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ARTICLE

Community-acquired *Acinetobacter* infections

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Abstract *Acinetobacter* infections have been attracting increasing attention during recent years because they have become common in hospitalized patients, especially in the intensive care unit (ICU) setting. However, the available literature suggests that the pathogen has another fearful potential; it can cause community-acquired infections. We searched PubMed and the reference lists of the initially identified articles and identified six case series regarding a total of 80 patients with community-acquired *Acinetobacter baumannii* infections; from these, 51 had pneumonia and 29 had bacteremia. Of these 80 patients, 45 (56%) died of the infection. In addition, we identified 26 case reports regarding 43 patients with community-acquired *Acinetobacter* infections; from these, 38 had pneumonia, two had meningitis, one had soft-tissue infection, one had ocular infection, and one had native valve endocarditis. Comorbidity was commonly present in patients reported in the case series as well as the case reports, mainly, chronic obstructive pulmonary disease, renal disease, and diabetes mellitus; heavy smoking and excess alcohol consumption were also common. Most of the studies originated from China, Taiwan, and tropical Australia. We also identified 12 retrospective or prospective studies (seven from the Far East, two from Oceania, one from N. Guinea, one from Palestine, and one from USA/Canada) that reported the frequency of community-acquired *Acinetobacter* infections; the range of isolation of *Acinetobacter* from patients with community-acquired pneumonia in these studies was 1.3%–25.9%. In conclusion, most community-acquired *Acinetobacter* infections have been reported from countries with tropical or subtropical climate, and mainly affect patients with some form of comorbidity or are associated with heavy smoking and excess alcohol consumption.

Authors' contributions MEF had the idea for the article and supervised the various stages of its progress. EAK, IK, and TK performed the literature search, study selection, and data extraction. MEF and EAK wrote the first version of the manuscript. All authors approved its final version.

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Introduction

Acinetobacter infections are becoming gradually more common in various settings and populations around the world. Specifically, *Acinetobacter baumannii* (previously known as *Acinetobacter calcoaceticus* var. *anitratus*) has become a common nosocomial pathogen, affecting especially patients receiving treatment in the intensive care unit (ICU) setting [1, 2]. Beyond this population, *Acinetobacter* affects war and trauma casualties, as it has been shown in soldiers in the Gulf War and the victims of trauma in various earthquakes, including that of Marmara, Turkey, in 1999 [1].

There are several unanswered questions regarding various aspects of *Acinetobacter* infections, including epidemiological and management issues. Among them is the continuing controversy regarding the mortality that is directly attributable to *Acinetobacter baumannii* infections in ICU patients, if any [2, 3]. However, there is accumulating evidence that this pathogen may cause serious infection and, thus, contributes substantially to the considerable mortality of this population [4].

Although the attention of *Acinetobacter baumannii* infections has been focused on hospitalized patients, there is another patient population that may be affected by this important pathogen, namely, patients in the community setting that have some form of morbidity, especially in the tropical and sub-tropical climates [5]. These patients may develop community-acquired *Acinetobacter* infections. Given the lack of synthesis of data on the issue, we sought to evaluate the available evidence regarding community-acquired *Acinetobacter* infections by performing a systematic review focused on this population.

Literature search

The relevant studies were retrieved through a search of the PubMed database (articles published after 1973 and archived by June 2006) by using the key-terms: "community AND Acinetobacter". Two hundred and thirty two (232) studies were initially screened. In order for a study to be included in our review, it should have been written in English, French, German, or Italian. The study should have regarded adult immunocompetent patients. It should be also clear by the study's authors that the person did not acquire the infection by his/her direct or indirect contact with the hospital environment and that it was with no doubt a community-acquired infection. For inclusion in our review, the study should have presented data regarding the clinical course of the infection and/or the rate of *Acinetobacter* isolates out of the total number of infective agents that were isolated from specimens taken from infected patients that presented the same type of infection and were being treated in the same clinic. Studies that regarded pediatric patients, hospitalized patients, immunocompromised patients, patients undergoing chemotherapy against malignancy, and patients with external medical devices that required medical attention on a regular basis were excluded from our review.

