

## Antimicrobial Susceptibility of *Acinetobacter* Species

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The *in vitro* activities of 16 antimicrobial agents against 180 *Acinetobacter* strains isolated from blood cultures ( $n = 162$ ), central venous catheters ( $n = 11$ ), and cerebrospinal fluids ( $n = 7$ ) were studied. MICs were determined by a microtiter broth dilution method. Considerable differences in antimicrobial drug susceptibility against strains belonging to different species could be demonstrated. *Acinetobacter baumannii* isolates ( $n = 108$ ) were generally more resistant than isolates identified as species other than *A. baumannii*. Multidrug resistance was common among *A. baumannii* isolates. Of the antimicrobial agents tested, imipenem was highly active against all *A. baumannii* isolates, and the other agents tested were only moderately active or inactive. Good activity against *Acinetobacter* species strain 3 was demonstrated for imipenem, amikacin, and ciprofloxacin. Most of the strains belonging to other species were susceptible to imipenem, ciprofloxacin, expanded-spectrum cephalosporins, amoxicillin-clavulanate, and the aminoglycosides but were resistant to ampicillin and older cephalosporins.

*Acinetobacter* species are opportunistic pathogens of low virulence. Their contribution to nosocomial infection, however, has been increasing over the past 30 years (3, 5, 17). Though widely prevalent in nature (2) and generally regarded as commensals of human skin and respiratory and genitourinary tracts (1, 9), they have been implicated as the cause of serious infectious diseases such as meningitis, pneumonia, tracheobronchitis, endocarditis, wound infections, and septicemia, mostly involving patients with impaired host defenses (5). Several outbreaks of hospital infection have been described, many of them due to contamination of hospital equipment and the hands of personnel. Treatment of serious infections due to *Acinetobacter* spp. is complicated by the widespread multidrug resistance of the organism (4, 10, 13, 21).

Until recently, the genus *Acinetobacter* contained the single species *Acinetobacter calcoaceticus* subdivided into the two subspecies or biovars *A. calcoaceticus* subsp. *anitratus* and *A. calcoaceticus* subsp. *lwoffii*. *A. calcoaceticus* subsp. *anitratus* was frequently reported to be much more resistant to antibiotics than *A. calcoaceticus* subsp. *lwoffii* (4, 5, 11, 18).

In 1986, the taxonomy of the genus *Acinetobacter* was changed extensively by Bouvet and Grimont, who outlined 12 different species by DNA-DNA-hybridization, including the named species *A. baumannii*, *A. calcoaceticus*, *A. haemolyticus*, *A. johnsonii*, *A. junii*, and *A. lwoffii* and six unnamed genomic species (6). Most *A. baumannii* strains and all *Acinetobacter* species strains 3 and 10 strains represent organisms that were formerly classified as *A. anitratus*, whereas all *A. junii*, *A. lwoffii*, and *Acinetobacter* species strain 11 strains were formerly classified as *A. lwoffii*.

Most studies reporting data on antimicrobial drug susceptibilities of *Acinetobacter* spp. were not based on this new taxonomy (4, 11, 18, 21). We therefore decided to study the *in vitro* activities of several antimicrobial agents against 180 *Acinetobacter* strains belonging to different species.

### MATERIALS AND METHODS

**Bacterial strains.** All strains were collected at our institution over a period of 18 months from different patients in 11 hospitals, with more than 30 different departments being involved. Isolates were stored in glycerol broth at  $-70^{\circ}\text{C}$ . Only strains from relevant clinical sources were included in this work. A total of 162 strains were isolated from blood cultures, 11 were isolated from central venous catheters, and 7 were isolated from cerebrospinal fluid. All strains were identified by carbon source utilization tests according to the simplified identification scheme of Bouvet and Grimont (7). Of these strains, 108 were identified as *A. baumannii*, and 72 could be assigned to other species. Seventeen strains represented *Acinetobacter* species strain 3, 16 were *A. johnsonii*, 15 were *A. lwoffii*, 6 were *A. junii*, 5 were *Acinetobacter* species strain 10, 3 were *Acinetobacter* species strain 12, 3 were *A. haemolyticus*, 2 were *Acinetobacter* species strain 6, and 5 could not be classified. Biotyping was performed on all strains identified as *A. baumannii* as described by Bouvet and Grimont (7). The origins of strains and distributions of species are shown in Table 1.

