

A Review of Neuraxial Epidural Morbidity

Experience of More Than 8,000 Cases at a Single Teaching Hospital

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Background: The true incidence of serious neuraxial complications such as epidural hematoma or abscess after postoperative epidural infusions is still uncertain, in part due to inconsistencies in multicenter data collection.

Methods: Prospective data were collected over 16 yr from the authors' Acute Pain Service, which is based in a large tertiary teaching institution with a nonobstetric general surgical population.

Results: Over this period, 8,210 epidural catheters were inserted for postoperative analgesia and 32 computed tomography or magnetic resonance imaging scans were undertaken to exclude potential neuraxial complications. From these, two spinal hematomas (1:4,105) and six epidural abscesses (1:1,368) were diagnosed. Only one patient required surgical decompression. There were no long-term neurologic sequelae in any patient. In the past 6 yr, the frequency of investigation and diagnosis of epidural abscess has increased. Overall, the combined rate of epidural abscess or hematoma was 1:1,026, (0.1%; 95% confidence interval, 0.04–0.19%) with a need for operative intervention of 1:8,210 (0.01%; 95% confidence interval, 0.0–0.07%).

Conclusions: Spinal hematoma was very rare (< 0.05%). Epidural abscess was also rare (< 0.1%) but remains a potentially serious complication. Early diagnosis, using magnetic resonance imaging in patients with appropriate clinical indicators, before the onset of neurologic signs, enables conservative therapy in many cases and may help to prevent the development of serious neurologic sequelae.

THE occurrence of an epidural abscess or hematoma is a rare but potentially serious complication of epidural catheterization, although their true incidence is difficult to quantify. Rates quoted in the literature vary enormously^{1–7} and are often difficult to apply to a general surgical population. Reasons for this variability include the population studied, the data collection methods and assumptions made, the duration of catheterization, differences in clinical practice, and the need for large numbers to quantify a rare event.

Published series have often included obstetric epidurals, chronic pain patients, and/or single-shot spinal and epidural procedures.¹ These data may not be generalizable to postoperative acute pain management with continuous epidural catheterization for a period of days. Phillips *et al.*⁴ reported a rate of epidural abscess for acute pain, not

including obstetric patients, of 0.125% (three in 2,401 patients over 5 yr). There were no obstetric epidural abscesses, so the combined rate including obstetric patients was more favorable, at 0.04% (three in 7,401 patients). The incidence of epidural abscesses is almost certainly most favorable for obstetric applications and least favorable for chronic pain applications,⁴ with the rates for postoperative acute pain patients being intermediate between the two. This most likely relates to the duration for which the catheter is left *in situ* and the underlying medical condition of the patient. Many of the published reports on this topic neglect to adequately specify the nature of the population studied.^{2,5,7}

Data collection methodology affects both the reliability and accuracy of the data. A prospective audit is likely to capture events more reliably than a retrospective chart review. Some studies quote the incidence of serious complications per number of epidurals performed; others quote per hospital admissions. Sometimes, complications are discussed without any reference to a denominator.² One of the largest series reported to date was by Wang *et al.*⁷ Although impressive by the sheer size of the investigation (an estimated 17,372 epidurals), the data collection methods vary from computerized registration of epidural anesthetics in some departments to assessment of stock used with allowances for wastage in others. For a rare event, large patient numbers need to be gathered, but to accurately identify the incidence, the denominator also needs to be described with equal accuracy. This has been a limitation in most other published series.

True variation in the rate of complications will also exist between hospitals or countries. There could be many reasons for this, such as differences in sterile techniques or practices, patient factors, and the duration for which catheters are left *in situ*. For example, the "hospital protocol" described by Royakkers *et al.*⁵ includes wearing a surgical cap, facemask, and sterile gloves but makes no mention of the presence or absence of a sterile gown.

The acute pain service (APS) at our institution has been collecting detailed data on all patients managed since its inception in 1990. This prospective clinical review was undertaken because it would enable analysis of long-term morbidity data with an accurate denominator in a single large tertiary teaching institution.

