**J Neurosurg 111:**306–310, 2009

# Brain abscess caused by multidrug-resistant *Acinetobacter baumannii*

## Case report

**Carlos H. Guinand Vives, M.D.,[1,2] Guillermo A. Monsalve Duarte, M.D.,[1] Sandra Valderrama Beltrán, M.D.,[3] and Johanna Osorio Pinzón, M.D.[3]**

*Departments of [1]Neurosurgery and [3]Infectious Diseases and [2]Universidad Militar Nueva Granada, Hospital Militar Central, Bogotá, D.C., Colombia*

This 24-year-old soldier had a history of polytrauma caused by firearm missiles of a fragmentation weapon. He was referred to the Hospital Militar Central, where multiple shrapnel wounds in the head, face, thorax, and extremities were found. A brain abscess was documented and drained, and a culture grew a multidrug-resistant *Acinetobacter baumannii*. An appropriate antibiotic treatment was started but did not lead to a good response, and the patient died. The clinical course of the illness is presented, as is its treatment and the role of *A baumannii* as an etiological agent of a brain abscess. To the authors' knowledge, there have been no reported cases in the worldwide literature of brain abscess by this infectious agent. *(DOI: 10.3171/2008.10.JNS08918)*

**Key Words** • **brain abscess** • **multidrug-resistant *Acinetobacter baumannii*** • **polymyxin** • **ventriculitis**

*Acinetobacter baumannii* has emerged as a threat to hospitalized patients,[13] especially MDRAB in neurosurgical patients.[1,7,14] There are numerous reports about *A baumannii* meningitis and ventriculitis in the worldwide literature, but a brain abscess caused by an MDRAB has not been reported.[5,14] While conducting a search of the PubMed database (May 18, 2008) without restrictions for the date or language and using both MeSH (["*Acinetobacter baumannii*" {MeSH}] AND ["brain abscess" {MeSH} OR "meningitis" {MeSH}]) and non-MeSH terms ("ventriculitis" and "multidrug-resistant *Acinetobacter baumannii*"), we found no reports of an *A baumannii* or MDRAB brain abscess. Given the paramount importance of this topic in the public health domain and the epidemiology of nosocomial infections,[4,10] we were encouraged to publish the first reported case in the worldwide literature of an MDRAB brain abscess.

### Case Report

*History and Examination*. This 24-year-old male soldier suffered polytrauma caused by fragmentation firearm missiles in combat 15 days before he was referred to the HMC. He initially presented at another institution with severe craniocephalic trauma from a firearm missile, face wounds, thorax trauma, and an open fracture of the right tibia due to fragments of the firearm missiles. A right thoracostomy was performed for hemothorax, as were curettage of the open fracture of the left tibia, suture of the right radial artery, and drainage of the left temporal epidural hematoma and frontoparietal intraparenchymal hematoma. While still in the ICU, focal symptomatic epilepsy was documented and appropriate treatment was started. Two days later a residual temporal epidural hematoma and left frontal subdural hematoma were found and drained via a craniotomy, and a tracheostomy was performed. A culture of the bronchial secretion demonstrated the growth of *Pseudomonas aeruginosa*, which was sensitive to gentamicin, ciprofloxacin, cefepime, cefoperazone, and ceftazidime and resistant to aztreonam. In the blood cultures was Escherichia coli, which was sensitive to ciprofloxacin, gentamicin, ceftazidime, and cefuroxime, and resistant to ampicillin-sulbactam. Because of these microorganisms and their antibiograms, 1 g of cefepime every 8 hours and 1 g of amikacin every day was intravenously administered, with an irregular response to the treatment.

The patient was admitted to the HMC in January 2008 with a bad general condition, hemodynamic stability, spontaneous breathing, and fever (38.7°C). His surgical wounds were in good condition, with the sutured frontal wound and left temporoparietal wound in the process of healing. During a neurological examination the

*Abbreviations used in this paper:* HMC = Hospital Militar Central; ICU = intensive care unit; MDRAB = multidrug-resistant *Acinetobacter baumannii*; MeSH = medical subject heading.

patient was alert, obeying simple orders; his pupils were equally reactive to light; and he had a right hemiparesis graded 2/5. Nonenhanced and enhanced brain CT scans obtained on the 1st admission day showed an extraaxial, noncompressive, epi- and subdural left frontotemporal collections, as well as a hypodense lesion (left parietal) that peripherally enhanced in an inhomogeneous manner with contrast medium (Fig. 1). Clinically, high-flow CSF leakage was found through the left parietal scalp injury, and thus, the patient was scheduled to undergo surgery.