TABLE 1. Origins of *Acinetobacter* isolates and distributions of species

| Species                                 | No. of isolates |                         |                     | Total |
|---|-----------------|-------------------------|---------------------|-------|
|   | Blood culture   | Central venous catheter | Cerebrospinal fluid |       |
| <i>A. baumannii</i>                     | 95              | 10                      | 3                   | 108   |
| <i>A. haemolyticus</i>                  | 3               |                         |                     | 3     |
| <i>A. johnsonii</i>                     | 16              |                         |                     | 16    |
| <i>A. junii</i>                         | 6               |                         |                     | 6     |
| <i>A. lwoffii</i>                       | 14              |                         | 1                   | 15    |
| <i>Acinetobacter</i> species strain 3   | 15              |                         | 2                   | 17    |
| <i>Acinetobacter</i> species strain 6   | 2               |                         |                     | 2     |
| <i>Acinetobacter</i> species strain 10  | 5               |                         |                     | 5     |
| <i>Acinetobacter</i> species strain 12  | 3               |                         |                     | 3     |
| <i>Acinetobacter</i> strains, ungrouped | 3               | 1                       | 1                   | 5     |
| Total                                   | 162             | 11                      | 7                   | 180   |

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TABLE 2. In vitro activities of 16 antimicrobial agents against 180 isolates of different *Acinetobacter* species