Materials and Methods

This project was conducted as a Quality Improvement initiative and as such did not require specific approval

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from the St. Vincent's Hospital Human Research and Ethics Committee (St. Vincent's Hospital, Melbourne, Victoria, Australia). The St. Vincent's Hospital APS database is a set of prospectively gathered data on all patients who have been under the care of the APS since it began in 1990. Each patient on the APS had a tracking sheet initiated by the anesthesiologist inserting the epidural catheter, immediately postinsertion, at the same time that the epidural drug infusion was prescribed. The tracking sheet contained baseline information regarding the procedure and details of the epidural placement. It also recorded daily information regarding pain scores, motor blockade, the presence of defined adverse events (nausea, pruritus, site infection), and free-text notes. On the rare occasions that the APS tracking sheets were not initiated or were misplaced, the pain service was notified, and a tracking sheet commenced when the APS registrar was called for epidural orders or with requests for epidural removal. After patient discharge from the hospital, these data were entered into a computerized database (including free-text comments). Any patient returning to the hospital with a problem related to APS care had appropriate additional comments added to their record by consultant anesthesiologists, registrars, or, from 2002, the APS nurse. A search of this database was performed for cases of serious or suspected neuraxial epidural morbidity, namely epidural abscesses and hematomas. Precoded fields included *insertion site infection* (defined as two or more of purulence, erythema, or tender swelling at the site), *pyrexia* (temperature of greater than 38.5°C for more than 6 h), *excess motor blockade*, and *abnormal termination of infusion* (i.e., earlier than planned). Free text comments fields were searched with key terms, including *abscess*, *hematoma*, *scan*, *magnetic resonance imaging (MRI)*, *computerized tomography (CT)*, *back pain*, *weakness*, *paralysis*, *bladder*, *inflammation*, *pus*, *purulent*, *antibiotics*, and *coagulation*. Records of patients identified in this manner were retrieved and reviewed. In addition, the original APS paper tracking sheets were all accessed. Cases of nonneuraxial epidural morbidity, such as pruritus, hypotension, nausea, and vomiting, were not considered further, and an early subset of this data has been published elsewhere.⁸ Our data were cross-checked against the hospital's diagnostic group and costing database, which is completed by medical records staff after discharge. A detailed hospital medical records-based coding search was performed for *epidural hemorrhage* and *intracranial and intraspinal abscess*, which are both specifically coded diagnoses, from January 1990 to December 2005.

Determination of the "denominator" (i.e., the total number of epidural catheters inserted and run on the wards postoperatively) was also possible from the APS database, and thus a precise complication rate was determined. Note that the database did not include single-

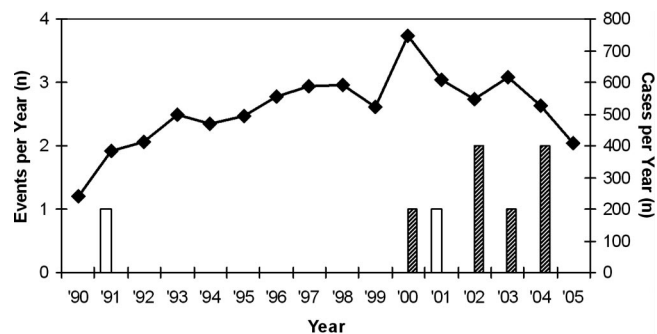


Fig. 1. Annual postoperative epidural infusion caseload (right axis, line graph) and neuraxial event frequency (left axis)—spinal hematoma (unshaded columns) and epidural abscess (shaded columns).

shot epidurals, epidurals where a catheter was inserted and removed in the operating suite (e.g., failed block, epidural anesthesia only), or other neuraxial blockade (e.g., spinals).

Statistics

Data were retrieved from a computerized database (Microsoft Access; Microsoft Corporation, Redmond, WA). Bivariate categorical data were analyzed using chi-square analysis, Fisher exact test, or logistic regression as appropriate. Ranked ordinal data were reduced to two categories for logistic regression. A *P* value of less than 0.2 was used to accept components in sequential multivariate analysis, and a *P* value of less than 0.05 was considered statistically significant. Odds ratios (ORs) are expressed with 95% confidence intervals (95% CIs). Mean values are expressed as mean \pm SD. Analysis was undertaken using STATA statistical software version 8.0 (Stata Corporation, College Station, TX).

Results

Demographics

Over the 16 yr from February 1990 to the end of December 2005, 8,210 epidural catheters were inserted for post-surgical analgesia at St. Vincent's Hospital and followed up by the APS. The annual caseload is shown in figure 1. The mean duration of infusion was 2.8 ± 1.3 days (mean \pm SD), ranging from less than 1 day to 13 days, with 32 patients having infusions for 7 days or more. The mean age was 59.3 ± 16.6 yr (mean \pm SD), and the most common surgical procedure coded was general abdominal procedures including upper abdominal surgery (31% of all cases). Details of epidural catheter management and surgical categories are shown in table 1.

