Epidural analgesia is not only associated with better pain control when compared with systemic opioids, but it may also lead to improved patient satisfaction.

However, epidurals can fail for a variety of reasons. Factors potentially affecting the function of an epidural include epidural catheter location, the analgesic agents being used, the infusion rates of the analgesic, duration of the epidural, and the epidural placement technique. Some of the most common known causes of failure include a dislodged catheter, a catheter that is not in the epidural space, a unilateral block, a leak in the catheter, or patient intolerance.

The aims of this study are to: (1) evaluate rates of epidural failure (2) determine reasons why the epidurals fail, and (3) determine how well both rest and incident pain is controlled during epidural infusion and for 48 hours after the epidural catheter has been removed. While previous studies have examined characteristics of the epidural that can lead to inadequate analgesia, few studies have examined the characteristics of patients who tend to have the most problems with postoperative pain control. We will specifically examine if catheter placement, severe baseline pain scores, pre-operative narcotic medications, and epidural failure lead to increased pain scores after the epidural is removed. The overall goal of this study is to gain
insight about ways to develop a quality system that addresses the current challenges in epidural pain management and to suggest general methods for future improvement of postoperative pain.

Methods

This study was approved by the University of North Carolina Institutional Review Board.

Study Design and Subjects

Two prospective observational cohort studies were completed. In the first study, examining epidural failure, we gathered data on 223 surgical patients who had postoperative epidurals placed between January 2008 and May 2008. In a follow-up study of pain management after epidural catheter removal, data were collected on an additional 64 patients who had epidurals placed for postoperative pain control between November 2008 and February 2009. For both studies, we collected data on patients who had an intact epidural for at least 24 hours after surgery, patients who were able to communicate (i.e., not intubated or obtunded), who were ≥18 years of age, and who had willingness to communicate with the care team. All patients in the study were managed by an Anesthesiology-based Acute Pain Service at The University of North Carolina Hospitals, and all data were collected observationally as part of a customary Quality Assurance (QA) practice.

For the first study, which focused on epidural failure, data were collected and recorded by the Acute Pain Service about preoperative narcotic use, baseline pain scores, type of operation, and epidural catheter placement. Epidural infusions consisted of opioids and/or local anesthetic (standard infusion = morphine 40μg/ml plus bupivcaine 1mg/ml) with additional epidural boluses or intravenous analgesic supplementation as necessary, as per the Acute Pain Service’s standard practice. Forty-one of 193 (21.2%) patients received intravenous opioid analgesia in
addition to epidural local anesthetic infusion. Patient-generated pain assessment was obtained on postoperative days 1 and 2 for pain at rest and with motion, using the numerical rating scale (NRS) (0= no pain; 10= worst possible pain imaginable). The success of epidural analgesia was rated using a five-point Epidural Function Scale with analgesic failure defined as a score of 3 or less. A score of 1 indicated no detectable levels or analgesia, and a score of 2 indicated possible levels and partial analgesia, but overall analgesia was rated as inadequate despite adjustments. A score of 3 indicated detectable levels of analgesia but required frequent boluses or adjustments. Success of epidural analgesia was rated either as 4, indicating adequate analgesia with modest boluses or adjustments, or 5, indicating adequate analgesia with basal infusion alone. When an epidural failed, the care team noted the cause of failure from a standard list (Figure 1).

**Cause of Analgesia Failure (choose all that apply):**

1. catheter was never placed in epidural space
2. unilateral block
3. sensory loss level discordant with surgical level of catheter placement
4. disconnection/leaking at connection of catheter and filter
5. catheter migration
6. Notification Failure: staff failed to communicate need for bolus/patient in pain
7. Delivery Failure: ordered medications not delivered (pump problems; pharmacy delays)
8. pain occurs outside of the area of intended epidural coverage (i.e. foot pain with thoracic epidural)
9. unknown reason block is insufficient to relieve pain despite appropriate epidural management
10. catheter site infection
11. other: ___________ (i.e. anticoagulation, sepsis necessitates termination of therapy)
12. Patient intolerance due to: a. hypotension b. pruritis c. altered mental status d. excessive block e. other

**Figure 1**—Causes of epidural analgesia failure that were used in the study.

Additional information was collected on PCA use, use of other IV analgesia, the number of opioid boluses required during every 24-hour time period, or any other breakthrough pain medication that was given during a 24-hour time period. Finally, information was gathered to determine patient satisfaction with their pain management. Patients were asked how satisfied
they were with their pain management care on a scale of 1-10, with 1 being completely
dissatisfied and 10 being completely satisfied.