| Species                                 | n                 | MIC <sup>a</sup> | Ampi-cillin | Mezlo-cillin | Pipera-cillin | Aug-mentin | Cefa-zolin | Cefox-itin | Cefu-roxime | Cefotax-ime | Cefta-zidime | Ceftri-axone | Aztreo-nam | Imi-penem | Amika-cin | Genta-micin | Tobra-mycin | Cipro-floxacin |
|---|-------------------|------------------|-------------|--------------|---------------|------------|------------|------------|-------------|-------------|--------------|--------------|------------|-----------|-----------|-------------|-------------|----------------|
| <i>A. baumannii</i> biotype 9           | 95 Range          | 8->64            | ≤4->256     | ≤4->256      | 2-32          | >64->64    | 32->64     | 8->64      | 2-64        | ≤1->64      | 2-64         | 4->64        | ≤0.5-2     | ≤4->128   | ≤1->32    | ≤1->32      | ≤0.25->8    |                |
|   | MIC <sub>50</sub> | 16               | 16          | 8            | 4             | >64        | >64        | 32         | 8           | 4           | 8            | 8            | 16         | ≤0.5      | 32        | >32         | 16          | >8             |
| <i>A. baumannii</i> biotype 6           | 13 Range          | 8->64            | 16->256     | 8->256       | 4-16          | >64->64    | 32->64     | 16->64     | 4->128      | 2-16        | 4->128       | 4->128       | 8-32       | ≤0.5-1    | ≤4->128   | ≤1->32      | ≤1->32      | ≤0.25->8       |
|   | MIC <sub>50</sub> | >64              | >256        | >256         | 8             | >64        | >64        | >64        | >128        | 16          | 32           | 64           | >64        | ≤0.5      | 64        | >32         | >32         | >8             |
| <i>A. haemolyticus</i>                  | 3 Range           | 2-32             | 16-32       | 8-16         | ≤1-2          | >64->64    | 16-16      | 8-16       | 4-4         | 2-4         | ≤1-4         | 2-8          | ≤0.5-≤0.5  | ≤4-32     | ≤1-2      | ≤1-16       | ≤0.25-0.5   |                |
|   | MIC <sub>50</sub> | 8                | 32          | 16           | ≤1            | >64        | 16         | 8          | 4           | 2           | 2            | 2            | 4          | ≤0.5      | 16        | 2           | 8           | ≤0.25          |
| <i>A. johnsonii</i>                     | 16 Range          | ≤1->64           | ≤4->256     | ≤4->256      | ≤1-8          | 16->64     | 4->64      | 2->64      | ≤1->128     | ≤1->64      | ≤1->128      | ≤1->128      | ≤1-32      | ≤0.5-1    | ≤4-≤4     | ≤1->32      | ≤1->32      | ≤0.25-4        |
|   | MIC <sub>50</sub> | ≤1               | 32          | 16           | 4             | >64        | >64        | 16         | 4           | 4           | 4            | 16           | 4          | ≤0.5      | ≤4        | 4           | 2           | ≤0.25          |
| <i>A. junii</i>                         | 6 Range           | ≤1-4             | ≤4-16       | ≤4-8         | ≤1-2          | 16->64     | 2-8        | ≤1-8       | ≤1-4        | ≤1-2        | ≤1-2         | ≤1-4         | ≤1-4       | ≤0.5-≤0.5 | ≤4->128   | ≤1-≤1       | ≤1-≤1       | ≤0.25-≤0.25    |
|   | MIC <sub>50</sub> | 2                | 16          | 8            | 2             | >64        | 4          | 4          | 2           | 2           | 2            | 2            | 2          | ≤0.5      | >128      | ≤1          | ≤1          | ≤0.25          |
| <i>A. lwoffi</i>                        | 15 Range          | ≤1-4             | ≤4-128      | ≤4-128       | ≤1-2          | ≤1->64     | ≤1->64     | 2->64      | ≤1->128     | ≤1->64      | ≤1->64       | ≤1->128      | ≤1->64     | ≤0.5-≤0.5 | ≤4-8      | ≤1-4        | ≤1-2        | ≤0.25-≤0.25    |
|   | MIC <sub>50</sub> | ≤1               | 8           | 8            | ≤1            | >64        | 16         | 4          | 4           | 2           | 2            | 8            | 8          | ≤0.5      | ≤4        | ≤1          | ≤1          | ≤0.25          |
| <i>Acinetobacter</i> species strain 3   | 17 Range          | 4-32             | 16-64       | 8-32         | 2-8           | >64->64    | >64->64    | 16->64     | 8-16        | 2-8         | 2-8          | 4-16         | 8-32       | ≤0.5-≤0.5 | ≤4-32     | ≤1->32      | ≤1-8        | ≤0.25->8       |
|   | MIC <sub>50</sub> | 16               | 32          | 16           | 4             | >64        | >64        | 32         | 8           | 16          | 4            | 8            | 16         | ≤0.5      | ≤4        | ≤1          | ≤1          | ≤0.25          |
| <i>Acinetobacter</i> species strain 6   | 2 Range           | ≤1-4             | ≤4-8        | ≤4-≤4        | ≤1-≤1         | 16->64     | 2-8        | 2-8        | ≤1-4        | ≤1-2        | ≤1-2         | ≤1-4         | 2-4        | ≤0.5-≤0.5 | ≤4-≤4     | ≤1-≤1       | ≤1-≤1       | ≤0.25-≤0.25    |
|   | MIC <sub>50</sub> | 4                | 8           | ≤4           | ≤1            | >64        | 8          | 8          | 4           | 2           | 2            | 4            | 4          | ≤0.5      | ≤4        | ≤1          | ≤1          | ≤0.25          |
| <i>Acinetobacter</i> species strain 10  | 5 Range           | 16->64           | 16-128      | 8-128        | 4-16          | >64->64    | 32->64     | 16-32      | 4-8         | 4-8         | 4-8          | 4-4          | 16-32      | ≤0.5-4    | ≤4-32     | 4->32       | ≤1-16       | ≤0.25-≤0.25    |
|   | MIC <sub>50</sub> | ≤1               | ≤4          | ≤4           | ≤1            | >64        | 2          | 2          | 4           | 4           | 4            | 4            | 2          | ≤0.5      | ≤4        | ≤1          | ≤1          | ≤0.25          |
| <i>Acinetobacter</i> species strain 12  | 3 Range           | ≤1-2             | 8-16        | 8-8          | ≤1-≤1         | >64->64    | 8-16       | 4-8        | ≤1-4        | ≤1-2        | ≤1-4         | ≤1-4         | 8-16       | ≤0.5-≤0.5 | ≤4-≤4     | ≤1-≤1       | ≤1-≤1       | ≤0.25-0.5      |
|   | MIC <sub>50</sub> | 32               | 32          | 128          | 16            | >64        | >64        | 32         | 8           | 8           | 8            | 4            | 32         | ≤0.5      | 32        | >32         | 16          | ≤0.25          |
| <i>Acinetobacter</i> strains, ungrouped | 5 Range           | ≤1->64           | ≤4->256     | ≤4->256      | ≤1-16         | 16->64     | 4-32       | 2-16       | ≤1-4        | ≤1-4        | ≤1-4         | ≤1-4         | 2-16       | ≤0.5-8    | ≤4-32     | ≤1-16       | ≤1-16       | ≤0.25-≤0.25    |
|   | MIC <sub>50</sub> | 2                | 16          | 8            | ≤1            | >64        | 8          | 4          | 2           | 2           | 2            | 4            | 8          | ≤0.5      | ≤4        | ≤1          | ≤1          | ≤0.25          |
| MIC <sub>90</sub>                       | ≤1                | 8                | ≤4          | ≤4           | ≤1            | >64        | 16         | 4          | 2           | 2           | 2            | 4            | 4          | ≤0.5      | ≤4        | ≤1          | ≤1          | ≤0.25          |
|   | >64               | >256             | >256        | >256         | 16            | >64        | 32         | 16         | 4           | 4           | 4            | 4            | 16         | 8         | 32        | 16          | 16          | ≤0.25          |

