Anesthesiology
1996; 85:988-98

Clinical and Bacteriologic Survey of Epidural Analgesia in Patients in the Intensive Care Unit

Bruno Darchy, M.D., Xavier Forceville, M.D.,* Eric Bavoux, M.D.,* Frédéric Soriot, M.D.,† Yves Domart, M.D.‡*

Background: **The risk of bacterial contamination related to epidural analgesia in patients cared for in the intensive care unit has not been assessed. Thus the authors studied patients who received care in the intensive care unit who were given epidural analgesia for more than 48 h to determine the rates of local, epidural catheter, and spinal space infection and to identify risk factors.**

Methods: **Each patient receiving epidural analgesia for longer than 48 h was examined daily for local and general signs of infection. A swab sample for culture was taken if there was local discharge; all epidural catheters were cultured on withdrawal. All patients underwent weekly neurologic monitoring for 1 month; those with positive epidural catheter cultures had one spinal magnetic resonance image scan.**

Results: **The 75 patients cared for in the intensive care unit who were studied had been receiving epidural analgesia for a median of 4 days (interquartile range, 3.5 to 5 days). Twenty-seven patients had signs of local inflammation (erythema or local discharge), and nine of these had infections. All the patients who had both local signs also had infection. All nine infections were local (12%), but four patients also had epidural catheter infections (5.3%). No patient with erythema alone or without local signs had a positive epidural catheter culture. No spinal space infection was diagnosed. *Staphylococcus epidermidis* was the most frequently cultured microorganism. Local infection was treated by removing the epidural catheter without any antibiotics. Concomitant infection at other sites (21 of 75 patients, or 28%), antibiotic therapy (64 of 75 patients, or 85%), the duration of epidural analgesia, and the insertion site level of the epidural catheter were not identified as risk factors for epidural analgesia-related infections.**

Conclusions: **The risk of epidural analgesia-related infection in patients in the intensive care unit seems to be low. The presence of two local signs of inflammation is a strong predictor of local and epidural catheter infection. (Key words: Epidural analgesia; ICU; infection; risk factors.)**

*Staff anesthesiologist.

†Resident in anesthesia.

‡Staff microbiologist.

Received from the Service de Réanimation Médicochirurgicale, Centre Hospitalier de Compiègne, Compiègne, France. Submitted for publication January 17, 1996. Accepted for publication June 16, 1996. Presented in part at the 33rd Interscience Conference on Antimicrobial Agents and Chemotherapy, New Orleans, October 17-20, 1993.

Address reprint requests to Dr. Darchy: Service de Réanimation, Centre Hospitalier, 8, rue Henri Adnot, 60200 Compiègne, FRANCE.

EPIDURAL analgesia is an anesthetic technique that has been used widely for several decades in patients having surgery or receiving obstetrical care. This technique is safe for intraoperative or short-term use (less than 24 h) if certain precautions are taken (aseptic insertion technique and sterile infusion mixtures) and contraindications are respected (patients with shock, bacteremia, clotting defects, or receiving anticoagulant therapy).[1,2] However, rare cases of epidural abscess or meningitis have been reported.[3-10] Their exact incidence is unknown but is estimated to be less than 0.01% when used during operation.[11-13] *Staphylococcus aureus* and *Streptococcus* species are the most commonly isolated microorganisms in these infections. Potential sources of contamination include direct inoculation during catheter insertion,[14] contaminated anesthetic solutions or syringes,[15-17] bacterial migration along the catheter tract,[5,18] and hematogenous spread from other infected sites.[18,19]

Epidural analgesia for several days is an effective method of pain relief for patients on surgical wards.[20,21] The risk of infection in this setting is low, with a local infection rate of 0.6 to 1.6% and no spinal space infection for a total of 5,241 patients.[20,21]

Epidural analgesia is also frequently used in patients in intensive care units (ICU), including those having high-risk surgery,[22] chest trauma,[23,24] and pancreatitis.[25] However, although the infectious risk of epidural analgesia on surgical wards has been assessed for thousands of patients, there is no published study on the bacteriological aspects of epidural analgesia for several days in the ICU. The particular infectious risk of patients in the ICU indicates that such data are needed. Thus we began this prospective study to determine the rates of local infection, catheter infection, and spinal space infection, and to identify risk factors associated with these infections in patients in the ICU who were receiving epidural analgesia for more than 48 h.

Materials and Methods

Study Population

This study was conducted in the 15-bed medical-surgical ICU affiliated with the 500-bed General Hospital at

Compiègne, France. All the patients older than 18 y who were admitted to the unit between November 1991 and January 1993 and who required epidural analgesia were eligible, except those with the following contraindications: clotting defects (platelet count < 100,000 per microliter, Ivy-Test > 10 min, prothrombin time ratio > 1.2, activated partial thromboplastin time ratio > 1.2), septic or nonseptic shock (systolic arterial pressure < 80 mmHg or use of vasopressor), and bacteremia. Selection of patients and indications for epidural analgesia were established by the ICU medical staff in the following circumstances: (1) prolongation of epidural analgesia for pulmonary high-risk postoperative patients when it was already started during the intraoperative period (no catheter was inserted in the ICU for this indication); (2) insertion of the epidural catheter in the ICU for patients with chest trauma, pancreatitis, or acute leg ischemia who had acute pain and no contraindications. All patients receiving epidural analgesia for more than 48 h were included. Patients whose epidural catheter or dressing were accidentally removed were excluded (no microbiologic data) from the microbiological survey but were included in the clinical local and neurologic follow-up.

Epidural analgesia was withdrawn for the following reasons: analgesia no longer required, failed block, local discharge (either serous or purulent) at the insertion site, accidental dural puncture or migration of the catheter into an epidural vessel, bacteremia or septic shock occurring during epidural analgesia, or neurologic signs of epidural abscess or meningitis.

Informed consent was obtained from the patients and the study was approved by the Ethics Committee of Compiègne General Hospital.