From the initially screened 232 studies, we excluded 23 that were written in languages other than English, French, German, or Italian. Out of the remaining 209 articles, we selected 59 studies that regarded adult immunocompetent patients with community-acquired *Acinetobacter* infections. Of those 59 studies, 16 were excluded (four evaluated the pathogen *Acinetobacter* from a microbiological scope, presenting its microbiological characteristics; three neither presented data regarding the infection's clinical course nor evaluated the rates of isolates, and, thus, they could not be included in our review; three presented concentrated results that included both community- and hospital-acquired infections; two regarded pediatric patients; two regarded patients undergoing continuous ambulatory peritoneal dialysis; one regarded patients with tunneled central venous catheters undergoing prolonged outpatient intravenous therapy; and, finally, one regarded patients with head trauma, craniotomy, or traumatic hydrocephalus). Thus, we reviewed in detail 43 studies. The references of these studies were also checked in order to ensure that relevant studies were not missed. Two of the authors (EAK and IK) independently performed the literature search and, at the end of their efforts, compared their results.

It was our decision to include studies in which the authors clearly reported that the identified pathogen was *Acinetobacter* and, thus, studies in which the infective agent was identified as *Mima* or *Herellea* were excluded. Finally, we decided to include in our review all studies, regardless of the species of *Acinetobacter*, but, additionally, to present the species as they were reported by the authors of each study.

Regarding the characterization of the studies as prospective or retrospective, it was decided that, when available, the study's authors' characterization of their work would be presented. For the rest of the studies, an effort was made to identify in the studies' methods section, whether the generation of the collected data preceded (retrospective study) or followed (prospective study) the hypothesis testing.

We extracted data regarding the underlying illnesses, clinical manifestations of the infection, antibiotic treatment, observed complications, clinical outcomes of the patients, and other characteristics of community-acquired *Acinetobacter* infections from relevant case series and case reports. We also collected data regarding the frequency of community-acquired *Acinetobacter* infections from other retrospective and prospective studies.

Reviewed studies

In Table 1, we present data from the reviewed case series of patients with community-acquired *Acinetobacter* infections. It is important to note that, in these studies, the authors evaluated groups of patients with the same type of infection and present their medical history, their infection's characteristics, and the clinical course, as well as their response to treatment, in the form of rates. There were six studies presenting information regarding a total of 80 patients with community-acquired *Acinetobacter baumannii* (formerly known as *A. calcoaceticus* var. *anitratus*) infections. From those, 51 had pneumonia. Bacteremia occurred in the remaining 29 patients. Several forms of comorbidity were common in patients included in these case series: chronic obstructive pulmonary disease, renal disease, and diabetes mellitus. Heavy smoking and excess alcohol consumption were also commonly present in patients included in the reviewed case series. Of 80 patients, 45 (56%) died of the infection. Finally, the reviewed case series originated from China, Taiwan, and tropical Australia.

Table 1 Case series of patients with community-acquired *Acinetobacter* infection