In the follow-up study of pain management after epidural catheter removal, data on 64 subjects
was collected about preoperative narcotic use, baseline pain scores, type of operation, and
epidural catheter placement. Identical observations were made in regards to epidural infusions,
and patient-generated pain assessment using the NRS. The follow-up study did include several
modifications, in that data were collected on pain scores at rest and with motion once per day
throughout the period of epidural analgesia, and also at 8-12 hours, 24 hours, and 48 hours after
removal of the epidural. The success of epidural analgesia was rated using the same five-point
Epidural Function Scale as in the initial QA study, and reasons for failure were assessed using
the same standard list. We collected data on supplemental analgesic medications-- including
PCAs, other IV analgesia, the number of opioid boluses required, and any other pain medication
received--while the epidural was in place as well as after it was removed.

Statistical Analysis

Statistical analysis was performed using SPSS (v. 16; SPSS, Inc.; Chicago, IL) and graphics
were prepared using SigmaPlot (v. 10; SPSS, Inc.). Descriptive statistics were generated and
select groups were compared using either Chi Square Analysis for categorical variables or
Analysis of Variance (ANOVA) (i.e., Students t test) for continuous variables. Separate repeated
measures ANOVA was run to compare pain scores over time and additionally for each stratified
variable over time. P<0.05 was considered statistically significant.
Methods for Systematic Review of the Literature:

The Medline/PubMed database was searched using the following search terms: "epidural analgesia," "postoperative pain," and "pain control" for articles on how epidurals are used in the postoperative setting as a method of pain control for surgical pain; "epidural analgesia," "postoperative pain," and "patient care management" for articles on assessment and management of postoperative pain with epidural analgesia and suggestions for improvement; "acute postoperative pain," "management," and "quality" for articles on other methods of analgesia besides epidurals that are used to manage postoperative pain and the overall quality of care in acute pain management; "acute postoperative pain" and "adverse health outcomes" for articles on the adverse health outcomes that can result from acute postoperative pain; "acute postoperative pain" and "predictive risk factors" for articles on patient characteristics that can act as predictive risk factors for increased postoperative pain; "acute postoperative pain" and "chronic preoperative pain" for articles on how chronic preoperative pain can influence a patient's experience of acute postoperative pain; "analgesic gap," "acute postoperative pain," and postoperative pain management for articles on the significance of an analgesic gap on the experience of pain during the acute postoperative period. "acute pain service" and "postoperative pain management" for articles on the influence of pain management by acute pain services.

Abstracts were reviewed for citations in peer-reviewed journals, using the limits of publication dates (last 10 years), language (English), and subjects (human) for five of the searches. For searches that were used in this paper on the analgesic gap, no limits were applied, as setting limits was not necessary to limit the search. No limits were applied to searches for acute postoperative pain and adverse health outcomes, preoperative patient characteristics,
preoperative risk factors, predictive risk factors, or chronic preoperative pain. For a detailed list of systematic search terms and limits, please refer to Table 5 in the appendix.

Articles were also used from the related articles or reference sections of select articles found in the PubMed search. Articles were excluded if they only included patients younger than age 18 or case studies.

Results

Complete data were obtained for a total of 185 of 223 patients (83.0%) in the first study designed to determine epidural failure rates and identify factors associated with failure. The distribution of pain scores at rest and with motion is shown in Figure 2. Pain scores were lower with rest than with motion, averaging $2.24 \pm 2.59$ (mean ± SD) at rest and $4.53 \pm 3.26$ with motion on postoperative day 1 (POD 1). On postoperative day 2 (POD 2), pain scores averaged $1.96 \pm 2.45$ at rest and $4.47 \pm 3.16$ with motion.
Overall, approximately 24% of epidurals failed. On POD 1, 43/181 (23.8%) of epidurals failed to provide an adequate level of analgesia and on POD 2, 37/159 (23.3%) of epidurals failed. The three most common reasons for failure of epidurals on either POD 1 or POD 2 were hypotension, pain occurring outside of the area of intended coverage, and unknown reasons why pain is not relieved despite appropriate epidural management (Figure 3).
Epidurals tended to fail more frequently with thoracic catheters versus lower extremity or abdominal catheters, although the difference was not significant (Figure 4).