Procedure for Epidural Catheter Insertion, Dressing, and Removal

A full aseptic procedure was used to insert the epidural catheter: The operator's hands were washed and a mask, sterile gown, and gloves were worn. The puncture site was prepared with a 10% povidone-iodine solution, and surrounding areas were covered with sterile drapes. The epidural space was located using the "loss-of-resistance" technique with either saline solution or air (Tuohy 18-gauge needle). A polyamide (polyvinylchloride and plastic-free) epidural catheter (Perifix, Luer Lock; B. Braun, Melsungen, Germany) was advanced 4 cm into the epidural space to ensure secure placement without subcutaneous tunneling. A dry sterile gauze pad was applied to prevent moisture and was covered with a transparent impermeable dressing (Opsite; Smith and Nephew, Hull, UK) to protect the insertion site, which is close to the perineal area, from possible gross contamination by urine or feces. No antimicrobial prophylaxis was administered specifically for the epidural insertion. The choice of epidural analgesia as the anesthetic technique did not influence the indication of prophylaxis nor the choice of antimicrobial agent *per se*. In patients whose operative procedure justified antimicrobial prophylaxis, antibiotic was administered in the operating room, after the epidural catheter was inserted. The dressing was removed every 24 h, the site was inspected and cleansed with 10% povidone-iodine solution, and a new sterile dressing was applied. Sterile anesthetic mixtures were prepared in an ICU workroom by nurses without glass filter needles. All agents were administered through an antimicrobial filter (401; B. Braun) according to the insertion site level of the catheters: Continuous infusion of 0.25% bupivacaine (3 to 5 ml/h; infusate changed every 12 h) was delivered on the lumbar catheters in the case of pelvic surgery or acute leg ischemia and bolus injection of "preservative-free" morphine chlorhydrate (60 μg/kg in 6 ml 0.9% saline every 18 h) was administered on the thoracic catheters in the case of upper abdominal surgery, thoracic trauma, or pancreatitis to avoid extensive sympathetic blockade. Epidural catheters were removed without prior antiseptic skin preparation by two of us (B.D. or F.S.), keeping the externalized portion and the tip of the catheter upward and away from the skin surface.

Data Collection and Follow-up

The following data were recorded when the epidural catheter was inserted: age, sex, indication, and insertion site of catheter (thoracic or lumbar), leukocyte count, antibiotic therapy (prophylactic or curative) up to 10 days before insertion and at the time of entry, distant foci of nonbacteremic infection, peak fever and lowest arterial blood pressure during the 24 h after insertion, and need for vasopressors or mechanical ventilation. The organ system failure score[26] and the simplified acute physiology score[27] were calculated within 24 h after admission to the ICU as indexes of disease severity. The McCabe score (three classes: fatal during hospitalization, ultimately fatal within 5 y, and not fatal)[28] was used as an index of the severity of the underlying medical condition. The following causes of immunodepression were also recorded: long-term corticosteroid therapy, neoplasia, hematologic malignancy, diabetes, severe chronic alcoholism, and human immunodeficiency virus infection.

Daily evaluations performed until epidural catheter

removal included assessment for general signs of infection (fever, chills, leukocytosis); inflammation at the insertion site (erythema, either serous or purulent local discharge); neurologic signs of spinal space infection as specified below in Definitions; duration of epidural analgesia and mechanical ventilation, and antibiotic therapy (type and duration) during epidural analgesia. Other-site infections were diagnosed according to the usual criteria published for nosocomial infections.[29,30]

All enrolled patients were monitored weekly, including a neurologic work-up by two of the ICU attending physicians (B.D. and F.S.) for 1 month after epidural catheter removal. Dorsolumbar magnetic resonance imaging, with sagittal sections using T_1- and T_2-weighted sequences before and after a gadolinium bolus, was performed 15 to 30 days after the epidural catheter was removed from every patient who had positive results of epidural catheter culture. Any deaths (up to 90 days) were recorded.

Microbiologic Procedures

Insertion Site. When a local discharge was observed, the insertion site was swabbed (Culturette; Becton-Dickinson, Cockeysville, MA) and the epidural catheter was immediately removed and cultured. The swab was smeared onto a 5% horse-blood-agar plate.

Epidural Catheter. After removal, each catheter was cultured quantitatively using a technique adapted from intravascular catheters[31]: The tip (5-cm distal segment) of the catheter was aseptically cut, transported in a sterile tube, and vigorously vortexed for 1 min in 1 ml 0.9% saline; 0.1 ml of this suspension was withdrawn with a calibrated loop and plated onto an agar-coated Petri dish. Two media were inoculated: trypticase soy agar and 5% horse-blood-agar. Plates were incubated at 37°C under aerobic conditions. All colony types were counted at 24, 48, and 72 h and identified by standard methods and criteria.[32]

Definitions

Local inflammation was defined as the occurrence of erythema or local discharge at the insertion site, without positive swab or epidural catheter cultures.

Local infection was defined as a local discharge at the insertion site plus a positive swab culture.

Epidural catheter colonization was defined, in the absence of a standardized definition, as the growth of at least one microorganism on quantitative epidural catheter culture regardless of the colony-forming unit (cfu) count, without local inflammation or spinal space infection.

Epidural catheter infection was defined as the growth of at least one microorganism on quantitative epidural catheter culture regardless of the colony-forming unit count, plus local inflammation or spinal space infection.

Spinal space infection included epidural abscess and septic meningitis.

Epidural abscess was defined as the association of general signs of infection (fever, chills, increased leukocytes), neurologic signs (persistent focal spinal pain, root pain, impaired cord function with increasing motor paralysis, sensory diminution, sphincter abnormalities), and positive findings on magnetic resonance images or epidural catheter culture.

Septic meningitis was defined as the association of general signs of infection, meningeal irritation (severe headache, nuchal rigidity, Kernig or Brudzinski signs), and a positive result of cerebrospinal fluid culture.