Author, year (ref)	Country (city)	Type of study	Time period	Type of infection	Isolate/ organism[a]	No. of patients	Sex	Age	Underlying illness	Presentation	Treatment	Complications	Mortality n/N (%)
Leung et al. 2006 [18]	China (Hong Kong)	Retrospective case–control	07/00–12/03	Pneumonia	*A. baumannii*	19	16 m, 3 f	Mean 72.6 ±9.6 years	Total 18/19, (COPD 12/19, DM, hypertension, heart disease, malignancy, smoking 16/19, alcoholism 3/19)	Acute onset of fever 17/19, shortness of breath 17/19, cough 16/19, sputum production 13/19, hemoptysis 1/19, pleuritic chest pain 2/19	Before culture β-lactam +macrolide. All sensitive to amikacin, ticarcillin/ clavulanate, cefoperazone/ sulbactam, ampicillin/ sulbactam	ARDS 16/19, DIC 11/19, shock requiring inotropic 11/19, required MV 12/19, acute renal failure 3/19	11/19 (58) (follow up 30 days)
Chen et al. [b] 2005 [19]	Taiwan (Taipei)	Retrospective	09/97–01/01	Bacteremia	*A. baumannii*	10	NR	NR	NR	Fever/hypothermia, chills, tachypnea, tachycardia	NR	NR	3/10 (30) (follow up 1–2 weeks)
Anstey et al. 2002 [5]	Australia (northern territory)	Retrospective	NR	Pneumonia	*A. baumannii*	8	NR	NR	Excess alcohol consumption in majority (rate is NR)	NR	NR	NR	5/8 (63)
Wang et al. 2002 [20]	Taiwan (Taipei)	Retrospective	07/94–06/99	Bacteremia	*A. baumannii*	19	14 m, 5 f	Median 64 years	Total 18/19 (smoking 7/19, alcoholism 3/19, malignancy 10/19, DM 3/19, renal disease 2/19, COPD 2/19)	Pneumonia 13/19, cholangiitis 1/19, catheter related 2/19, enterocolitis 1/19, spontaneous bacterial peritonitis 1/19, primary bacteremia 1/19	Isolates susceptible to carbapenems, ceftazidime, cefepime, cefpirome, aminoglycosides, fluoroquinolones	Septic shock 11/19	11/19 (58) (follow up 90 days)
Chen et al. 2001 [21]	Taiwan (Taipei)	Retrospective	01/93–08/99	Pneumonia	*A. baumannii*	13	9 m, 4 f	Mean 64 years (range 37–85)	Total 13/13 (alcoholism 4/13, malignancy 5/13, DM 4/13, cerebrovascular disease 4/13, renal insufficiency 3/13, liver cirrhosis 2/13, smoking 4/13)	Fever 11/13, cough 12/13, purulent sputum 7/13, blood-stained sputum 4/13, dyspnea 10/13, drowsiness 6/13, pleuritic pain 4/13	Imipenem, and most were susceptible to aminoglycosides, ceftazidime, ciprofloxacin, and extended-spectrum penicillin	12/13 respiratory failure or shock, DIC 5/13, renal failure 5/13, 11/13 required admission to the ICU	8/13 (62)
Anstey et al. 1992 [22]	Australia (Darwin)	Retrospective	03/81–02/91	Pneumonia	*A. baumannii* (*A. calcoaceticus* var. *anitratus*)	11	10 m, 1 f	Mean 56 years (range 41–70)	Cigarette smoking 10/11, alcoholism 9/11, chronic obstructive airway disease 5/11, DM 4/11, chronic renal failure 1/11, corticosteroid use 1/11, CHF 3/11	Fever 9/11, productive cough 11/11, shortness of breath, pleuritic pain 8/10, blood-stained sputum 5/11, in shock 4/11, central cyanosis 3/11	TMP-SMZ, gentamycin, penicillin, ampicillin, cefotaxime, ceftazidime, ciprofloxacin, imipenem (in combinations of 2 or 3)	Fulminant course (respiratory distress 11/11)	7/11 (64) (4/7 died in the first 24 h)

Abbreviations: COPD=chronic obstructive pulmonary disease, DM=diabetes mellitus, ARDS=acute respiratory distress syndrome, DIC=disseminated intravascular coagulation, MV=mechanically ventilated, CHF=congestive heart failure, ICU=intensive care unit, TMP-SMZ=trimethoprim-sulfamethoxazole, NR=not reported, m=male, f= female, n, N=number

[a] The identified pathogen as reported by the authors in the included studies, respectively

[b] The authors investigated *Acinetobacter baumannii* bacteremia both nosocomial and community-acquired. We chose to present only those results that clearly regarded community-acquired *Acinetobacter* bacteremia