Failure rates also were higher among patients whose preoperative pain score was ≥5 (p<0.08 POD1 and p<0.01 POD2; Figure 5) and among patients who were using narcotics preoperatively (p<0.001 POD1 and p<0.0005 POD2; Figure 6).
Figure 4—Percentage of failed catheters based on location of catheter placement. The figure shows the percentage of catheters that failed, on the y-axis, based on the location of the epidural (thoracic, lower extremity, abdominal). The x-axis shows postoperative day 1 and 2.

Figure 5—Percentage of failed catheters based on preoperative pain score. The figure shows the percentage of catheters that failed, on the y-axis, for patients with preoperative pain scores <5 versus those with preoperative pain scores ≥5. The x-axis shows postoperative day 1 and 2.
Figure 6--Percentage of failed catheters based on preoperative narcotic use. The figure shows the percentage of catheters that failed, on the y axis, for patients having no preoperative narcotic use versus those with preoperative narcotic use. The x-axis shows postoperative day 1 and 2.

Overall, patient satisfaction with epidural analgesia was quite high, despite the high rates of failure. The distribution of patient satisfaction scores is shown in Figure 7. The average satisfaction score was $8.62 \pm 1.78$ on a scale of 1 ("completely dissatisfied") to 10 ("completely satisfied"). Only 10/136 (7.4%) patients had a satisfaction score $\leq 5$. 
Figure 7—Patient Satisfaction scores were obtained from 136/185 (73.5%) patients. This figure shows the number of patients on the y-axis, reporting their satisfaction with pain control of 1 (completely dissatisfied) to 10 (completely satisfied), on the x-axis.

Data were obtained from an additional 64 patients in a second study designed to evaluate pain management in patients after the epidural catheter has been discontinued and care is transferred from the Anesthesiology-based Acute Pain Service to the Surgical Service. Overall, a total of 20/64 (31.2%) epidurals failed in the follow-up study, consistent with the rate found in the first study.

As Figure 8 shows, the distribution of pain scores shifted to the right after the epidural catheter was removed, indicating an increase in pain scores both at rest and with motion. This shift is especially evident at the first time point after epidural removal. The distribution of pain scores began shifting back to the left over the course of the 48 hours.
Figure 8—Percentage of patients with pain on last postoperative day with catheter and at various time points after catheter removal. The figures show the percentage of patients, on the y-axis, reporting pain scores of 0 (no pain) to 10 (worst pain imaginable), on the x-axis, for pain on the last day with epidural catheter at rest (panel A) and with motion (panel E) at 8-12 hours after removal at rest (panel B) and with motion (panel F), at 24 hours after removal at rest (panel C) and with motion (panel G), and 48 hours after removal at rest (panel D) and with motion (panel H).

<table>
<thead>
<tr>
<th>Time Point</th>
<th>Mean Pain Score ± SD at rest</th>
<th>Mean Pain Score ± SD with motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last POD day with Epidural Catheter</td>
<td>2.0±2.2</td>
<td>4.5±3.4</td>
</tr>
<tr>
<td>8-12 hours after removal</td>
<td>3.1±2.2</td>
<td>6.0±2.6</td>
</tr>
<tr>
<td>24 hours after removal</td>
<td>2.8±2.4</td>
<td>5.6±2.8</td>
</tr>
<tr>
<td>48 hours after removal</td>
<td>2.5±2.4</td>
<td>5.2±2.9</td>
</tr>
</tbody>
</table>

Table 1—Average pain scores (±SD) at rest and with motion at last time point with epidural catheter, and then at 8-12 hours, 24 hours, and 48 hours following catheter removal.
Pain scores immediately before catheter removal averaged 2.0±2.2 at rest and 4.5±3.4 with motion. Eight to twelve hours after catheter removal, average pain scores increased to 3.1±2.2 at rest and 6.0±2.6 with motion. Average pain scores remained above baseline (i.e., before catheter removal) for 48 hours, the duration of follow-up (Table 1). The increase in average pain scores was significant, for scores at rest (p<0.001) and with motion (p<0.01; Figure 9).