Statistical Analysis

The characteristics of the patients are expressed as means ± standard deviation or as the number of patients. Comparisons between patients were made using the Student's *t* test for continuous variables, and chi-squared test with Yate's correction when indicated, or Fisher's exact test for categorical variables. A probability value less than 0.05 was considered statistically significant. Because of the small sample size, the beta inverse distribution was used to calculate the exact confidence limits.[33]

Results

Characteristics of the Study Group

A total of 889 patients were admitted to the ICU during the 15-month study period. The reasons for admission were medical in 560 (63%), postoperative in 204 (23%), and trauma in 125 (14%). Eighty-six patients received epidural analgesia, accounting for 9.7% of the overall population and for 36% of the 240 patients with potential indications for epidural analgesia (postoperative, 204; chest trauma, 17; acute pancreatitis, 16; acute leg ischemia, 3). Five eligible patients were not included because of failed block (one case) and accidental dural puncture or migration of the catheter into an epidural vessel (four cases) before the 48th h. Of the 81 patients included at 48 h, 6 were subsequently excluded because of accidental epidural catheter or dressing removal. Thus the final study group contained 75 patients,

Table 1. Characteristics of the 75 Patients

No. of patients	75
Male/female	41/34
Mean age (yr) ± SD	61 ± 17
Mean SAPS ± SD	10.7 ± 5.8
Mean OSF score ± SD	1 ± 0.89
Patients with fatal (within 5 yr) McCabe score (n)	36
Patients with Immunosuppression (n)	49
Corticosteroid therapy	1
Neoplasia	39
Hematologic malignancy	1
Diabetes	4
Severe alcoholism	9
HIV infection	1
Mechanical ventilation (n)	51
Mean duration of mechanical ventilation (days) ± SD	1.8 ± 1.6

n = number of patients; SAPS = Simplified Acute Physiology Score; OSF = organ system failure.

who are described in table 1. Sixty-four patients were given 65 courses of antibiotic therapy, which are summarized in table 2. Antimicrobial prophylaxis was prescribed according to the antibiotic prophylaxis policies recommended by the Société Française d'Anesthésie et de Réanimation and by the Compiègne Hospital Comité du Médicament, including amoxicillin-clavulanate for abdominal surgery and cefamandole for vascular surgery. Sixty-two patients were admitted to the ICU after a surgical procedure, 59 for an abdominal indication and three for a vascular (aortobiiliac graft) indication.

Characteristics of Epidural Analgesia

Table 3 lists the characteristics of the 75 epidural analgesics given. Catheters for postoperative analgesia

Table 2. Distribution of the 65 Antibiotic Courses (64 Patients)

	Prophylactic (N = 44)	Therapeutic (N = 21)
Amoxicillin-clavulanate	33	10
Piperacillin	1	0
Cefamandole	2	2
Third generation cephalosporin alone or in combination*	7	5
Others†	1	4

* Combination with aminoglycoside and/or metronidazole.

† Including quinolones, cotrimoxazole, vancomycin, and aminoglycosides alone or in association.

Table 3. Characteristics of the 75 Epidural Analgesia Courses

No. of patients	75
EA duration (days) (mean ± SD) [range]	4.4 ± 1.8 [2–14]
EA indications	
Postoperative analgesia	62
Chest trauma	10
Pancreatitis	2
Acute leg ischemia	1
EA insertion site levels	
Thoracic	38
Lumbar	37
Reasons for EA withdrawal	
No longer indicated	61
Local discharge	12
Dural or vascular migration	0
Bacteremia during EA	2
Spinal space infection	0

EA = epidural analgesia.

(62 of 75 patients) were inserted in the operating room just before surgery. Catheters for other indications (13 of 75) were inserted in the ICU using the same aseptic procedure. Figure 1 shows the distribution of epidural analgesia duration. The mean duration was 4.4 ± 1.8 days and the median was 4 days (interquartile range,

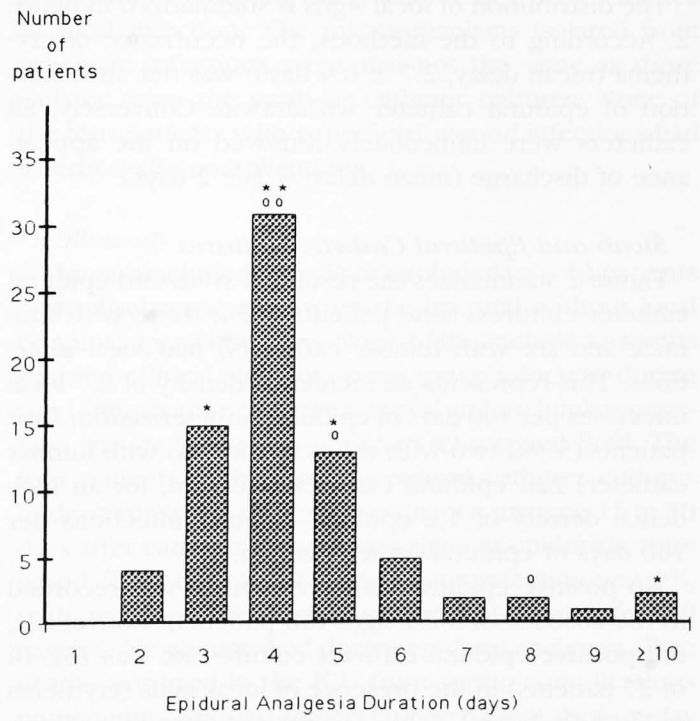

Fig. 1. Distribution of patients according to epidural analgesia duration. * Each symbol represents one patient with a positive swab culture. ○ Each symbol represents one patient with a positive swab and epidural catheter culture.