Table 2 Case reports of community-acquired *Acinetobacter* infection

Author, year (ref)	Country (city)	Time period	Type of infection	Isolate/ organism[a]	Patients	Sex	Age	Underlying illness	Presentation	Treatment	Complications	Outcome
Sharma et al. 2005 [13]	India (Delhi)	NR	Chronic pneumonia	*A. baumannii*	1	male	62	COPD, smoking, alcohol consumption	Cough, low fever for 4 months, sputum, weight loss, appetite decrease	Anti-TB treatment (rifampicin, isoniazid, ethambutol, pyrazinamide)	None	Survived
Chiang et al. 2003 [23]	Taiwan (Taipei)	NR	Skin and soft-tissue infection	*A. baumannii*	1	male	79	Smoking, alcohol consumption daily, 10-year-old scar on his left foot	Fever, chills, local redness, pain, and swelling over the scar extending over the ankle to the leg	Oxacillin, ampicillin/ sulbactam, ceftazidime, meropenem	Non-hemorrhagic bullae on the foot, tarry stool, hypotension, tachycardia, confusion	Survived
Drault et al. 2001 [24]	France (Fort-de-France)	NR	Pneumonia	*A. baumannii*	1st	male	49	DM, alcoholism, smoking, angina	Fever hypotension, respiratory failure, cardiac failure	Cefixime, amoxicillin/ clavulanate, pefloxacin, imipenem, amikacin	Required admission in the ICU and mechanical ventilation	Survived
		NR	Pneumonia	*A. baumannii*	2nd	female	55	NR	Fever, cardiac shock	Cefotaxime, ofloxacin, amikacin	Required MV in the ICU	Died within 14 h
Chang et al. 2000 [25]	Taiwan (Kaohsiung Hsien)	1999	Meningitis	*A. baumannii*	1	male	51	DM, hypertension, renal disease	Fever, headache, progressive consciousness disturbance, hypotension, meningeal irritation signs	Ceftazidime, penicillin G	Convulsive type status epilepticus, coma	Died within 26 days
Prashanth 2000 et al. [6]	India (Pondicherry)	NR	Ocular infection with corneal perforation	*A. junii*	1	female	35	20 days ago: left eye trauma with a thorn caused pain, watering, redness, photophobia, and diminished vision in the affected eye	Lid edema, blepharospasm, circum corneal congestion (6–7-mm corneal ulcer, 5-mm hypopyon)	Ciprofloxacin eye drops, therapeutic penetrating keratoplasty	Diminished vision, the cornea perforated on day 5	Survived (20/ 100 visual acuity unaided)
Carter et al. 1999 [14]	USA (Tampa, Florida)	NR	Chronic pneumonia	*A. baumannii*	1	male	80	Hypertension, mitral regurgitation, prostate cancer (had been treated with radiation)	Fever, chronic cough occasionally productive, pleuritic pain, dyspnea on walking one block	TMP-SMZ	Anemia of chronic disease	Survived
Yang et al. 1997 [26]	Taiwan (Taipei)	NR	Pneumonia	*A. baumannii*	1	male	35	G6PD deficiency, hepatitis B carrier, asthma	Pleuritic pain, fever, cough, blood-tinged sputum, icteric sclera, generalized yellowish skin discoloration	Amikacin, ceftazidime, amoxicillin/ clavulanate, pefloxacin	Hypotension, dyspnoea, severe hemolysis, abscess formation	Survived
Bilgic et al. 1995 [8]	Turkey (Ankara)	1990	Pneumonia	*A. calcoaceticus*	1	male	20	Smoking	Dyspnea, fever, cough, hemoptysis, and vomiting, hypoxemia	Benzylpenicillin, cephalothin, ceftriaxone, amikacin	None	Survived