Figure 9—This figure shows pain scores at rest (panel A) and with motion (panel B), on the y axis, and the time points on the x axis (immediately before catheter removal, 8-12 hours after removal, 24 hours after removal, and 48 hours after catheter removal).

Thoracic catheter, preoperative pain scores ≥5, preoperative narcotic use, and the failure of epidural analgesia were associated with poorer outcomes in the first study. Therefore, in the follow-up study, patients were stratified by these four factors to determine whether the increase in pain after catheter removal was seen in all stratified subsets (Table 2, 3).
### Table 2

<table>
<thead>
<tr>
<th>Patient Characteristics</th>
<th>Mean pain score on last POD with catheter</th>
<th>Mean pain score 8-12 hours after removal of catheter</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracic Epidural</td>
<td>2.73 ± 1.74</td>
<td>3.64 ± 2.01</td>
<td>N.S.</td>
</tr>
<tr>
<td>Lower Extremity Epidural</td>
<td>1.18 ± 1.99</td>
<td>2.09 ± 1.69</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Abdominal Epidural</td>
<td>2.2 ± 2.34</td>
<td>3.47 ± 2.43</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Patients taking pre-operative narcotics</td>
<td>3.14 ± 2.73</td>
<td>4.47 ± 2.09</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Patients not taking pre-operative narcotics</td>
<td>1.42 ± 1.64</td>
<td>2.40 ± 2.00</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Severe pre-operative pain (≥5)</td>
<td>2.75 ± 2.79</td>
<td>3.75 ± 2.38</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>No severe pre-operative pain (&lt;5)</td>
<td>1.64 ± 1.79</td>
<td>2.77 ± 2.13</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Epidural failure</td>
<td>3.45 ± 2.19</td>
<td>3.95 ± 2.56</td>
<td>N.S.</td>
</tr>
<tr>
<td>No epidural failure</td>
<td>1.32 ± 1.86</td>
<td>2.68 ± 1.99</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Table 2—Average pain scores at rest are shown for epidural location, taking/not taking preoperative narcotics, with/without severe preoperative pain, and with/without epidural failure on the last postoperative day with the epidural catheter and at 8-12 hours after removal of the catheter. All values are expressed as mean ± SD. “N.S.” stands for “not significant.”
Motion:

<table>
<thead>
<tr>
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<th>Mean pain score 8-12 hours after removal of catheter</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracic Epidural</td>
<td>5.09 ± 2.39</td>
<td>5.82 ± 2.71</td>
<td>N.S.</td>
</tr>
<tr>
<td>Lower Extremity Epidural</td>
<td>3.86 ± 3.71</td>
<td>5.86 ± 2.68</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Abdominal Epidural</td>
<td>4.67 ± 3.52</td>
<td>6.00 ± 2.43</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Patients taking pre-operative narcotics</td>
<td>5.90 ± 3.70</td>
<td>6.81 ± 2.44</td>
<td>N.S.</td>
</tr>
<tr>
<td>Patients not taking pre-operative narcotics</td>
<td>3.84 ± 3.07</td>
<td>5.58 ± 2.56</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Severe pre-operative pain (≥5)</td>
<td>5.20 ± 4.02</td>
<td>6.50 ± 2.76</td>
<td>N.S.</td>
</tr>
<tr>
<td>No severe pre-operative pain (&lt;5)</td>
<td>4.20 ± 3.08</td>
<td>5.75 ± 2.47</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Epidural failure</td>
<td>6.65 ± 3.01</td>
<td>6.60 ± 2.98</td>
<td>N.S.</td>
</tr>
<tr>
<td>No epidural failure</td>
<td>3.55 ± 3.14</td>
<td>5.70 ± 2.34</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Table 3— Average pain scores with motion are shown for epidural location, taking/not taking preoperative narcotics, with/without severe preoperative pain, and with/without epidural failure on the last postoperative day with the epidural catheter and at 8-12 hours after removal of the catheter. All values are expressed as mean ± SD. "N.S." stands for "not significant."