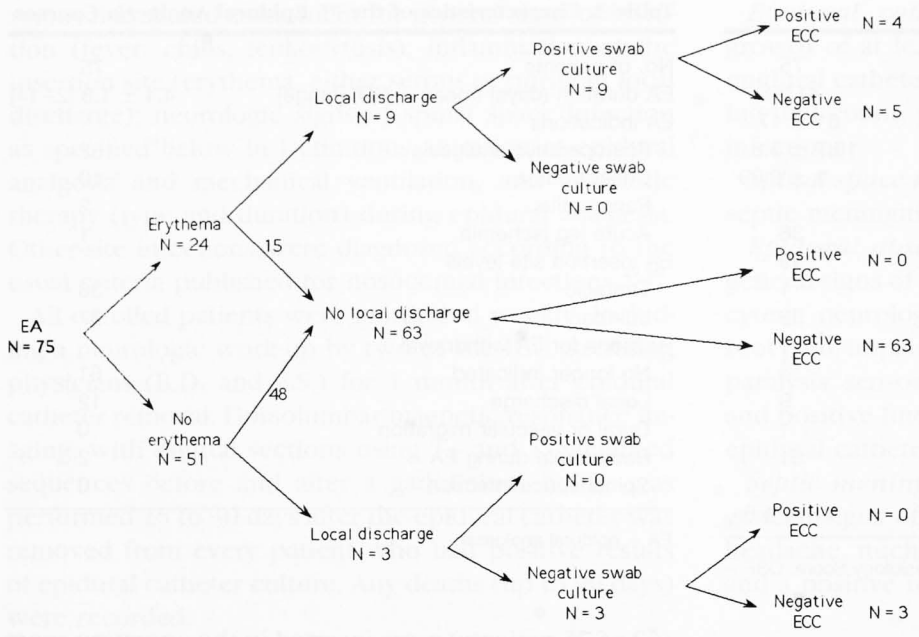

Fig. 2. Distribution of the 75 patients according to local signs and culture results. EA = epidural analgesia; ECC = epidural catheter culture.

3.5 to 5 days), for a total of 330 epidural catheter-days. The mean duration was identical at every insertion site level.

Local Signs

The distribution of local signs is summarized in figure 2. According to the methods, the occurrence of erythema (mean delay, 2.7 ± 0.4 days) was not an indication of epidural catheter withdrawal. Conversely, all catheters were immediately removed on the appearance of discharge (mean delay, 4.2 ± 2 days).

Swab and Epidural Catheter Cultures

Figure 2 summarizes the results of swab and epidural catheter cultures. Nine patients (12%; three with thoracic and six with lumbar catheters) had local infections. This represents an incidence density of 2.7 local infections per 100 days of epidural catheterization. Four patients (5.3%; two with thoracic and two with lumbar catheter) had epidural catheter infection, for an incidence density of 1.2 epidural catheter infections per 100 days of epidural catheterization.

No positive epidural catheter cultures was recorded in the absence of local signs (48 patients). Conversely, the positive epidural catheter culture rate was 15% (4 of 27 patients) in the presence of local signs (erythema or local discharge). Table 4 shows the operating characteristics of local signs when considering the results of epidural catheter culture. The duration of epidural analgesia in the nine patients with positive results of swab or epidural catheter cultures is represented in figure 1. Concomitant antibiotic therapy did not influence the results of swab or epidural catheter cultures: 9 of the 64 patients given antibiotics had positive cultures, whereas none of the 11 patients without antibiotic therapy (NS) did.

Microbiologic Data

Table 5 shows the microbiologic data from swab and epidural catheter cultures. The nine positive swab cultures yielded 12 microorganisms. Three of the nine positive swab cultures were polymicrobial, each of them growing *Staphylococcus epidermidis* plus one other pathogen. The four positive epidural catheter cultures yielded a total of six microorganisms. Two epidural

Table 4. Operating Characteristics of Local Signs for Diagnosis of Positive Epidural Catheter Culture (PECC)

Operating Characteristic (%)	Erythema *versus* PECC	Local Discharge *versus* PECC	Erythema and Local Discharge *versus* PECC
Sensitivity	100	100	100
Specificity	72	89	93
Negative predictive value	100	100	100
Positive predictive value	17	33	44
Overall accuracy	73	89	93

Table 5. Results of Swab and Epidural Catheter Cultures and Susceptibility of the Isolated Microorganisms to the Prescribed Antibiotic Therapy

No. of Patients	Swab Culture	EC Culture (day of removal)	Colony Count (cfu/ml)	Antibiotic Therapy and Duration (days)	Susceptibility
63	No local discharge	Sterile			
3	Sterile	Sterile			
1	*S. epidermidis*	Sterile (D4)		Amox-clav (D1-D2)	S
1	*S. epidermidis*	Sterile (D5)		Ceftriaxone (D1)	S
1	*S. epidermidis*	Sterile (D10)		Netilmicin (D3-D18)	R
				Ciprofloxacin (D3-D18)	
1	*S. epidermidis*	Sterile (D4)		Amox-clav (D1-D10)	S
	E. cloacae				R
1	*P. aeruginosa*	Sterile (D3)		Amox-clav (D1-D2)	R
1	*S. epidermidis*	*S. epidermidis* (D8)	20	Amox-clav (D1-D2)	S
				Norfloxacin (D7-D14)	
1	*S. epidermidis*	*S. epidermidis* (D4)	10^2	Amox-clav (D3-D10)	S
1	*S. epidermidis*	*S. epidermidis* (D4)	10^2	Cefotaxime (D1-D3)	R
	Corynebacterium spp.	*Corynebacterium* spp.	10^3	Metronidazole (D1-D3)	R
1	*S. epidermidis*	*S. epidermidis* (D5)	30	Amox-clav (D1-D2)	R
	E. coli	*E. coli*	10^2		S

EC = epidural catheter; amox-clav = amoxicillin-clavulanate; S = susceptible; R = resistant.

catheter cultures were polymicrobial, each of them growing *S. epidermidis* plus one other pathogen. The number and type of microorganisms recovered from the swab cultures and epidural catheter cultures taken from the four patients who had both were in agreement. The colony counts in epidural catheter cultures were 20 to 10^3 cfu/ml. There was no clinical difference in terms of local signs, general signs, and neurologic follow-up, regardless of the threshold used ($\geq 10^2$ or $\geq 10^3$ cfu/ml). These four patients also had local infections. *S. epidermidis* accounted for two thirds of the isolated microorganisms. Antibiotic therapy was not specifically prescribed for local or epidural catheter infections.