Radiologic Investigations

During this period, 30 MRIs and 2 CT scans were performed to investigate possible neuraxial complications. From the mid-1990s, MRI scans were used in preference to CT scanning because of the greater fidelity

Table 1. Surgery Types and Epidural Infusion Details

	Abdominothoracic	Cardiac	Colorectal	General Abdominal	Orthopedic	Plastic	Thoracic	Urology	Vascular	Other
Number (%)	34 (0.4)	61 (0.7)	1,090 (13.3)	2,359 (28.7)	1,384 (16.9)	145 (1.8)	999 (12.2)	770 (9.4)	727 (8.9)	641 (7.8)
Duration, mean (SD), days	4.0 (1.0)	2.7 (0.8)	3.0 (1.3)	3.0 (1.3)	2.1 (1.1)	3.1 (1.4)	3.1 (1.3)	2.9 (1.2)	2.1 (1.4)	2.7 (1.4)
Level, median	T7	T1	T10	T8	L3	L3	T7	T10	L3	T9
Site infections, %	5.9	0.0	2.8	3.1	0.5	0.7	3.0	1.6	1.5	1.5
Pyrexia, %	2.9	0.0	4.9	3.5	1.4	6.2	2.6	5.6	2.1	3.1
Fallout, %	12.9	3.6	10.3	11.3	9.2	7.6	12.1	12.8	8.6	7.2
Epidural abscess, n			1	1			2	1	1	
Spinal hematoma, n				1	1					

"Other" includes uncoded and combined procedures.

Level = upper vertebral level of catheter insertion; pyrexia = sustained (> 6 h) episode of temperature > 38.5°C.

in defining intraspinal pathology.⁵ The total number of MRI examinations performed annually in our institution since 1994 is shown in figure 2 along with the numbers ordered by the APS. In 16 cases, epidural abscess was suspected; in 10 cases, the indication was for suspected hematoma; and in 4 cases, the possibility of either was considered. Therefore, imaging for possible abscess occurred in 1:410 epidurals (0.24%), and imaging for possible hematoma occurred in 1:586 epidurals (0.17%). Epidural abscess was confirmed in 6 scans, an epidural hematoma was confirmed in 1 scan, and a subarachnoid hematoma was confirmed in 1 scan (fig. 1 and table 2).

Epidural Abscess

Of the 8,210 patients, 6 were diagnosed with an epidural abscess (1:1,368 or 0.073%; 95% CI, 0.015–0.135%). Five patients were successfully treated with antibiotics alone. One patient required surgical decompression (1:8,210 or 0.01%; 95% CI, 0–0.07%). Clinical signs indicating an MRI/CT scan for possible abscess (n = 20 patients) were evidence of an epidural insertion site infection (12 cases), pyrexia (8 cases), epidural insertion site infection plus pyrexia (7 cases), back pain (4 cases), or neurologic signs (1 case) (table

2). The combination of pyrexia and epidural insertion site infection was present in 5 of the 6 epidural abscess patients (with site tenderness only in the remaining patient). Seven of the 20 MRI scans sought for suspected epidural abscess were from patients with pyrexia and epidural insertion site infection, whereas this combination was present in only 30 patients overall (0.36%).

To ensure that no diagnoses of epidural abscess were missed, we cross-checked our 8,210 APS patients with 171 epidural abscess patients who were identified by the hospital medical records–based search over the same period. These patients were cross-referenced by Unit Record Number and again (separately) by surname with our APS database. This process identified only one possible additional epidural abscess patient; however, on chart review, this coding had been erroneously generated by a note made by the Infectious Diseases registrar, "Impression—Epidural Abscess," before a normal MRI scan and uneventful subsequent follow-up.