Average pain scores in patients with lower extremity or abdominal epidurals increased significantly after catheter removal at rest and with motion. A significant increase in average pain score at rest and with motion was not seen in patients with thoracic epidurals. Patients who had thoracic epidurals were also noted to have higher average pain scores on the last postoperative day with the epidural catheter than those with lower extremity or abdominal catheters.

Patients not taking narcotics preoperatively showed a significant increase in pain scores after removal of the epidural catheter at rest and with motion (p<0.001). Patients who took narcotics
preoperatively showed a significant increase in pain scores at rest (p<0.05) but did not show a significant increase in pain with motion. Patients taking preoperative narcotics had higher average pain scores at rest and with motion than patients who did not take preoperative narcotics.

Patients with baseline pain scores <5 had a significant increase in pain scores at rest (p<0.0001) and with motion (p<0.001) after removal of the epidural catheter. Patients with baseline pain scores ≥5 showed a significant increase in pain scores after removal of the epidural at rest (p<0.05), but not with motion. Patients with preoperative pain scores ≥5 had higher average pain scores at rest and with motion than patients who had preoperative pain scores <5.

Finally, patients who did not experience epidural failure while the catheter was intact had a significant increase in pain at rest and with motion (p<0.0001) after removal of the epidural catheter. Patients whose epidural failed to provide adequate analgesia did not experience a significant increase in pain after removal of the epidural at rest and with motion. Patients who experienced epidural failure had higher average pain scores at rest and with motion than patients who did not experience epidural failure.

**Discussion**

The results for the first study showed an overall failure rate of approximately 24%, consistent with other studies 39,40. The three most common reasons for epidural failure were hypotension, pain occurring outside of the area of intended coverage, and unknown reasons why pain is not relieved despite appropriate epidural management. Failure rates were significantly higher among patients whose preoperative pain score was ≥5 and among patients who were using
narcotics preoperatively. There was not a significant difference in epidural failure rates among patients with thoracic, lower extremity, or abdominal epidurals, although thoracic epidurals tended to have higher failure rates. Overall, patient satisfaction with epidural analgesia was high.

The results for the follow-up study show that pain scores increase after the epidural catheter is removed and remain elevated for at least 48 hours. On the last postoperative day with the epidural catheter, average pain scores were higher at rest and with motion for patients with thoracic epidurals, patients who took preoperative narcotics, patients who had severe preoperative pain, and patients who had experienced failure of epidural analgesia. However, when patients were stratified into subsets, significant increases in pain with motion were seen only for patients having lower extremity or abdominal epidurals, patients not taking preoperative narcotics, patients without severe preoperative pain, and patients who did not experience a failure in epidural analgesia. At rest, significant increases in pain were seen among all groups, except patients with thoracic epidurals and patients who experienced failure of epidural analgesia.

The reason(s) why pain scores increased after catheter removal in patients whose epidural infusion appeared to produce good pain control is unclear; however since patients are transferred to another service immediately after the epidural is removed, the increase in pain scores may reflect a problem with communication between teams during transfer from the Acute Pain Service to the Surgical Service, ultimately leading to an analgesic gap.

A previous study, examining the inadequacy of analgesia following the discontinuation of postoperative epidural infusion or iv morphine, identified the "analgesic gap" as one potential problem that may cause pain scores to increase during this transitional period. During transitions between treatment modalities, it is not uncommon for a patient to experience an
analgesic gap, defined as “the shortfall of pain management during patients’ transition from a postsurgical epidural analgesia or IV PCA to oral analgesics” \textsuperscript{41}. In a study by Ng et al., a period of inadequate analgesia occurred in 40 of 89 patients within 48 hours after surgery and in 17 of 22 (77\%) patients with pain scores ≥5 after IV PCA was discontinued \textsuperscript{41}.

An important factor in avoiding an analgesic gap is equianalgesic conversions between treatment modalities and drugs. The need for equianalgesic dosing occurs frequently, especially when a patient who has just had an epidural or IV PCA discontinued is transferred from the Acute Pain Service to the Surgical Service. Currently, equianalgesic conversions are rarely acknowledged when an epidural is discontinued and the patient is transferred to another mode of analgesia. Inadequate oral analgesia is quite common when a patient is transferred from an epidural or IV PCA. Rather than simply start a patient on a new drug regimen based on the type of operation, a comprehensive patient assessment must be conducted \textsuperscript{42}. Physicians must use a standardized approach for conversion between analgesics that also allows for individualized results to meet unique patient needs\textsuperscript{42}.