*Operation*. During surgery the osseous borders of the skull defect were cleaned, and the left parietal intraparenchymal collection was drained. A necrotic, yellowish, nonpurulent, and nonfoul-smelling fluid collection of ~ 30 ml was found inside the left parietal collection, as were several osseous fragments, which were removed from the brain parenchyma and from inside the abscess.

*Postoperative Course*. Empiric antibiotic treatment was started: vancomycin, metronidazole, and cefepime. A culture of the collection demonstrated *A baumannii* in the brain and *P aeruginosa* in the skull table (Tables 1 and 2), whereas cultures of the epi- and subdural secretions were negative for bacteria. Given these results, the cefepime scheme was changed to 2 g of intravenous meropenem every 8 hours and 100 mg of intravenous tigecycline on the 1st day of administration and 50 mg every day thereafter. The response to this antibiotic treatment was inadequate, and thus, 750 mg of intravenous levofloxacin every day was added to the therapeutic regimen. The patient continued to experience persistent fever and deterioration in his general and neurological physical condition; therefore, 100,000 UI of polymyxin B sulfate was administered intraventricularly on the 1st day of administration and 50,000 UI/day thereafter with the aim of completing 6 weeks of treatment. Initially, the polymyxin B sulfate was administered through the bone defect in the skull while applying universal measures of asepsis and antisepsis. With the polymyxin B sulfate, the patient showed improvement in his fever and very discrete neurological improvement.

Later, he presented with respiratory deterioration requiring ventilatory support, and a new tracheostomy was done. The Department of Neurosurgery decided to perform a ventriculostomy because of the patient's progressive ventriculomegaly, as evidenced on brain CTs (Fig. 2), and for the polymyxin B sulfate administration. On the 3rd day of the polymyxin B regimen, the patient was afebrile without a systemic inflammatory response. In the 4th week from the HMC admission date at the neurological follow-up, the patient was in a superficial coma, and he presented with marked neurological deterioration, bilateral nonreactive mydriasis, and respiratory arrest; he died on the 13th day of the intraventricular polymyxin B application. He had shown no adverse reactions to or side effects from the administered medications.

## Discussion

*Acinetobacter* species are gram-negative coccobacilli that are oxidase-negative, nonfermentative, nonsporulated, and strictly aerobic, growing on complex media between 20° and 30°C. They are widely distributed in nature—water, soil, and even fruits—and have been isolated in the skin, pharynx, and nostrils of healthy people, including healthcare workers.[1]

The risk factors for acquiring an infection by *A baumannii* are not well understood. Patients can carry the microorganisms for weeks or even months prior to the predisposing event, and the hands of these same patients or assisting personnel or inanimate materials can become carriers of the agent. It has even been isolated from environmental surfaces and surgical elements. Nonetheless, the following risk factors have been identified: male sex, severity of the baseline disease, long stay in the ICU, mechanical ventilation, antimicrobial treatments (especially imipenem, meropenem, and third-generation cephalosporins), surgical procedures with suction and irrigation elements, cardiovascular disease, prior infection by *A baumannii*, cushions, and contaminated oxygen humidifiers.[10,13]