Epidural Insertion Site Infection

The vertebral level of catheter insertion was mid to low thoracic (T6–T11) in 87% of patients (median insertion levels are presented in table 1). The incidence of epidural insertion site infection was independently associated with the level of insertion being 2.8% at the thoracic levels (T6–T11) compared with 0.8% at the lumbar (L1–L4) levels ($P < 0.01$, n = 6,266). However, mean duration of catheter insertion was longer for thoracic catheters than lumbar catheters (thoracic, 3.0 ± 1.3 days; lumbar, 2.1 ± 1.2 days; $P < 0.01$), due in large part to the planned use of epidural analgesia for a maximum of 48 h in orthopedic surgical patients. Logistic regression analysis relating epidural insertion site infection (184 cases) to patient age, duration of catheter insertion, spinal level of insertion, and type of surgery (n

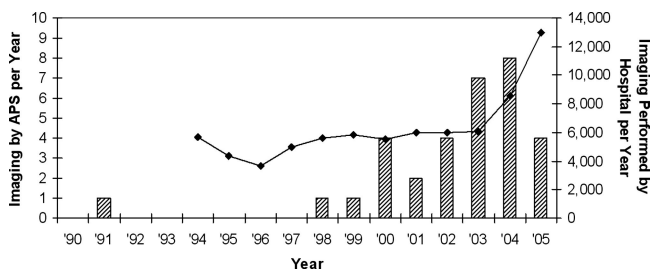


Fig. 2. Annual imaging frequency. Imaging (computed tomography or magnetic resonance imaging scans) ordered by the acute pain service (APS) (left axis, shaded columns). Imaging performed by the hospital (right axis, line graph).

Table 2. Demographic Data, Symptoms, and Treatment of Eight Patients with Epidural Abscess or Hematoma after Epidural Catheter

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8
Year	1991	2000	2001	2002	2002	2003	2004	2004
Age, yr	17	50	31	60	83	66	31	21
Sex	M	M	F	F	F	M	M	M
Hematoma or abscess	Ha	Ab	Ha	Ab	Ab	Ab	Ab	Ab
Immunocompromised	No	Yes, cancer	Yes, cancer	Yes, cancer	Yes, cancer	No	Yes, prednisolone, azathioprine	No
Thromboprophylaxis	No, 1 h after indomethacin	SC heparin 1 h after removal	Removal 1 h after 5,000 U SC dalteparin	SC heparin > 12 h before removal	SC heparin > 12 h before and 8 h after removal	SC heparin > 12 h before removal	SC heparin > 12 h before removal	SC heparin > 12 h before removal
Level of insertion	T9–T10	T6–T7	L2–L3	T7–T8	T10–T11	L4–L5	T8–T9	T7–T8
Epidural drug(s)	0.5% B + Epi	0.2% R + Fent	0.2% R + Fent	0.2% R + Fent	0.2% R + Fent	0.2% R	0.2% R + Fent + Epi	0.2% R + Fent
Catheterization period, days	5	1 + 1,2 epidural catheters	2	2	5	3	4	4
Site purulent	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Fever	No	Yes (38.6°C)	No	Yes (39°C)	Equivocal (37.5°C)	Yes (39°C)	Yes (38.2°C)	Yes (38.5°C)
Back pain	Yes	No	No	No	No	Yes	No	Yes
Lower limb neurologic deficits	Yes	No	No	No	No	No	No	Yes
Surgery needed	No	No	No	No	No	No	No	Yes
Source of positive culture	—	Catheter tip and skin	—	Skin	Skin	Blood	Skin	Blood and surgical specimen
Bacteria	—	Sensitive <i>S. aureus</i>	—	Sensitive <i>S. aureus</i>	Sensitive <i>S. aureus</i>	Sensitive <i>S. aureus</i>	Sensitive <i>S. aureus</i>	MRSA
Duration of oral antibiotics, months	—	7	—	? (Transferred to country hospital)	4	5	6	8
Postoperative neurologic deficits at 2 months	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Ab = abscess; B = bupivacaine; Epi = epinephrine; Fent = fentanyl; Ha = hematoma; MRSA = methicillin-resistant *Staphylococcus aureus*; R = ropivacaine; SC = subcutaneous

= 5,115 for all included categories) was performed. A significant association was identified between epidural insertion site infection and duration of catheterization (in days: OR, 1.4; 95% CI, 1.2–1.6; $P < 0.001$), *i.e.*, for each postoperative day the epidural remained *in situ*, the risk of site infection increased by 40% per day. In addition, general abdominal or thoracic surgery was associated with a greater risk for insertion site infections than orthopedic or vascular surgical procedures (OR, 3.3; 95% CI, 1.7–6.4).

Other Factors

Bupivacaine (0.1%) with fentanyl (0, 2, or 4 $\mu\text{g}/\text{ml}$) was the predominant local anesthetic used for postoperative infusion before 1996. Ropivacaine (0.2%) with fentanyl (0, 2, or 4 $\mu\text{g}/\text{ml}$) has been used almost exclusively since 1996.