When conducting a patient assessment to develop the best method for pain control, a thorough history is necessary, taking into account all factors that may influence how a patient experiences pain. A recent study by Chou et al. found that higher preoperative pain was predictive of higher anticipated postoperative pain, and both preoperative pain and anticipated postoperative pain were independently predictive of higher postoperative pain \textsuperscript{43}. The results of the study by Chou et al. have important implications when looking at predictive factors for postoperative pain, but the study was limited to foot and ankle procedures, and it did not take into account the use of pain medications which have the potential to greatly influence how patients perceive their postoperative pain.
In another study examining how patient characteristics can affect the experience of pain after surgery, Ready found that patients with prior opioid use had considerably higher pain scores at rest and with motion than patients who did not use opioids (rest pain 4.1 vs. 2.5; pain with motion 7.8 vs. 6.0). It was also noted that 8-hour PCA morphine utilization was almost three times higher in the group of patients with prior opioid use (41 vs. 14 mg)\(^3\). Similar results were found by Rapp et al. who concluded that patients in the acute postoperative setting who had taken preoperative opioids tended to have more ineffective pain relief with standard treatment dosages\(^44\).

Ready also looked at patient satisfaction with a numerical rating scale of 1 (very dissatisfied) to 10 (very satisfied) and noted that 50% of patients rated their satisfaction with the acute pain service as a 10, and 89% rated their satisfaction as 8 or higher\(^3\). When Ready examined how patient satisfaction is related to pain scores, he found that pain scores with motion during therapy had no effect on reported satisfaction in this population. Patients with pain scores of 8-10 were as satisfied as patients with pain scores of 1-3\(^3\). This shows that pain scores cannot be used to predict patient satisfaction with the acute pain service. Although patient satisfaction is extremely important, it may not be the best measurement of quality pain management. This point is highlighted in our study where patients reported very high satisfaction with their pain management team, while simultaneously experiencing inadequate analgesia after discontinuation of their epidural.

Due to the findings of previous studies, including the first study in this paper, it was thought that patients who had higher pain scores during epidural infusion, as well as higher failure rates of epidural analgesia, would have more significant increases in pain after the epidural was removed. However, the significant increases in pain after epidural removal tended
to occur in groups who had well-controlled pain during epidural infusion. These results identify several factors that must be addressed in order to improve postoperative pain.

First of all, we identified groups of patients that are more likely to experience more severe pain with the epidural, as well as epidural failure, during the postoperative period. Secondly, a period of time was identified during which pain scores tend to increase and analgesia proves to be inadequate during postoperative recovery. Finally, we identified groups of patients that are most likely to have significant increases in postoperative pain after the removal of an epidural. Since acute postoperative pain can lead to adverse outcomes and affect both medical resource use and a patient’s ability to resume normal daily activities after discharge from the hospital, it is necessary to focus on these specific groups of patients and specific time frames as critical factors in the improvement of pain control 45.

Public Health Implications

Patient-specific characteristics, such as preoperative narcotic use, severe preoperative pain, location of the epidural catheter, and failure of epidural analgesia, were all identified as affecting patients’ experience with postoperative pain. This information should be used to improve the current method for identifying and catering to patients’ individual pain management plans. Development of a preoperative screening tool to help determine the potential for postoperative pain could reduce adverse outcomes associated with postoperative pain, improve postoperative pain interventions, and reduce postoperative costs associated with pain management by using resources more efficiently 46.
Future Studies

More research is needed to assess why analgesia is inadequate during the 48 hours after removal of the epidural catheter in specific groups of patients. There are several possible explanations, but the exact reason is unclear. For example, we must determine the total amount of anesthesia that the patient is receiving while the catheter is in place versus the total amount of anesthesia the patient is receiving after removal of the catheter. Also, analgesic gaps should be studied, as inadequate pain control tends to occur when a patient is being transferred from one treatment modality to another. Another question to examine is whether or not the anesthesiology and surgical teams are communicating about removal of the epidural catheter and developing a pain management plan for the patient once the epidural comes out. In terms of preoperative screening, a standardized protocol could be implemented to assess how much preoperative screening will affect postoperative pain.