Nowadays, *A baumannii* has increased its incidence as an etiological pathogen of infections such as pneumonias, bacteremias, urinary tract infections, soft-tissue infections, osteomyelitis, and meningitis.[10] There have been multiple reports of infections caused by MDRAB in combat-injured soldiers in Iraq, Afghanistan, South Sudan, Vietnam, and Kuwait,[3,16] where it has been found to produce colonies in ~ 2–17% of soldiers. It is difficult to know the exact origin of the infection in our patient given that he belonged to a military population, he was injured in combat, and he was referred to our institution after 15 days of previous hospitalization; however, he could probably match the infection in any of the healthcare centers where he was initially treated and stabilized. Clinical studies have shown that the isolates of *A baumannii* that produce colonies in healthy soldiers are different from those in infected people.[16] It is important to take into account the settings in which military personnel receive care. Their risk of catching infections caused by multidrug-resistant microorganisms in the units is high, and this reality encourages us to maintain isolation measures in these patients until a review of inpatient cultures can be completed. Moreover, we insist on implementing measures to prevent the transmission of nosocomial infections, such as hand washing, contact isolation, cleaning and disinfecting environmental surfaces and medical instruments, and enforcing the antibiotic control program to prevent the misuse of antibiotics and avoid new multidrug-resistant bugs.[6,10,13] Everyday there are more reports of isolated species of *A baumannii* resistant to almost all available antimicrobial agents, becoming a current public health issue and increasing healthcare costs.[4,10,11] Notably, an important characteristic of *A baumannii* is a predisposition to cause outbreaks, which is related to 3 factors: 1) high antibiotic resistance, 2) resistance to desiccation, and 3) deficiency in cleaning protocols and the training of medical and nursing personnel in the management of potential infectious elements. This last factor is vitally important in the prevention measures promoted by the infection committee in each healthcare institution.[6,14] Our hospital attends a military population; therefore, the in-

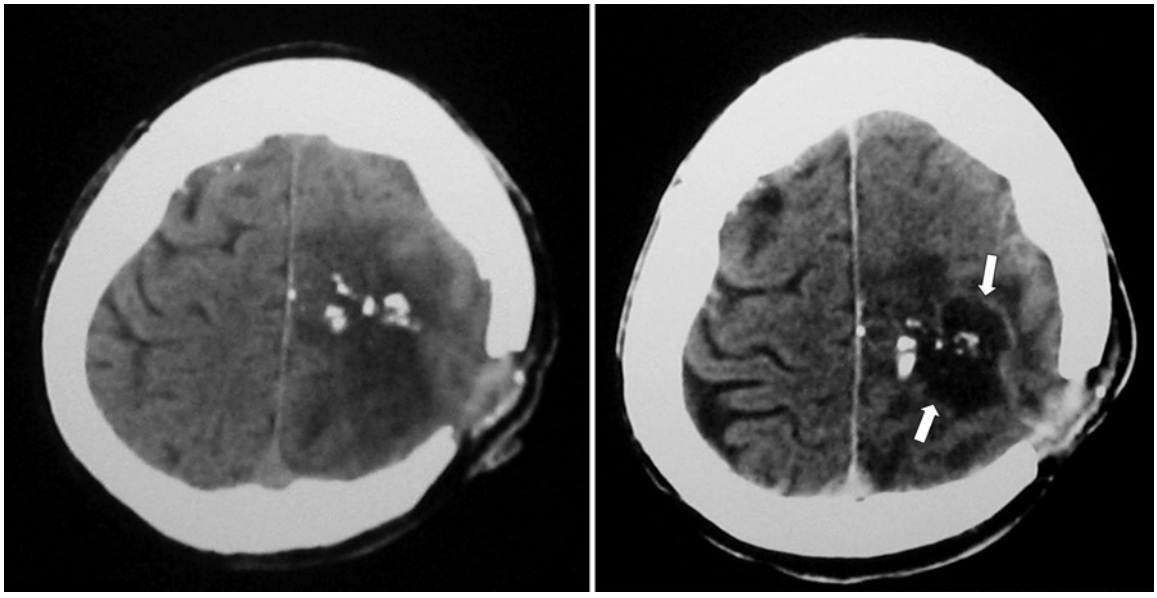

FIG. 1. Nonenhanced *(left)* and enhanced *(right)* brain CT scans obtained in a soft tissue window, showing a left parietal skull defect with left frontoparietal intraparenchymatous osseous fragments and surrounding edema. With the administration of contrast medium, a delimitation of an intraparenchymatous collection with irregular borders was revealed *(white arrows)*, with a homogeneous peripheral enhancement that suggests a brain abscess.

cidence of infection caused by *A baumannii* is expected to be high. Nevertheless, this case is the first reported instance of a neuroinfection by this germ at our institution.