<sup>a</sup> MIC<sub>50</sub> and MIC<sub>90</sub>, MICs for 50 and 90% of isolates tested, respectively.

TABLE 3. Percentage of isolates fully susceptible at NCCLS breakpoints<sup>a</sup>

| Species                                 | n  | % of isolates fully susceptible to: |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|---|----|-------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|   |    | AMP                                 | MZ  | PIP | AUG | CFZ | FOX | CRM | CFT | CAZ | CAX | AZT | IPM | AMK | GM  | TOB | CP  |
| <i>A. baumannii</i> biotype 9           | 95 | 9                                   | 63  | 64  | 91  | 0   | 0   | 1   | 68  | 68  | 68  | 46  | 100 | 36  | 2   | 2   | 6   |
| <i>A. baumannii</i> biotype 6           | 13 | 8                                   | 69  | 77  | 92  | 0   | 0   | 0   | 85  | 85  | 85  | 46  | 100 | 85  | 77  | 92  | 92  |
| <i>A. haemolyticus</i>                  | 3  | 67                                  | 33  | 100 | 100 | 0   | 0   | 67  | 100 | 100 | 100 | 100 | 100 | 67  | 100 | 33  | 100 |
| <i>A. johnsonii</i>                     | 16 | 94                                  | 38  | 63  | 100 | 0   | 13  | 44  | 69  | 81  | 81  | 81  | 100 | 100 | 94  | 94  | 94  |
| <i>A. junii</i>                         | 6  | 100                                 | 100 | 100 | 100 | 0   | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 83  | 100 | 100 | 100 |
| <i>A. lwoffii</i>                       | 15 | 100                                 | 80  | 87  | 100 | 7   | 40  | 67  | 93  | 93  | 93  | 60  | 100 | 100 | 100 | 100 | 100 |
| <i>Acinetobacter</i> species strain 3   | 17 | 18                                  | 29  | 71  | 100 | 0   | 0   | 0   | 59  | 100 | 88  | 12  | 100 | 94  | 88  | 88  | 94  |
| <i>Acinetobacter</i> species strain 6   | 2  | 100                                 | 100 | 100 | 100 | 0   | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| <i>Acinetobacter</i> species strain 10  | 5  | 0                                   | 40  | 60  | 60  | 0   | 0   | 0   | 100 | 100 | 100 | 0   | 100 | 60  | 20  | 40  | 100 |
| <i>Acinetobacter</i> species strain 12  | 3  | 100                                 | 100 | 100 | 100 | 0   | 67  | 100 | 100 | 100 | 100 | 67  | 100 | 100 | 100 | 100 | 100 |
| <i>Acinetobacter</i> strains, ungrouped | 5  | 80                                  | 80  | 80  | 80  | 0   | 40  | 80  | 100 | 100 | 100 | 80  | 80  | 80  | 80  | 80  | 100 |

<sup>a</sup> AMP, ampicillin; MZ, mezlocillin; PIP, piperacillin; AUG, augmentin; CFZ, cefazolin; FOX, cefoxitin; CRM, cefuroxime; CFT, cefotaxime; CAZ, ceftazidime; CAX, ceftriaxone; AZT, aztreonam; IPM, imipenem; AMK, amikacin; GM, gentamicin; TOB, tobramycin; CP, ciprofloxacin.