Limitations

The study has limited generalizability in that data were not gathered on all epidurals placed. We collected data on most patients receiving epidurals for postoperative pain control during specific time frames. However, there was no method to systematically select patients that would be used in this study, and selection bias could have occurred. Another limitation of this study is that assessment of epidural failure was somewhat subjective when using the epidural function scale. This could lead to measurement bias, especially since the same person did not collect the data for every patient, potentially affecting the reliability and validity of the data in determining the number of epidural failures.
Recall or reporting bias may have played a role in the reporting of previous narcotic use by patients as well as expectation bias when patients were asked about their satisfaction with the care they were receiving. Expectation bias could have led to patients rating their satisfaction and pain relief higher than it actually was because the patients felt like they wanted to please their physicians. Finally, there was a small sample size (N=64) in the second part of this study. This could affect external validity when using the small number of patients to generalize about all patients receiving epidural analgesia for postoperative pain management.

Conclusion

Knowing what factors to look for during a preoperative assessment could greatly influence how we develop postoperative pain management plans. For example, knowing that a patient has been on preoperative narcotics and has experienced severe preoperative pain can alert the care team to the fact that this patient may have higher pain scores with an epidural. The care team must also be aware that patients not taking preoperative narcotics and those who do not have severe preoperative pain may have more significant increases in pain once their epidural is removed. Being proactive when developing a pain management plan can be more effective and efficient than treating uncontrolled postoperative pain once it has already occurred.

Improving communication with the patient and among providers, along with developing multimodal care plans using the patient characteristics noted in this study, pain management plans can become more individualized to meet patients’ needs. This will reduce patients’ fear and anxiety relating to their operation, prevent adverse health outcomes associated with postoperative pain, and promote a more efficient use of health resources to manage pain leading to reduced health care costs.
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- Dr. Anthony Viera, MD, MPH, my advisor in the Health Care and Prevention MPH program at the UNC School of Public Health, for his time and effort with editing and teaching.
### Appendix:

#### Table 5
Systematic Review Literature Searches

<table>
<thead>
<tr>
<th>Date</th>
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<th>Main Search Terms</th>
<th>Modifiers</th>
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</table>
Table 6. Epidural Quality Assessment Data Collection Sheet

Epidural QA/QI Study

For Catheter #: □ 1 □ 2 □ 3

Date Epidural Catheter placed: _____ / _____ / _____

Surgical Service: ________________

Surgery: __________________________

Surgical Area: □ Thoracic □ Upper Abdominal
□ Lower Extremity □ Lower Abdominal
□ Other: ________________________ □ Upper&Lower Abdominal

Pre-Op chronic narcotic meds (daily for >2 weeks)?
□ yes □ no

Drug & Dose Regimen: ________________________________

Baseline Pain Score [pre-op]: __________ (0-10 VAS Scale)

Epidural “Cocktail”
□ Morphine, dose: __________
□ Fentanyl, dose: __________
□ Bupivacaine, dose: __________
□ Other: __________ dose: ________
□ Other: __________ dose: ________
Rate: ______________

Epidural Pulled (date and time):

Orders written for pain meds (time):