There have been two changes in type of skin preparation solution over the 16 yr: aqueous povidone iodine (1990–1993), alcoholic chlorhexidine (1994–2003), and alcoholic iodine (2004–2005). This information along with the annual rate of insertion site infection is shown in figure 3.

Epidural Hematoma

Two spinal hematomas (1:4,105 or 0.024%; 95% CI, 0–0.06%) were diagnosed, although only one of these was a true epidural hematoma (table 2). Neither of these required surgical intervention or resulted in adverse sequelae. The clinical indications for imaging on suspicion of spinal hematoma were unexpectedly prolonged (not resolving over 12 h) leg weakness in 13 cases, one of which also had back and leg pain, and individual cases of leg pain, neck pain, and catheter displacement during full anticoagulation. The number of investigations requested has increased over the past 6 yr of the report

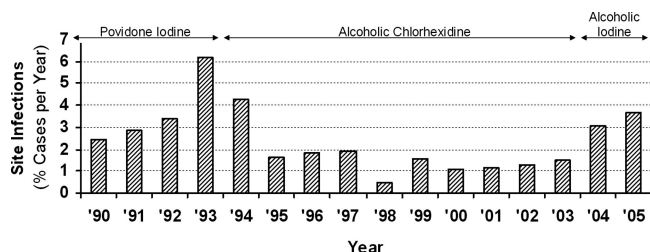


Fig. 3. Annual incidence of epidural insertion site infection showing the skin preparation solution used before epidural insertion.

period. Despite this, no case of epidural hematoma was identified over this time.

Low-molecular-weight heparins were introduced to our institution for thromboprophylaxis in high-risk patients (*e.g.*, orthopedics) in 1992. Since this time, the standard thromboprophylaxis regimen in our institution has been 5,000 U dalteparin once daily, commenced 6–12 h postoperatively.

Of concern is the risk that epidural catheters may become displaced at a time of peak anticoagulant activity. The accidental displacement rate for catheters has remained relatively constant at 9.9% over the 16-yr period. Displacement is more common for thoracic level catheters (T6–T11, 10.9%) than lumbar (L1–L4, 9.8%; $P < 0.01$, Fisher exact test). One patient with subarachnoid bleeding (patient 3) was associated with a catheter removal approximately 1 h after 5,000 U dalteparin subcutaneously.

We cross-checked our 8,210 APS patients with 115 epidural hematoma patients who were identified by the hospital medical records–based search over the same period. These patients were cross-referenced by Unit Record Number and again (separately) by surname with our APS database. There were no additional matches.

Outcomes

The combined risk of serious neuraxial complications (abscess or hematoma) was therefore 1:1,026 or 0.10% (95% CI, 0.04–0.19%). The need for surgical intervention was 1:8,210 (0.01%; 95% CI, 0–0.07%). The decision to manage patients conservatively or surgically was based on the presence and progression of neurologic signs and was made in consultation with specialist neurologic, neurosurgical, and infectious disease clinicians. No patient sustained any permanent neurologic deficit.

Discussion

We found the incidence of major adverse neuraxial events related to epidural catheter use for postoperative analgesia to be approximately 1:1,000. This is consistent with data reported from other large series.^{4,6} The distinguishing aspect of this data is that it was collected entirely prospectively and from a single institution; therefore, data consistency, clinical practices, and true denominator information are known. Epidural abscess was diagnosed in 6 cases (0.07%) after 20 imaging investigations for this possibility, and was associated with epidural insertion site infection and pyrexia. Spinal hematoma was found in 2 cases (0.02%).

The early diagnosis of epidural abscess is important because delay in therapy can lead to permanent neurologic complications. In this series, the combination of epidural insertion site infection and pyrexia ($> 38.5^{\circ}\text{C}$) occurred in 30 cases, 5 of which had an epidural abscess.



Fig. 4. Magnetic resonance imaging scans for case 8. (A) Normal scan taken 2 days before epidural abscess diagnosis. (B) Scan confirming epidural abscess.

The remaining patient with a confirmed epidural abscess had an epidural insertion site infection without pyrexia. A rapid passage to imaging in these cases, aided by early involvement of neurologic, neurosurgical, and infectious disease clinicians, meant that conservative management (4–7 months of antibiotic therapy) was effective in five patients. Imaging for abscess in our series occurred from 5 to 11 days after catheter placement. In the patient requiring surgical management (case 8), clinical suspicion (pyrexia, epidural insertion site infection, back pain) led to an initial MRI, which was reported (and reviewed) as normal (fig. 4A), and the patient was sent home. Two days later (11 days after insertion), this patient represented with neurologic signs. A repeat MRI was performed (fig. 4B), revealing a T1–T9 epidural abscess, which was surgically decompressed. This highlights the importance of continued follow-up, because the progression of epidural abscess to the point of clinical diagnosis typically takes days rather than hours.