Other-site Infections during Epidural Analgesia

Table 6 shows the 24 other-site infections that occurred in 21 patients during epidural analgesia. Seven patients had intraabdominal infections (without bacteremia or shock) at the time of catheter insertion. Seventeen nosocomial infections occurred during epidural analgesia in 16 patients. Two of the 21 patients had multiple infections: Bacteremic pneumonia due to *S. aureus* and a urinary tract infection due to *Serratia marcescens* later developed in one patient who underwent surgery for complicated sigmoiditis. One other patient, also operated on for sigmoiditis, had a lower respiratory tract infection, but no pathogen was isolated. Neither of the two patients with bacteremia had positive swab or epidural catheter cultures.

Of the 21 patients with other-site infection, four had local infections, whereas five local infections occurred among the other 54 patients (19% *vs.* 9%; chi squared = 0.60). The presence of an other-site infection during the epidural analgesia did not influence the incidence of local infection. The microorganisms isolated from other-site infections were also not the same as those isolated from the swab or catheter cultures. None of the four patients with superficial wound infections had insertion site complications.

Follow-up

The nonincluded (n = 5) or excluded (n = 6) patients were discharged alive from the hospital without local or spinal space infection. None of the included patients showed clinical signs of spinal space infection during the 1 month after catheter removal and no lumbar puncture was performed to obtain cerebrospinal fluid. The four patients with positive epidural catheter cultures underwent spinal magnetic resonance imaging 15 to 30 days after catheter removal; no signs of epiduritis were noted. Thus the rate of spinal space infection was 0%, with an exact 95% confidence interval ranging from 0 to 4.8%. No patient died during epidural analgesia. Two deaths occurred in the ICU from septic complications unrelated to epidural analgesia: one patient died on day 89 with disseminated candidiasis and another on day 60 with multiple-organ failure, peritonitis, and celiotomy. All the other patients were discharged alive from

Table 6. Other-site Infections and Microbiologic Cultures (Swab and Epidural Catheter)

No. of Patients (n = 21)	Other-site Infections (n = 24) (isolated microorganisms)	Local Discharge	Swab Culture	EC Culture
1	Nonbacteremic perforated sigmoiditis (NA)	Yes	*S. epidermidis* *E. cloacae*	Sterile
2	Nonbacteremic perforated sigmoiditis (NA)	No	ND	Sterile
2	Nonbacteremic perforated gastric ulcer (*Enterococcus faecalis* + *Candida albicans:* 1; *E. coli:* 1)	No	ND	Sterile
1	Nonbacteremic perforated sigmoiditis (NA) Presumptive LRTI (NA)	No	ND	Sterile
1	Nonbacteremic perforated sigmoiditis (NA) Bacteremic pneumonia (*S. aureus*) UTI (*S. marcescens*)	No	ND	Sterile
1	Central venous catheter-associated bacteremia (*S. aureus*)	No	ND	Sterile
1	Nonbacteremic pneumonia (*P. aeruginosa*)	Yes	*S. epidermidis*	Sterile
5	Presumptive LRTI (NA)	No	ND	Sterile
1	Presumptive LRTI (NA)	Yes	*S. epidermidis*	*S. epidermidis:* 20 cfu/ml
1	UTI (*E. coli*)	No	ND	Sterile
1	UTI (*E. coli*)	Yes	*S. epidermidis*	*S. epidermidis:* 10^3 cfu/ml
4	Superficial abdominal wound infection (*S. epidermidis:* 1; *C. albicans:* 1; NA: 2)	No	ND	Sterile

NA = not available; ND = not done; UTI = urinary tract infection; LRTI = low respiratory tract infection.

the ICU, but two patients died before being discharged from the hospital, one of end-stage biliary cancer (day 70) and the other of gastrointestinal hemorrhage (day 52).

Comparison of Patients according to Swab and Epidural Catheter Culture Results

The patients were divided into group A (n = 9), patients with positive results of swab and/or epidural catheter cultures; and group B (n = 66), patients with negative swab and epidural catheter cultures (table 7). The two groups did not differ with respect to age, sex, simplified acute physiology score, McCabe score, underlying immunodepression, presence of shock, requirement for antibiotics (prophylactic or curative), leukocyte count and other-site infections during epidural analgesia, epidural catheter parameters (indication, insertion site, duration), and mortality. Group A patients had a slightly higher organ system failure score and were more often febrile or had their lungs mechanically ventilated.

Discussion

Epidural analgesia lasting several days has become an accepted method of postoperative and posttraumatic analgesia because its use may reduce the proportion of patients needing ventilation, the duration of ventilation, and the complications of mechanical ventilation and general sedation.[22] The question arises as to whether these potential benefits are outweighed by the infectious complications of epidural analgesia itself, particularly in the ICU setting, as the risk of nosocomial infection is high in this population. For example, in our ICU, the incidence of nosocomial infection was 11.2 per 100 patients admitted during the study period. The only published data on the infectious risk of epidural analgesia in ICU patients are in a 7-y-old ASA abstract by Stene and colleagues.§ They studied 34 patients sustaining trauma in an ICU who were given epidural analgesia for 1 to 8 days; 56% developed local infection and 18% had positive catheter cultures without spinal space infection. However, no details of the clinical characteristics of patients, local signs, microbiological data, and the other-site infections were given. Our study found that 27 of 75 (36%) patients had local inflammation; the rate of local infection was 12%, epidural catheter infection occurred in 5.3%, and spinal space infection in none of the 75 ICU patients having epidural analgesia

§Stene JK, Simjee S, Jaberi M, Burns B: Lack of infections from long term post-trauma epidural analgesia (abstract). ANESTHESIOLOGY 1989; 71:A747.