Achar et al. 1993 [27]	Kuwait	1989	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1	male	65	Smoking, alcohol consumption moderate	Dyspnea, fever, rigors, cough with blood-stained sputum	Crystalline penicillin, gentamycin, piperacillin amikacin TMP-SMZ erythromycin.	Tachypnea, cyanosis, septic shock, required MV in the ICU	Survived
Bick and Semel 1993 [11]	USA (Chicago, Illinois)	1991	Pneumonia	*A. baumannii*	1	female	74	None	Dyspnea, fever, chills, non-productive cough, septic shock	Gentamycin, ticarcillin/clavulanic acid, erythromycin, ciprofloxacin	Septic shock complicated by renal failure, DIC, respiratory failure requiring MV in the ICU	Survived
Bernasconi et al. 1993 [28]	Switzerland (Zurich) (patient: Sri Lanka native)	1992	Pneumonia	*A. baumannii*	1	male	38	Smoking, alcoholism	Pleuritic pain, dyspnea, fever, cough, somnolence, tachycardia, tachypnea	Amoxicillin/ clavulanic acid and erythromycin	Respiratory failure, required admission in the ICU and MV. Septic shock, renal failure, DIC	Died within 30 hours
Reindersma et al. 1993 [7]	Netherlands (Sittard)	NR	Meningitis	*A. calcoaceticus* var. *lwoffii*	1	female	19	None	Fever, headache, vomiting, confusion, meningeal-irritation signs	Amoxicillin, chloramphenicol, cefotaxime	None	Survived
Gradon et al. 1992 [29]	USA (New York)	NR	Infective endocarditis of a native valve	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1	female	48	None (NR smoking habits and alcohol consumption)	Four-week history of intermittent fever, chills, malaise, weight loss	Imipenem	Abdominal pain requiring emergency laparotomy and splenectomy. Splenic abscesses	Survived
Gottlieb and Barnes 1989 [30]	Australia (Sydney)	NR	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1	male	62	Alcoholism, chronic liver disease, smoking, DM, chronic bronchitis	Fever, left pleuritic chest pain, diarrhea, vomiting, cyanosis, shock	Ampicillin, gentamycin, erythromycin	Fulminant course, required MV in the ICU, intractable respiratory failure, shock	Died within 24 h
Krisanapan et al. 1989 [31]	Thailand (Songkla)	NR	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1st	male	71	Smoking	Fever, cough, chest pain, tachypnea	Penicillin, gentamycin	Septic shock	Died within 4 days
		NR	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	2nd	male	42	NR	Chest discomfort, dyspnea, restlessness	Penicillin, gentamycin, ceftazidime	Respiratory failure requiring MV	Survived
Barnes et al. 1988 [9]	New Guinea (Papua)	All 5 cases between 03/86–01/87	Pneumonia	*A. calcoaceticus*	1st	male	52	Smoking, chronic bronchitis	Fever, pleuritic chest pain, dyspnea, cough	Penicillin	NR	Died within 48 h
			Pneumonia	*A. calcoaceticus*	2nd	male	50	Bronchiectasis	Fever, pleuritic chest pain, dyspnea, cough	Ampicillin, gentamycin	NR	Survived
			Pneumonia	*A. calcoaceticus*	3rd	male	18	None	Fever, pleuritic chest pain, dyspnea, cough	Penicillin, gentamycin	NR	Survived

Table 2 (continued)

Author, year (ref)	Country (city)	Time period	Type of infection	Isolate/ organism[a]	Patients	Sex	Age	Underlying illness	Presentation	Treatment	Complications	Outcome
			Pneumonia	*A. calcoaceticus*	4th	male	28	Smoking	Fever, pleuritic chest pain, dyspnea, cough	Penicillin, gentamycin	NR	Survived
			Pneumonia	*A. calcoaceticus*	5th	male	26	Smoking	Fever, pleuritic chest pain, dyspnea, cough	Penicillin	NR	Died within 48 h
Westh and Terp 1988 [32]	Denmark (Copenhagen)	1986	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1	male	72	Chronic bronchitis	Dyspnea, tachypnea, tachycardia, chest pain	Benzylpenicillin, ampicillin, dicloxacillin, netilmicin, cefuroxime, doxycycline	Shock, renal failure necessitating hemodialysis, required MV in the ICU	Died within 23 days of acute myocardial infraction (pneumonia regressed)
Henderson et al. 1987 [33]	USA (Cheyenne, Wyoming)	NR	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1	male	54	Smoking, alcoholism, DM, hypertension	Chest pain, dyspnea, tachypnea, tachycardia	Ampicillin, tobramycin, TMP-SMZ	Ileus resolved without surgery	Survived
Suchyta et al. 1987 [15]	USA (San Antonio, Texas)	1984	Chronic pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1	male	56	Smoking	Progressive weight loss, dyspnea, cough, fever of 4 months duration, moderate respiratory distress	Tetracycline, isoniazid, rifampin, ethambutol, clindamycin, gentamycin (not treated in time for *Acinetobacter*)	Chest wall invasion with sinus tract formation, pulmonary embolus, respiratory failure that required MV	Died within 8 days of cardio-pulmonary arrest
Vathesatogkit et al. 1987 [34]	Thailand (Bangkok)	NR	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1st	male	70	Smoking	Dyspnea, fever, chills, non-productive cough, confusion	Cefacidal, gentamycin	Required MV in the ICU	Died within 24 h
		NR	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	2nd	male	39	Alcoholism	Dyspnea, fever, shock, cyanosis	Cefacidal, gentamycin	Required MV in the ICU, DIC	Died within 11 days
		NR	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	3rd	female	48	Alcoholism	Fever, productive cough, progressive dyspnea, tachypnea, cyanosis, stupor	Gentamycin	NR	Survived
		NR	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	4th	male	71	Chronic bronchitis	Fever, productive cough	Penicillin, carbenicillin and gentamycin	NR	Died within 28 days