Epidural insertion site infection is clearly a factor in epidural abscess formation. We have demonstrated a significant association with duration of insertion (OR, 1.4), as has been observed by others,¹ and upper body procedures (abdominal or thoracic) (OR, 3.3). It should be noted that sterile insertion techniques were used for all epidural catheter insertions over the entire 16 yr. This involved sterile hand scrub, sterile gown, gloves, and mask with skin preparation as noted and sterile draping. The change to alcohol-based skin preparation solutions from 1994 was based on advice from our microbiology department that alcohol-based antiseptics were more effective than aqueous solutions. This has been confirmed in recent investigations.⁹

The absence of diagnosed epidural abscesses, but not epidural hematoma, before the year 2000 may relate to a number of factors. Insertion site infection rates were not dramatically different over this period, and it is more likely that a decreased threshold for clinical concern coupled with the increased accessibility of MRI scans contributed to the increased number of scans performed, and this in turn may have led to an increase in diagnosis of epidural abscess. Although MRI scanning

has been available at our institution since 1991, newer scanners since 1996 have brought increased efficiency, image resolution, and accessibility. Figure 2 demonstrates the steady yearly increase in the number of MRI examinations performed, especially in the past 2 yr. MRI is currently the investigation of choice in cases of suspected epidural abscess or hematoma.^{5,10} To minimize the possibility of having missed even one case of epidural abscess during this time because of the impact that this would have on the overall incidence in this series, we accessed our hospital medical records database. The search we performed retrieved disease-group coding for both epidural abscesses and hematomas from January 1990 to December 2005. We found no missed events from this search.

We consider the possibility that heightened vigilance in response to literature reports in the late 1990s of the relatively high frequency of epidural hematoma and abscess resulted in the detection of epidural space infections that may not have proceeded to neurologically threatening abscesses. The rarity of neurologic symptoms at the time of diagnosis and the response to conservative therapy in our series lends support to this theory. In the early to mid 1990s, epidural insertion site infections were often caused by flucloxacillin-sensitive *Staphylococcus aureus* species, and it is possible that treatment of these site infections may also have inadvertently treated deeper infections that were not investigated by CT or MRI scans at that time. Finally, the infrequency of these events underlines the value of a large series such as is presented here, because a sample over even 5 yr may significantly underestimate or overestimate the overall incidence.

The clinical criteria for which an MRI scan is performed are important, as discussed above. Royakkers *et al.* advocated MRI scans in any patient after epidural who develops back pain with evidence of local and systemic infection, regardless of the presence or absence of neurologic signs.⁵ We would support this principle, but suggest that more selective criteria would be more clinically reasonable. That is, the combination of epidural insertion site infection plus pyrexia would seem to be a sound basis for investigation with an MRI, and the presence of any third factor (including, of course, neurologic changes or back pain) would mandate prompt investigation. Although pyrexia after surgery has a number of causes and these should be investigated, it remains an important clinical sign in conjunction with an insertion site infection. The health economic impact of spinal cord compression from epidural abscess is considerable, and therefore, the use of MRI scanning in

cases where a high index of clinical suspicion exists is justified—this would have resulted in less than two additional scans per year in our series based on the above criteria.

The introduction of low-molecular-weight heparin since 1992 has been identified as a factor in increasing the incidence of postoperative epidural hematoma.¹¹ We identified only one intraspinal hematoma associated with low-molecular-weight heparin in this period, although there has clearly been an increase in diagnostic investigations for problems such as persistent motor blockade on suspicion of neuraxial complications.

In conclusion, over 16 yr and 8,210 cases, we have identified a 1:1,368 incidence of epidural abscess and a 1:4,105 incidence of spinal hematoma. These incidences are consistent with current literature. Epidural abscesses were associated with epidural insertion site infection and pyrexia in all but one case. Catheter site infection was in turn associated with abdominal or thoracic surgery and duration of epidural infusion. There were no long-term neurologic complications in any patient. The low rate of surgical intervention and lack of any long-term sequelae is the distinguishing feature of this series.

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