*Acinetobacter* species are currently considered ubiquitous microorganisms but are mostly associated with nosocomial infections (> 90%) and seldom with community acquired infections (4%). The gross mortality rate of patients with infections by *A baumannii* in the ICU is ~ 26–68%. Attributable mortality is difficult to calculate precisely. Recent clinical studies have demonstrated that infection by an MDRAB is an independent factor in death;[8,11] however, there are methodological problems in most of the studies because of a small sample size, the diversity of the studies, and the lack of an adjustment for the risk based on the severity of disease in the patient. Authors of other studies have not shown this relationship, and they consider infection by *A baumannii* as a marker of death but not as an independent factor.[2,17] An interesting topic to consider is the possible multiresistance of *A baumannii* to antibiotics as a death-related factor because of the difficulty of administering an active antibiotic treatment, as suggested by several authors.[4,8,17]

*Acinetobacter baumannii* is a microorganism intrinsically resistant to many antibiotics, and the emergence of resistance during therapy occurs frequently. Carbapenems or ampicillin/sulbactam are the gold standards in the treatment of MDRAB; however, the recent resistance to these antibiotics in the past years have obligated us to use alternatives like colistin and tigecycline for MDRAB in CNS infections, because they share in vitro activity against this agent.[15] Polymyxin B sulfate acts to join the phospholipids of the cell membrane and induce its rupture and thus the death of the bacteria. In a systematic review of the literature, a 91% (10 of 11 episodes) rate of effectiveness of intraventricular or intrathecal polymyxin B sulfate for nosocomial meningitis due to *A baumannii* was found. The most frequent adverse effect was a local meningeal irritation, which was always reversible and appeared to be dependent on the antibiotic dosage.[9] Tigecycline is a glycylcycline that inhibits protein synthesis by joining to the 30s subunit and penetrates to the CSF with noninflamed meninges at a serum concentration of 5.5–52.4%. There have been few case reports of intravenous tigecycline for the treatment of MDRAB meningitis. Polymyxin B sulfate and tigecycline appear to be useful and safe antibiotics in the treatment of MDRAB when there are no other therapeutic options. Note, however, that there is no certainty about what is the best therapeutic option and/or combination, and its application route.[17] For this reason it is important in the near future to provide physicians with more clinical studies in this field so that they have a better understanding of the utility of these antibiotics in treating this disease.[12,19]

Meningitis caused by *Acinetobacter* species are ~ 10% of the gram-negative cases of meningitis and 4% of the nosocomial meningitis cases. Although there are isolated reports of primary meningitis, the usual presentation is secondary meningitis by *A baumannii*, particularly after neurosurgical procedures including drainage of hematomas, ventriculostomies, ventriculoperitoneal shunt placements, lumbar punctures, head trauma, and so forth. Some authors have reported mortality rates of 20–27% for meningitis caused by *A baumannii*. The clinical manifestations of the brain abscess by *A baumannii* in the currently reported case do not differ from those of brain abscesses caused by other pathogens: fever and the pro-

**TABLE 1: Antibiotic sensitivity of *A baumannii* isolated in the left frontoparietal brain abscess***

| Level of Response | | | | | |
|---|---|---|---|---|---|
| Susceptible | | Intermediate | | Resistant | |
| levofloxacin | ≤2 | amikacin | 32 | ampicillin/sulbactam | >16/8 |
| | | ceftazidime | 16 | ampicillin | >16 |
| | | ceftazidime/clavulanic acid | >2 | aztreonam | >16 |
| | | | | cefazolin | >16 |
| | | | | cefepime | >16 |
| | | | | cefotaxime | >32 |
| | | | | cefotaxime/clavulanic acid | >4 |
| | | | | cefotetan | >32 |
| | | | | ceftriaxone | >32 |
| | | | | cefuroxime | >16 |
| | | | | ciprofloxacin | >2 |
| | | | | gentamicin | >8 |
| | | | | imipenem | >8 |
| | | | | meropenem | >8 |
| | | | | moxifloxacin | ≤2 |
| | | | | ticarcillin/clavulanic acid | >64 |
| | | | | tobramycin | >8 |
| | | | | trimethoprim/sulfamethoxazole | >2/38 |