Table 7. Comparison of Patients According to the Positivity (Group A) and Negativity (Group B) of Swab and Epidural Catheter Culture Results

Variable	Group A (n = 9)	Group B (n = 66)	*P* Value
Mean age (yr) ± SD	63.8 ± 18.9	60.7 ± 16.2	NS
Male/female	5/4	36/30	NS
Mean SAPS ± SD	13.2 ± 6.4	10.3 ± 5.2	NS
McCabe score			
Fatal or ultimately fatal within 5 yr	5	31	NS
Nonfatal	4	35	
Mean OSF score ± SD	1.6 ± 0.88	1 ± 0.89	0.06
Mechanical ventilation (n)	9	42	0.05*
Mean duration of mechanical ventilation (days) ± SD	2.4 ± 2.45	1.7 ± 1.39	0.10
Immunosuppression factor (n)	7	42	NS
AB up to 10 days before EA (n)	1	5	NS*
AB during EA (n)	9	55	NS*
Other-site infection (n)	4	17	NS*
Bacteremia during EA (n)	0	2	NS*
Core temperature > 38.5°C during EA (n)	7	26	0.07*
WBC > 12,000/ml during EA (n)	4	24	NS
Shock (n)	0	5	NS*
Deaths (3 months of follow-up) (n)	1	3	NS*
Mean EA duration (days) ± SD	5.2 ± 2.28	4.3 ± 1.80	NS
EC insertion site (thoracic/lumbar) (n)	3/6	35/31	NS
EA indications (n)			
Postoperative	7	55	NS*
Chest trauma	1	9	NS*
Pancreatitis	1	1	NS*
Other	0	1	NS*

SAPS = Simplified Acute Physiology Score; OSF = organ system failure; n = number of patients, not number of episodes; AB = antibiotics; EA = epidural analgesia; WBC = white blood cell count; NS = not significant.

* Fisher's exact test.

for more than 48 h. The incidence density of local infection was 2.7 and that of epidural catheter infection was 1.2 per 100 days of epidural catheterization. For comparison, the incidence density of central venous catheter-related bacteremia in our ICU during the same period was 0.5 per 100 days of catheterization.

Our study, including 75 patients, did not have a sufficient power to establish the safety of epidural analgesia in ICU patients regarding the most severe infectious complication of this technique, namely spinal space infection. Fortunately, spinal space infection after epidural analgesia occurs rarely, in fewer than 0.01% of patients when the technique is used for short-term surgical or obstetrical procedures.[11-13] Even if we hypothesize the risk of such a complication to be much greater in patients in the ICU, a study aimed to demonstrate an "acceptable" risk (defined as the upper limit value of 95% confidence interval at a 90% power level) of 1% or 0.1% should have to include, respectively, 550 or 5,500 patients if no more that one spinal space infection was observed. Such a study would be difficult to conduct, even in a multicenter design. Thus we can only establish from our data that the upper risk of spinal space infection in patients in the ICU receiving epidural analgesia for a median of 4 days is 4.8%. In 1993, we introduced patient-controlled analgesia using intravenous morphine as an alternative technique to control acute pain in our ICU (resulting in a 50% decrease of epidural analgesia in our ICU). However, after this study was terminated, we have cared for 101 other patients in the ICU with epidural analgesia prolonged for more than 48 h and we observed no spinal space infections. Although these patients did not undergo the methodologic survey design of the present study, this additional group could suggest that the upper risk of spinal space infection in patients in the ICU receiving epidural analgesia would be less than 2% (95% confidence interval).

The type of dressing used, consisting of a dry gauze covered by a transparent impermeable dressing (Smith and Nephew, Hull, UK), deserves comment. Clearly the presence of a gauze pad implies that the dressing must be removed to inspect the insertion site. On the other

hand, the use of a single transparent impermeable dressing is controversial. Conly and associates,[34] comparing transparent and dry gauze dressings for central venous catheters, have shown that transparent dressing leads to a warm, moist insertion site, with a high microbial burden, and is associated with increased rates of insertion site colonization and catheter-related infections. This finding has been confirmed by several other investigators, and transparent plastic dressings are considered a risk factor for catheter-related infection.[35] At our institution, we use gauze dressings for most central venous catheters, but we cover the gauze pad with OpSite when the insertion site is likely to be contaminated by gross secretions or excreta (femoral access, or internal jugular access in patients whose trachea is intubated *via* an endotracheal or tracheostomy tube). By analogy with the dressing procedure used for central venous catheters, we have chosen this type of dressing for epidural catheters when they are kept in place longer than the intraoperative period.

In the absence of a standardized definition, our definition for epidural catheter infection covered superficial infection involving the insertion site or subcutaneous tissue (local inflammation) as well as deep infection (spinal space infection), both associated with a positive culture of the epidural catheter tip. The bacteriologic design of our study did not include the culture of the subcutaneous 5-cm proximal segment of the catheter. We chose to culture the tip of the epidural catheter, assuming that it would be more relevant to suspect a spinal space infection, and having swab culture of local discharge for more superficial infection. This fact precludes any comparison between the results of tip cultures or swab cultures and the results of cultures of the subcutaneous segment of catheter. This point would be of interest in subsequent studies on this topic.

S. epidermidis was the predominant microorganism found, representing 62% (10 of 16 patients) of the cultured pathogens, and was recovered in all four positive epidural catheter cultures and in eight of nine positive swab cultures. These results are consistent with the microbiological data available for epidural analgesia in ward patients[21,**] and those available for prolonged intrathecal analgesia,[36] where skin flora predominate. These findings contrast with the microorganisms usually involved in most epidural analgesia-related spinal space infections (*S. aureus, Streptococcus* spp., gram-negative rods).[3-10] However, the finding of cultures of *Pseudomonas aeruginosa*, *Escherichia coli*, and *Escherichia cloacae* in our study and *S. aureus* or *Streptococcus* spp. in others[21,34] emphasize the possibility that more virulent microorganisms could occur, easily leading to spinal space infections.

The four patients who had positive epidural catheter cultures also had local infections. We considered these catheters to be infected. However, the absence of any case of spinal space infection in our study precludes any definitive interpretation of the risk of spinal space infection associated with positive epidural catheter cultures. It is impossible to exclude catheter contamination that could have occurred during removal. The insertion site was just swabbed when local discharge existed; no antiseptic solution was applied before the epidural catheter was withdrawn. It is noteworthy that five of the nine epidural catheters removed through a positive culture local discharge remained sterile. Moreover, local antiseptic preparation may not be very effective, because Stene and colleagues found 18% of positive epidural catheter cultures, despite systematic skin disinfection with 70% alcohol.