First pain med administered (time):
<table>
<thead>
<tr>
<th>Post-Op Day</th>
<th>Epidural Function Scale (#, see below)</th>
<th>For Epidural Function 1-3, Cause of Analgesia Failure (#, see below)</th>
<th>Catheter d/c as planned? (if &quot;NO&quot; choose failure # from list below)</th>
<th>Breakthrough Pain Meds (number of doses)</th>
<th>Pain Score R=Rest M=Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>#: ____</td>
<td>□ catheter continued □ held □ yes d/c per plan* □ no; reason</td>
<td>□ PCA used □ other IV Analgesia □ # of boluses:____ □ other:______</td>
<td>R=</td>
<td>M=</td>
</tr>
<tr>
<td></td>
<td>□ unable to assess</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>#: ____</td>
<td>□ catheter continued □ held □ yes d/c per plan* □ no; reason</td>
<td>□ PCA used □ other IV Analgesia □ # of boluses:____ □ other:______</td>
<td>R=</td>
<td>M=</td>
</tr>
<tr>
<td></td>
<td>□ unable to assess</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>#: ____</td>
<td>□ catheter continued □ held □ yes d/c per plan* □ no; reason</td>
<td>□ PCA used □ other IV Analgesia □ # of boluses:____ □ other:______</td>
<td>R=</td>
<td>M=</td>
</tr>
<tr>
<td></td>
<td>□ unable to assess</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>#: ____</td>
<td>□ catheter continued □ held □ yes d/c per plan* □ no; reason</td>
<td>□ PCA used □ other IV Analgesia □ # of boluses:____ □ other:______</td>
<td>R=</td>
<td>M=</td>
</tr>
<tr>
<td></td>
<td>□ unable to assess</td>
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<tr>
<td>5</td>
<td>#: ____</td>
<td>□ catheter continued □ held □ yes d/c per plan* □ no; reason</td>
<td>□ PCA used □ other IV Analgesia □ # of boluses:____ □ other:______</td>
<td>R=</td>
<td>M=</td>
</tr>
<tr>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
## Breakthrough Pain

**Date of Catheter Meds Pain Meds Removal (number of doses)**

<table>
<thead>
<tr>
<th>Post Catheter Time 1</th>
<th>Breakthrough Pain Meds</th>
<th>Pain Meds</th>
<th>Pain Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-12 hours AM/PM</td>
<td>□ PCA used</td>
<td>1. Drug and dose;</td>
<td>R=</td>
</tr>
<tr>
<td></td>
<td>□ other IV Analgesia</td>
<td>2. Drug and dose;</td>
<td>M=</td>
</tr>
<tr>
<td></td>
<td>□ # of boluses: _____</td>
<td>3. Drug and dose;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ other: ____</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post Catheter Time 2</th>
<th>Breakthrough Pain Meds</th>
<th>Pain Meds</th>
<th>Pain Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 hours AM/PM</td>
<td>□ PCA used</td>
<td>1. Drug and dose;</td>
<td>R=</td>
</tr>
<tr>
<td></td>
<td>□ other IV Analgesia</td>
<td>2. Drug and dose;</td>
<td>M=</td>
</tr>
<tr>
<td></td>
<td>□ # of boluses: _____</td>
<td>3. Drug and dose;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ other: ____</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Post Catheter Time 3</th>
<th>Breakthrough Pain Meds</th>
<th>Pain Meds</th>
<th>Pain Score</th>
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</thead>
<tbody>
<tr>
<td>48 hours AM/PM</td>
<td>□ PCA used</td>
<td>1. Drug and dose;</td>
<td>R=</td>
</tr>
<tr>
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<td>□ other IV Analgesia</td>
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<tr>
<td></td>
<td>□ # of boluses: _____</td>
<td>3. Drug and dose;</td>
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</tr>
<tr>
<td></td>
<td>□ other: ____</td>
<td></td>
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</table>

### Cause of Analgesia Failure (choose all that apply):

1. catheter was never placed in epidural space
2. unilateral block
3. sensory loss level discordant with surgical level of catheter placement
4. disconnection/leaking at connection of catheter and filter
5. catheter migration
6. Notification Failure: staff failed to communicate need for bolus/patient in pain
7. Delivery Failure: ordered medications not delivered (pump problems; pharmacy delays)
8. pain occurs outside of the area of intended epidural coverage (i.e. foot pain w/thoracic epidural)
9. unknown reason block is insufficient to relieve pain despite appropriate epidural management
10. catheter site infection
11. other: ______ (i.e. anticoagulation, sepsis necessitates termination of therapy)
12. Patient intolerance due to: a. hypotension  c. altered mental status  
   b. pruritis   d. excessive block   e. other: ______

### Epidural function scale (1-5):

1. No detectable levels or analgesia
2. Possible levels, at least partial analgesia, but overall inadequate despite adjustments
3. Detectable levels, analgesia requiring frequent boluses/adjustment
4. Analgesia adequate with modest adjustment/boluses
5. Analgesia adequate with basal infusion alone

---

Pain Score

- **R** = Rest
- **M** = Motion

---

35
References