* Values represent the minimum inhibitory concentration expressed in mg/L.

gressive deterioration in consciousness and the patient's general condition.[1,18]

These days, the prognosis for brain abscesses caused by common germs is acceptable—a survival rate of 74%—given the improvement in imaging techniques and new antibiotic treatments.[18] However, the prognosis of an MDRAB brain abscess is not clear, and in fact is probably poor; but it is too early to formulate a hypothesis in this respect. Besides, physicians must not lose sight of the horizon and must avoid the belief that only a single-antibiotic regimen is appropriate to control this type of infection. Patient-care personnel must remember their obligation to involve the administrative institutional committees, infection control committee, and occupational health committee in achieving a decrease in the incidence of infection by this microorganism.[12]

**TABLE 2: Antibiotic sensitivity of *P aeruginosa* isolated in the cranial bone table***

| Susceptible | |
|---|---|
| amikacin | ≤4 |
| aztreonam | ≤8 |
| ceftazidime | 4 |
| ciprofloxacin | ≤1 |
| imipenem | ≤4 |
| meropenem | ≤4 |
| trimethoprim/sulfamethoxazole | >2/38 |

* Values represent the minimum inhibitory concentration expressed in mg/L.

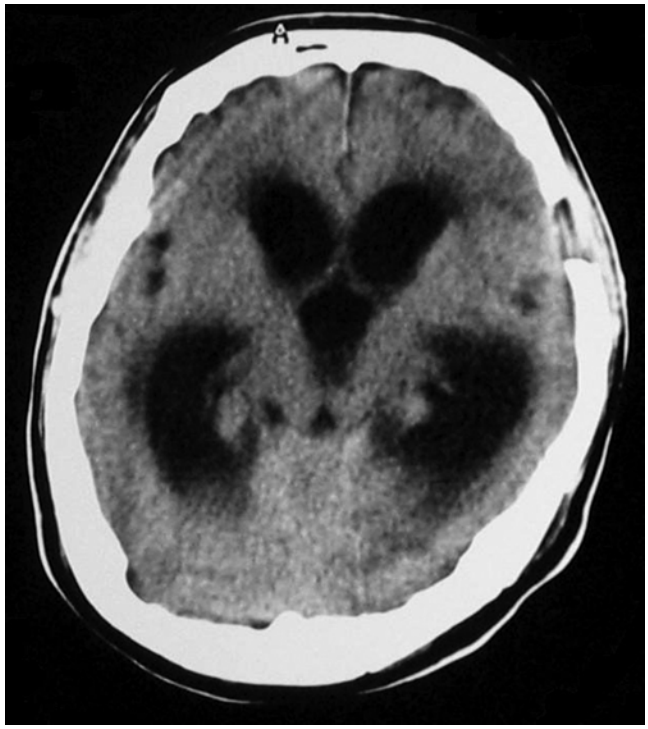

FIG. 2. Nonenhanced brain CT scan obtained in a soft tissue window, displaying supratentorial hydrocephalus with activity signs.

## Conclusions

To our knowledge, we here present the first case report in the worldwide literature of a brain abscess caused by MDRAB. A poorly understood entity with a probable bad prognosis, this disease presents great challenges in its antibiotic management, especially the basic but paramount challenge of a control program for the infection caused by this multidrug-resistant microorganism.

### References


1. Bergogne-Bérézin E, Towner KJ: *Acinetobacter* spp. as nosocomial pathogens: microbiological, clinical, and epidemiological features. **Clin Microbiol Rev 9:**148–165, 1996
2. Blot S, Vandewoude K, Colardyn F: Nosocomial bacteremia involving *Acinetobacter baumannii* in critically ill patients: a matched cohort study. **Intensive Care Med 29:**471–475, 2003
3. Center for Disease Control and Prevention (CDC): *Acinetobacter baumannii* infections among patients at military medical facilities treating injured U.S. Service members, 2002-2004. **MMWR Morb Mortal Wkly Rep 53:**1063–1066, 2004
4. Cosgrove SE: The relationship between antimicrobial resis-