**Susceptibility testing.** MICs were determined by a micro-titer broth dilution method. Four or five colonies were suspended in 0.5 ml of brain heart infusion broth and incubated for 6 h at 35°C. A 0.01-ml portion of the suspension was transferred into 25 ml of autoclaved distilled water. Microtiter plates (MicroScan MIC Plus Type MK Dried Panels; Baxter-Travenol, West Sacramento, Calif.) were inoculated with a Renok inoculator according to the manufacturer's recommendations to achieve a final well concentration of  $1 \times 10^5$  to  $4 \times 10^5$  CFU/ml. Each plate contained 16 different lyophilized antimicrobial agents serially diluted in Mueller-Hinton broth, and the concentrations of most agents tested ranged in twofold steps from 1/8 through 4 times the breakpoint for fully susceptible isolates adopted by the National Committee for Clinical Laboratory Standards (NCCLS). Plates were incubated for 18 h at 35°C. The MIC was defined as the lowest concentration of drug that prevented visible growth. *Escherichia coli* ATCC 25922 and *Pseudomonas aeruginosa* ATCC 27853 served as controls.

## RESULTS AND DISCUSSION

This study presents the susceptibilities of nine different species of the genus *Acinetobacter* to 16 antimicrobial agents. The activities of the various agents against different *Acinetobacter* species are shown in Table 2. Table 3 shows the percentages of isolates fully susceptible at NCCLS breakpoints.

*A. baumannii* strains were generally more resistant than strains identified as species other than *A. baumannii*. This is consistent with three recently published reports (8, 19, 20). Within *A. baumannii* strains, isolates belonging to biotype 9 were more resistant than other biotypes, confirming previous data (10). Among species other than *A. baumannii*, strains of *Acinetobacter* species strains 3 and 10 and *A. johnsonii* showed the highest resistance. The most susceptible strains were found in the species *A. junii* and *A. lwoffii*; similar data were published recently (19).

In terms of MICs for 90% of the isolates, the most active agent against *A. baumannii* strains was imipenem. No strain resistant to imipenem was found, whereas others have

reported 5% of *Acinetobacter* strains being resistant to imipenem (13). Amoxicillin-clavulanate showed moderate activity, whereas ampicillin, broad-spectrum penicillins, cephalosporins, aminoglycosides, and ciprofloxacin were less active.

The trend towards resistance to expanded-spectrum cephalosporins was also demonstrated by Joly-Guillou et al. (13) and seemed to be related to the presence of cephalosporinases (14, 16). Recently, the presence of an extended broad-spectrum  $\beta$ -lactamase was reported (12). Others have also found increasing resistance of *A. baumannii* strains to modern quinolones (10, 20) as well as to amikacin and tobramycin (13). Resistance to amikacin was shown to be due to the presence of an aminoglycoside phosphotransferase (15).

Excellent activity against *Acinetobacter* species strain 3 strains was shown for imipenem, amikacin, ciprofloxacin, and amoxicillin-clavulanate. Of the other beta-lactams tested, only ceftazidime showed moderate in vitro activity. Isolates constituting *Acinetobacter* species strain 3 differed from *A. baumannii* strains in their greater susceptibility to ciprofloxacin and the aminoglycosides.

Against isolates identified as species other than *A. baumannii* and *Acinetobacter* species strain 3, imipenem, amikacin, ceftazidime, ceftriaxone, amoxicillin-clavulanate, and ciprofloxacin exhibited good activity. Some strains were even susceptible to ampicillin and older cephalosporins. We found only one unclassified proteolytic *Acinetobacter* strain which was resistant to imipenem.

Treatment of nosocomial infections due to *A. baumannii* species has become more and more complicated by the rapid increase in the resistance of these species to most antimicrobial agents (4, 10, 13, 21). Often, imipenem remains the only effective treatment. The overuse of new drugs may have contributed to an escalation of resistance. Treatment of infections due to species other than *A. baumannii* does not seem to pose serious problems. It should be noted that the percentage of strains identified as species other than *A. baumannii* was greater than previously reported (7, 8).