		NR	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	5th	male	72	DM, CVA	Fever, chills, blood-streaked sputum tachypnea, cyanosis	Cefazolin, gentamycin, TMP-SMZ, amikacin	NR	Survived
Cordes et al. 1981 [35]	USA (Hartford, Connecticut)	1979	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1st	male	54	Pneumoconiosis	Dyspnea, cough, red-brown sputum, fever, pleuritic pain, tachypnea, tachycardia, peripheral cyanosis	Penicillin	Acute respiratory failure, required MV, bradycardia, hypotension, cardiac arrest	Died within 24 h
		1979	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	2nd	male	63	Smoking, alcohol consumption, hypertension	Fever, chills cough, pleuritic pain, blood-streaked sputum, tachycardia, tachypnea	Penicillin, gentamycin, carbenicillin	Respiratory failure requiring MV	Survived
		1979	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	3rd	male	56	Pneumoconiosis, low alcohol consumption (post-mortem lung tissue cultures grew *Aspergillus*)	Weakness, dyspnea, cough, bloody sputum, fever, tachypnea	Ticarcillin, tobramycin	Required MV, septic shock, metabolic acidosis, renal failure requiring peritoneal dialysis, arrhythmias requiring cardiac pacemaker	Died within 9 days
Fernández Guerrero et al. 1980 [10]	Spain (Madrid)	1979	Pneumonia	*A. calcoaceticus*	1	male	32	Had been receiving for a month methylprednisolone 8 mg every other day	Fever, chills, malaise, generalized aches, cough, hemoptysis, chest pain	Benzylpenicillin, gentamycin	Shock, stupor, seizures	Died within 29 h
Rudin et al. 1979 [b] [12]	USA	All cases between 1972–1977	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1st	male	58	Alcoholism, asthma, alveolar proteinosis	Fever, dyspnea, pleuritic chest pain, productive cough	Clindamycin	Shock, cardiac arrest	Died within 15 h
			Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	2nd	male	41	Alcoholism, hepatitis, acute pancreatitis	Fever, dyspnea, pleuritic chest pain, productive cough	Penicillin, gentamycin, carbenicillin	Shock	Survived
			Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	3rd	female	35	Alcoholism, barbiturate abuser	Fever, dyspnea, pleuritic chest pain, productive cough	Penicillin, gentamycin	Shock	Died within 13 days

Table 2 (continued)

Author, year (ref)	Country (city)	Time period	Type of infection	Isolate/ organism[a]	Patients	Sex	Age	Underlying illness	Presentation	Treatment	Complications	Outcome
			Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	4th	female	74	None	Fever, dyspnea, pleuritic chest pain, productive cough	Penicillin, gentamycin	NR	Survived
			Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	5th	male	44	Alcoholism, chronic bronchitis	Fever, dyspnea, pleuritic chest pain, productive cough	Penicillin, gentamycin, carbenicillin	NR	Survived
Goodhart et al. 1977 [36]	USA (Philadelphia)	1974	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1st	female	33	Smoking, alcohol heavy intake during the last year, history of narcotics use	Fever, dyspnea, pleuritic pain, nausea, vomiting, cough, rusty sputum, tachypnea, respiratory distress	Cephalothin, gentamycin	Cardiac arrest	Died within 27 h
		1976	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	2nd	male	58	Alcoholism, smoking, cirrhosis, myocardial infract, CHF	Fever, pleuritic pain, productive cough, pink sputum, dyspnea, cyanosis, tachypnea, respiratory distress	Penicillin G, nafcillin, ampicillin, gentamycin	Pulmonary edema, hypotension, ventricular irritability, SVT, required MV	Survived
Wallace et al. 1976 [37]	USA	1975	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1	male	50	Alcoholism, smoking	Fever, dyspnea, pleuritic chest pain, cough, confusion, moderate respiratory distress, tachycardia, tachypnea	Penicillin, gentamycin, carbenicillin, tetracycline	Required MV in the ICU	Survived
Wands et al. 1973 [38]	USA (Baltimore, Maryland)	NR	Pneumonia	*A. calcoaceticus* var. *anitratus* (*A. baumannii*)	1	male	69	Chronic renal failure, hypertension, obstructive uropathy	Malaise, anorexia, dyspnea, pleuritic pain, non-productive cough, acute respiratory distress, tachypnea, tachycardia	Gentamycin, cephalothin, tetracycline	Required peritoneal dialysis and MV	Died within 3 days