An additional issue is the result of the bacteriostatic effect of local anesthetics and the number of times the catheter is handled. We did not account for these possible effects when analyzing the bacteriologic results. However, as an indirect argument, the insertion site level had no influence on the swab and catheter culture results (table 7), whereas it was closely linked to the anesthetic agents used. Bupivacaine (0.25%) was continuously infused through lumbar catheters, whereas bolus injections of morphine were administered via the thoracic catheters. This fact also emphasizes the absence of a relationship between the lumbar insertion site level and the potential infectious risk related to the proximity of the perineal area.

We tried to identify patients particularly exposed to spinal space infection. We considered local infection or positive epidural catheter cultures (group A patients) to be high-risk circumstances. The two local signs recorded in our study, erythema and local discharge, were found to be statistically significant predictive parameters. In the absence of local signs (erythema or discharge), no positive epidural catheter cultures was observed (negative predictive value, 100%). Erythema alone was not a risk for catheter colonization. The association of erythema plus local discharge provided the best operating characteristics for diagnosing positive epidural catheter culture, with an overall accuracy of

**Sanchez-Mora D, Mermel LA, Parenteau S, Giorgio C, Towne G: Epidural catheter infection. Poster Session 44, 33rd Interscience Conference on Antimicrobial Agents and Chemotherapy, New Orleans, Louisiana, October 17-20, 1993.

93%. These findings suggest that catheter removal is not necessary if erythema appears alone, particularly as others[21] have attributed the inflammation to catheter movement at the insertion site. Routine culture of the epidural catheter is probably irrelevant without local signs.

The epidural catheter was always removed on the appearance of a local discharge. Regardless of the swab or epidural catheter culture results, no antibiotic therapy was specifically prescribed. Immediate catheter removal was the only therapeutic procedure required in our patients. This is in agreement with the findings of de Leon-Casasola and coworkers[20] in 4,227 ward patients. However, the microorganisms isolated were weak pathogens (*S. epidermidis, Corynebacterium* spp.), and antibiotic therapy may be needed in the case of local infections with *S. aureus*, *Streptococcus* spp., or gram-negative rods.

Our study was designed to identify risk factors for local, epidural catheter, and spinal space infections. Except for local inflammation, most demographic, clinical, biologic, and epidural catheter parameters are not effective. Some clinical parameters (organ system failure score, need for mechanical ventilation, and fever, for example), all indicators of illness severity, tended to be more severe in group A patients (positive swab or epidural catheter cultures), but these findings cannot help to predict infection in a given patient. However, we admit that the sizes of the groups lead to a low statistical power.

In our study, the duration of epidural catheterization did not appear to be a risk factor for local or epidural catheter infections. The four positive epidural catheter cultures and the nine local infections were evenly distributed on both sides of the mean catheterization time (4.4 days). However, there was no positive epidural catheter culture before day 4. These results are similar to those of Scott,[21] who found no correlation between epidural analgesia duration and local infections in 1,014 ward patients receiving analgesia for 1 to 6 days. However, de Leon-Casasola and coworkers[20] found a correlation between duration of epidural catheterization and infection in ward patients. They reported a 0.3% rate of local infection. Their 13 infections all occurred after day 7 (mean analgesia duration, 6.3 ± 2.6 days). The only difference in their methodology that might explain such a discrepancy is the absence of systematic changing and cleaning of catheter dressings.

We used quantitative epidural catheter culture to determine a threshold between colonization and infection. In fact, the absence of epidural catheter colonization or spinal space infection and the small number of positive epidural catheter cultures (n = 4) precludes our drawing any conclusion about the significance of quantitative catheter culture. There was also no correlation between epidural analgesia duration and colony counts. We registered four positive epidural catheter quantitative cultures: the three positive cultures on days 4 and 5 grew $\geq 10^2$ cfu/ml, whereas the positive epidural catheter culture on day 8 grew only 20 cfu/ml. Thus there appears to be no positive correlation between the duration of epidural catheterization and quantitative cultures. Our results differ from those of Bevacqua and associates,[36] who found a correlation between duration of epidural catheterization and epidural catheter cultures. They used the roll-on semiquantitative culture method for 139 intrathecal catheters and divided patients into three groups according to the colony count (sterile, 1 to 10 cfu and > 10 cfu). They observed that the duration of epidural catheterization significantly increased in these groups (55, 83, and 130 hours, respectively). However, because the range of epidural catheter duration in the three groups broadly overlapped, no accurate correlation was established between the colony count and the duration of epidural catheterization. Positive cultures were encountered as early as 24 hours after catheterization. The safety of epidural analgesia in patients having a documented other-site infection at the time of epidural catheter insertion or occurring during the course of epidural analgesia is most important. According to the contraindications of epidural analgesia, patients with bacteremia or shock were not eligible for epidural analgesia. Nonetheless, we started epidural analgesia in seven patients suffering from focal intraabdominal infections (perforated sigmoiditis or gastric ulcers) but without bacteremia or septic shock. In addition, 17 nosocomial infections supervened during epidural analgesia, two of which were bacteremias, for a total of 24 other-site infection in 21 patients. The microorganisms isolated from swab and epidural catheter cultures were always different from those responsible for the other-site infections (table 6). The rates of local infection or epidural catheter infection were not significantly different from those of patients without other-site infections.

We found that the use of epidural analgesia for a median of 4 days in patients in the ICU was associated with a 36% rate of local inflammation and a 12% rate of local infection. These rates are greater than those described with studies of ward patients[20,21] (3.8% and 0.6 to 1.6%, respectively). Nevertheless, none of our patients required surgical debridement or antibiotics.