## REFERENCES

1. Al-Khoja, M. S., and J. H. Darrell. 1979. The skin as the source of *Acinetobacter* and *Moraxella* species occurring in blood cultures. *J. Clin. Pathol.* **32**:497-499.
2. Baumann, P. 1968. Isolation of *Acinetobacter* from soil and water. *J. Bacteriol.* **96**:39-42.
3. Bergogne-Berezin, E., and M. L. Joly-Guillou. 1985. An underestimated nosocomial pathogen, *Acinetobacter calcoaceticus*. *J. Antimicrob. Chemother.* **16**:535-538.
4. Bergogne-Berezin, E., and M. L. Joly-Guillou. 1986. Comparative activity of imipenem, ceftazidime and cefotaxime against *Acinetobacter calcoaceticus*. *J. Antimicrob. Chemother.* **18**(Suppl. E):35-39.
5. Bergogne-Berezin, E., M. L. Joly-Guillou, and J. F. Vieu. 1987. Epidemiology of nosocomial infections due to *Acinetobacter calcoaceticus*. *J. Hosp. Infect.* **10**:105-113.
6. Bouvet, P. J., and P. A. Grimont. 1986. Taxonomy of the genus *Acinetobacter* with the recognition of *Acinetobacter baumannii* sp. nov., *Acinetobacter haemolyticus* sp. nov., *Acinetobacter johnsonii* sp. nov., and *Acinetobacter junii* sp. nov. and emended description of *Acinetobacter calcoaceticus* and *Acinetobacter lwoffii*. *Int. J. Syst. Bacteriol.* **36**:228-240.
7. Bouvet, P. J., and P. A. Grimont. 1987. Identification and biotyping of clinical isolates of *Acinetobacter*. *Ann. Inst. Pasteur Microbiol.* **138**:569-578.
8. Freney, J., P. J. Bouvet, and C. Tixier. 1989. Identification et détermination de la sensibilité aux antibiotiques de 31 souches cliniques d'*Acinetobacter* autres que *A. baumannii*. *Ann. Biol. Clin. Paris* **47**:41-44.
9. Glew, R. H., R. C. Moellering, and L. J. Kunz. 1977. Infections with *Acinetobacter calcoaceticus* (*Herellea vaginicola*): clinical and laboratory studies. *Medicine* **56**:79-97.
10. Hercouet, H., J. Bousser, P. Y. Donnio, and J. L. Avril. 1989. Activité in vitro des antibiotiques sur les souches hospitalières de *Acinetobacter baumannii*. *Pathol. Biol. Paris* **37**:612-616.
11. Joly-Guillou, M. L., and E. Bergogne-Berezin. 1986. Activité comparative in vitro du ceftizoxime, de la ceftazidime et de l'imipénème. *Pathol. Biol. Paris* **34**:625-628.
12. Joly-Guillou, M. L., and E. Bergogne-Berezin. 1990. Présence d'une  $\beta$ -lactamase à spectre élargi chez *Acinetobacter baumannii*. *Presse Med.* **19**:672-673.
13. Joly-Guillou, M. L., E. Bergogne-Berezin, and J. F. Vieu. 1990. Epidémiologie et résistance aux antibiotiques des *Acinetobacter* en milieu hospitalier. *Presse Med.* **19**:357-361.
14. Joly-Guillou, M. L., E. Vallee, E. Bergogne-Berezin, and A. Philippon. 1988. Distribution of beta-lactamases and phenotype analysis in clinical strains of *Acinetobacter calcoaceticus*. *J. Antimicrob. Chemother.* **22**:597-604.
15. Lambert, T., G. Gerbaud, and P. Courvalin. 1988. Transferable amikacin resistance in *Acinetobacter* spp. due to a new type of 3'-aminoglycoside phosphotransferase. *Antimicrob. Agents Chemother.* **32**:15-19.
16. Morohoshi, T., and T. Saito. 1977.  $\beta$ -Lactamase and  $\beta$ -lactam antibiotics resistance in *Acinetobacter anitratum*. *J. Antibiot.* **30**:969-973.
17. Retalliau, H. F., A. W. Hightower, R. E. Dixon, and J. R. Allen. 1979. *Acinetobacter calcoaceticus*: a nosocomial pathogen with an unusual seasonal pattern. *J. Infect. Dis.* **139**:371-375.
18. Rolston, K. V., and G. P. Bodey. 1986. In vitro susceptibility of *Acinetobacter* species to various antimicrobial agents. *Antimicrob. Agents Chemother.* **30**:769-770.
19. Tjernberg, I. 1990. Antimicrobial susceptibility of *Acinetobacter* strains identified by DNA-DNA hybridization. *APMIS* **98**:320-326.
20. Traub, W. H., and M. Spohr. 1989. Antimicrobial drug susceptibility of clinical isolates of *Acinetobacter* species (*A. baumannii*, *A. haemolyticus*, genospecies 3, and genospecies 6). *Antimicrob. Agents Chemother.* **33**:1617-1619.
21. Vallee, E., M. L. Joly-Guillou, and E. Bergogne-Berezin. 1990. Activité comparative de l'imipénème, du céfotaxime et de la ceftazidime vis-à-vis d'*Acinetobacter calcoaceticus*. *Presse Med.* **19**:588-591.