Abbreviations: COPD=chronic obstructive pulmonary disease, DM=diabetes mellitus, TB=tuberculosis, TMP-SMZ=trimethoprim-sulfamethoxazole, CVA=cerebrovascular accident, SVT=supra-ventricular tachycardia, DIC=disseminated intravascular coagulation, MV=mechanical ventilation, ICU=intensive care unit, ARDS=acute respiratory distress syndrome, MI=myocardial infraction, CHF=congestive heart failure, NHL=non-Hodgkin lymphoma, NR=not reported, m=male, f=female

[a] The identified pathogen as reported by the authors in the included studies, respectively

[b] One out of six presented cases was excluded from our review because the infected patient was on chemotherapy for NHL treatment, and, therefore, was considered to be immunocompromised

Table 3 Frequency of *Acinetobacter* infections among patients with community-acquired infections

Author, year (ref)	Country (city)	Type of study	Time-period examined	Type of infection evaluated	No. of patients with the infection	Total n of isolates	Acinetobacter isolates N (%)	Mortality comments
Hu et al. 2005 [39]	Taiwan (Taipei)	Retrospective	01/01–12/01	Pneumonia (treated in the medical ICU)	169	75	8 (10.7)	5/8 infected with *Acinetobacter* died
Lau et al. 2004 [40]	Taiwan (Taipei)	Prospective	06/99–06/00	Urinary tract infection	201	224	4 (1.8)	
Loh et al. 2004 [41]	Malaysia (Seremban)	Prospective	08/02–03/03	Pneumonia	108	73	3 (4.1)	1/3 infected with *Acinetobacter* died
Wu et al. 2003 [42]	Taiwan (Taichung)	Prospective	01/98–01/00	Pneumonia	69	58	15 (25.9)	
Astal et al. 2002 [43]	Palestine (Gaza)	Prospective	01/00–06/00	Urinary tract infection	121	121	3 (2.5)	
Hooi et al. 2002 [44]	Malaysia (Penang)	Prospective	11/99–08/00	Pneumonia	98	46	3 (6.5)	1/3 infected with *Acinetobacter* died
Lu et al. 2002 [45]	Taiwan (Kaohsiung Hsien)	Retrospective	01/86–12/99	Bacterial meningitis	109	103	3 (2.9)	2/3 infected with *Acinetobacter* died
Marik 2000 [46]	USA-Canada (105 hospitals)	Retrospective	NR (Norasept II database, placebo limb)	Pneumonia (presenting as septic shock)	148	104	4 (3.9)	4/4 infected with *Acinetobacter* died
Ismail et al. 1997 [47]	Singapore	Retrospective	1995	Bacteremia (in patients >60 years old)	110	NR	NR (3.4)	
Patel et al. 1991 [48]	Australia (Alice Springs)	Retrospective	01/84– 12/86	Bacterial infections among Aboriginal with diabetes	165	NR	1 (NR)	The infected with *Acinetobacter* died
Karalus et al. 1991 [49]	New Zealand (Hamilton)	Prospective	1988 (10 months)	Pneumonia	92	77	1 (1.3)	
Barnes et al. 1988 [9]	New Guinea (Papua)	Prospective	03/86–01/87	Pneumonia	175	112	5 (4.5)	2/5 infected with *Acinetobacter* died

Abbreviations: NR=not reported, BAL=bronchoalveolar lavage, ICU=intensive care unit

In Table 2, we present the identified case reports of community-acquired *Acinetobacter* infections. There were 26 case reports presenting information regarding 43 patients (34 males and 9 females) with community-acquired *Acinetobacter* infections. In the case reports that presented more than one (up to five) case, the presentation focused separately on every one of the presented patients and reported the patient's as well as the infection's characteristics. From those 43 patients, 38 had pneumonia, two had meningitis, one had soft-tissue infection, one had ocular infection, and one had native valve endocarditis. The patient with the ocular infection grew *A. junii* in the relevant cultures [6]. The cultures of one patient with meningitis grew *A. calcoaceticus* var. *Lwoffii* [7]. In three studies (presenting a total of seven patients), the variety of *A. calcoaceticus* was not clarified [8–10], while in the remaining 21 studies (regarding 34 patients), it was specified that the infection's causative bacterium was *A. baumannii* (*Acinetobacter calcoaceticus* var. *anitratus*).