tance and patient outcomes: mortality, length of hospital stay, and health care costs. **Clin Infect Dis 42:**S82–S89, 2006
5. Chen SF, Chang WN, Lu CH, Chuang YC, Tsai HH, Tsai NW, et al: Adult *Acinetobacter* meningitis and its comparison with non-Acinetobacter gram-negative bacterial meningitis. **Acta Neurol Taiwan 14:**131–137, 2005
6. Denton M, Wilcox MH, Parnell P, Green D, Keer V, Hawkey PM, et al: Role of environmental cleaning in controlling an outbreak of *Acinetobacter baumannii* on a neurosurgical care unit. **Intensive Crit Care Nurs 21:**94–98, 2005
7. Diomedi A: [*Acinetobacter baumannii* pandrug-resistant: update in epidemiological and antimicrobial managing issues.] **Rev Chilena Infectol 22:**298–320, 2005 (Span)
8. Falagas ME, Bliziotis IA, Siempos II: Attributable mortality of *Acinetobacter baumannii* infections in critically ill patients: a systematic review of matched cohort and case-control studies. **Crit Care 10:**R48, 2006
9. Falagas ME, Bliziotis IA, Tam VH: Intraventricular or intrathecal use of polymyxins in patients with gram-negative meningitis: a systematic review of the available evidence. **Int J Antimicrob Agents 29:**9–25, 2007
10. Fournier PE, Richet H: The epidemiology and control of *Acinetobacter baumannii* in health care facilities. **Clin Infect Dis 42:**692–699, 2006
11. Lee NY, Lee HC, Ko NY, Chang CM, Shih HI, Wu CJ, et al: Clinical and economic impact of multidrug resistance in nosocomial *Acinetobacter baumannii* bacteremia. **Infect Control Hosp Epidemiol 28:**713–719, 2007
12. Lee CM, Lim HK, Liu CP, Tseng HK: Treatment of pandrug resistant *Acinetobacter baumannii*. **Scand J Infect Dis 37:**195–199, 2005
13. Maragakis LL, Perl TM: *Acinetobacter baumannii*: epidemiology, antimicrobial resistance, and treatment options. **Clin Infect Dis 46:**1254–1263, 2008
14. Metan G, Alp E, Aygen B, Sumerkan B: Carbapenem-resistant Acinetobacter baumannii: an emerging threat for patients with post-neurosurgical meningitis. **Int J Antimicrob Agents 29:**112–116, 2007
15. Rodríguez Guardado A, Blanco A, Asensi V, Pérez F, Rial JC, Pintado V, et al: Multidrug-resistant Acinetobacter meningitis in neurosurgical patients with intraventricular catheters: assessment of different treatments. **J Antimicrob Chemother 61:**908–913, 2008
16. Scott P, Deye G, Srinivasan A, Murray C, Moran K, Hulten E, et al: An outbreak of multidrug-resistant *Acinetobacter baumannii-calcoaceticus* complex infection in the US military health care system associated with military operations in Iraq. **Clin Infect Dis 44:**1577–1584, 2007
17. Sunenshine RH, Wright MO, Maragakis LL, Harris AD, Song X, Hebden J, et al: Multidrug-resistant *Acinetobacter* infection mortality rate and length of hospitalization. **Emerg Infect Dis 13:**97–103, 2007
18. Tseng JH, Tseng MY: Brain Abscess in 142 patients: factors influencing outcome and mortality. **Surg Neurol 65:**557–562, 2006
19. Wadi JA, Al Rub MA: Multidrug resistant Acinetobacter nosocomial meningitis treated successfully with parenteral tigecycline. **Ann Saudi Med 27:**456–458, 2007

---

Manuscript submitted July 21, 2008.
Accepted October 3, 2008.
Please include this information when citing this paper: published online December 5, 2008; DOI: 10.3171/2008.10.JNS08918.

*Address correspondence to:* Guillermo Monsalve, M.D., Servicio de neurocirugía, séptimo piso norte, Hospital Militar Central, Transversal 3 N° 49-00, Bogotá, D.C., Colombia. email: gamonsalve@gmail.com.