The presence of two local signs of inflammation, erythema and local discharge, was strongly associated with local or epidural catheter infection. The most frequently cultured microorganism was *S. epidermidis*. Although no spinal space infection occurred in the present study, the upper risk of this serious event, calculated according to our sample size, can be estimated to 4.8% (95% confidence). Quantifying this risk and the possible risk associated with the presence of other-site infections requires other studies including more patients. Meanwhile, it seems wise to recommend a meticulous daily inspection of the insertion site and the removal of epidural catheters if erythema and local discharge are both present.

The authors thank Didier Dreyfuss for a critical review of the manuscript and Owen Parkes for editing the English text.

References

1. Miller RD: Anesthesia. New York, Churchill Livingstone, 1986, pp 1083–4

2. Katz J, Benumof J, Kadis L: Anesthesia and Uncommon Diseases. Philadelphia, WB Saunders, 1981, pp 595–628

3. Usubiaga JE: Neurological complication following epidural anesthesia. Int Anesthesiol Clin 1975; 13:50–6

4. Saadi A: Epidural abscess complicating thoracic epidural analgesia. ANESTHESIOLOGY 1976; 44:244–6

5. Loarie DJ, Fairley HB: Epidural abscess following spinal anesthesia. Anesth Analg 1978; 57:351–3

6. Fine PG, Hare BD, Zahniser JC: Epidural abscess following epidural catheterization in a chronic pain patient: A diagnostic dilemma. ANESTHESIOLOGY 1988; 69:422–4

7. Gelfand MS, Bakhtian BJ: Spinal sepsis due to *Streptococcus milleri:* two cases and review. Rev Infect Dis 1991; 13:559–63

8. Waldman SD: Cervical epidural abscess after cervical epidural nerve block with steroids. Anesth Analg 1991; 72:717–8

9. Klygis LN, Reisberg BE: Spinal epidural abscess caused by group G streptococci. Am J Med 1991; 91:89–90

10. Reynolds PC, Hahn MB: Early diagnosis of a spinal epidural abscess. Reg Anesth 1991; 16:57–8

11. Bonica JJ, Backup PH, Anderson CE: Peridural block-review of 3,697 cases. ANESTHESIOLOGY 1957; 18:337–9

12. Lund PC. Peridural anesthesia—Review of 10,000 cases. Acta Anaesthesiol Scand 1962; 6:143–59

13. Massey Dawkins CJ: An analysis of the complications of extradural and caudal block. Anaesthesia 1969; 24:554–64

14. North JB, Brophy BP: Epidural abscess: A hazard of spinal epidural anaesthesia. Aust N Z J Surg 1979; 49:484–5

15. Barreto RS: Bacteriological culture of indwelling epidural catheters. ANESTHESIOLOGY 1962; 23:643–6

16. James FM, George RH, Naiem H, White GJ: Bacteriological aspects of epidural analgesia. Anesth Analg 1976; 55:187–90

17. Hunt JR, Rigor BM, Collins JR: The potential for contamination of continuous epidural catheters. Anesth Analg 1977; 56:222–5

18. Berman RS, Eisele JH: Bacteremia, spinal anesthesia and development of meningitis. ANESTHESIOLOGY 1978; 48:376–7

19. Backer AS, Ojemann RG, Swartz MN, Richardson EP: Spinal epidural abscess. N Engl J Med 1975; 293:463–8

20. de Leon-Casasola OA, Parker M, Lema MJ, Harrison P, Massey J: Postoperative epidural bupivacaine-morphine therapy. ANESTHESIOLOGY 1994; 81:368–75

21. Scott DA, Beilby DSN, McClymont C: Postoperative analgesia using epidural infusions of fentanyl with bupivacaine. ANESTHESIOLOGY 1995; 53:727–37

22. Yeager MP, Glass DD, Neff RK, Brinck-Johnsen TBJ: Epidural anesthesia and analgesia in high-risk patients. ANESTHESIOLOGY 1987;66:729–36

23. Rankin APN, Comber REH: Management of 50 cases of chest injury with a regimen of epidural bupivacaine and morphine. Anesth Intensive Care 1984; 12:311–4

24. Ulmann DA, Fortune JB, Greenhouse BB, Wimpy RE, Kennedy TM: The treatment of patients with multiple rib fractures using continuous thoracic epidural narcotic infusion. Reg Anesth 1989; 14:43–7

25. Tassonyi E, Kum M, Rosza I, Vimlatti C: Epidural block in pancreatitis. Reg Anesth 1981; 6:8–12

26. Knaus NA, Draper EA, Wagner DP: Prognosis in acute organ system failure. Ann Surg 1985; 202:685–93

27. Le Gall JR, Loirat P, Alperovitch A: A simplified acute physiology score for ICU patients. Crit Care Med 1984; 12:975–7

28. McCabe WR, Jackson GG: Gram-negative bacteremia. Etiology and ecology. Arch Intern Med 1962; 64:847–64

29. Meduri GU, Johanson WG: International consensus: clinical investigation of ventilator-associated pneumonia. Chest 1992; 102(Suppl 1):551s–88s

30. Garner JS, Jarvis WR, Emori TG, Horan TC, Hugues JM: CDC definitions for nosocomial infections. Am J Infect Control 1988; 16:128–40

31. Brun-Buisson C, Abrouck F, Legrand P, Huet Y, Larabi S, Rapin M: Diagnosis of central venous catheter-related sepsis: Critical level of quantitative tip culture. Arch Intern Med 1987; 147:873–7

32. Lennette EH, Balows A, Hausler WJ Jr, Shadomy HJ: Manual of Clinical Microbiology. Washington DC, American Society Microbiology, 1985

33. Daly L: Simple SAS macros for the calculation of exact binomial and Poisson confidence limits. Comput Biol Med 1992; 22:351–61

34. Conly JM, Grieves K, Peters B: A prospective, randomized study comparing transparent and dry gauze dressings for central venous catheters. J Infect Dis 1989; 159:310–9

35. Raad II, Bodey GP: Infectious complications of indwelling vascular catheters. Clin Infect Dis 1992; 15:197–210

36. Bevacqua BK, Slucky AV, Cleary WF: Is postoperative intrathecal catheter use associated with central nervous system infection? ANESTHESIOLOGY 1994; 80:1234–40