Chronic obstructive pulmonary disease, renal disease, diabetes mellitus, alcoholism, and heavy smoking were also commonly recognized as underlying conditions among the patients included in the reviewed case reports that are presented in Table 2. For four patients [74 (two patients), 19, and 18 years old), it was clearly reported by the authors that no underlying condition (including smoking and alcoholism) was present [11, 12, 7, 9]. In 35 out of 38 patients, *Acinetobacter* pneumonia manifested with an acute course, while for the remaining three patients, the diagnosis of "chronic" pneumonia was given [13–15]. Of

the 43 patients included in the reviewed case reports, 19 died of the infection, and, among the 19 deaths, 10 occurred in the first 48 h of hospitalization.

Lastly, in Table 3, we present data regarding the frequency of community-acquired infections that were caused by *Acinetobacter* in various patient populations and settings. One study contained useful data regarding both the clinical manifestations of community-acquired *Acinetobacter* infection and its frequency [9], and, thus, data from this study were included in both Tables 2 and 3, respectively. Seven of the 12 enlisted studies originated from the Far East (Taiwan, Malaysia, and Singapore). Two more studies were from Oceania (one from tropical Australia and the other from New Zealand). Finally, one was from N. Guinea, one from Palestine, and one from USA/Canada. The range of isolation of *Acinetobacter* from patients with community-acquired pneumonia in these studies was 1.3%–25.9%.

Evaluation of the available evidence

The most important finding of our systematic review is that there are several reports in the form of case reports, case series, and prospective and retrospective studies dealing with community-acquired *Acinetobacter* infections. This information suggests that this pathogen is a considerable cause of community-acquired infections, especially in tropical and subtropical climates.

The published evidence regarding community-acquired *Acinetobacter* infections mainly originated from countries with tropical or subtropical climate. It is noteworthy that, based on the available data, community-acquired *Acinetobacter* infections mainly occur in patients with some form of comorbidity, such as chronic obstructive pulmonary disease, renal disease, and diabetes mellitus, and/or are associated with heavy smoking and excess alcohol consumption. There was a scarcity of information in the publications we reviewed regarding the time of the year that the infections occurred.

It should be emphasized that the mortality of patients with community-acquired *Acinetobacter* pneumonia and/or bacteremia is considerable (56% in the case series included in this review). Although there is a possibility that publication bias is operating favoring the report of patients with severe community-acquired *Acinetobacter* infections, the reviewed data suggest that these infections are indeed associated with considerable mortality.

Our review has several limitations regarding the search strategy we used. It should be emphasized that we included in our review studies identified in the PubMed database that were written in English, French, German, or Italian. Subsequently, it is very possible that we missed other relevant articles on community-acquired *Acinetobacter* infections published in local journals. This is especially important for this review because of the increased incidence of community-acquired *Acinetobacter* infections in countries with tropical or subtropical climate.

Another limitation of our literature search for relevant studies on community-acquired *Acinetobacter* infections is related to the changes of the taxonomic classification of *Acinetobacter*. Specifically, the classification of oxidase-negative, non-nitrate-reducing, catalase-positive, Gram (−) bacteria in the genus *Acinetobacter* was introduced in 1968 [16, 17]. Prior to that, confusion over taxonomy existed among investigators, microbiologists, and clinicians who used classifications of *Acinetobacter spp.*, in various genera, such as *Mima* and *Herellea*. Several different names were used in the literature before 1970 for bacteria of this genus, such as *Herellea vaginicola*, *Mima polymorpha*, *Bacterium anitratum*, *Achromobacter anitratus*, etc. The limited number of relevant papers in the older literature, as well as the uncertainty on whether each of those studies truly regarded *Acinetobacter spp.*, led us to the decision not to expand our search to include articles published prior to 1973. Finally, it is important to note that it is likely that a publication bias exists in these reports.

Conclusion

Clinicians and microbiologists should be aware regarding the existence and severity of community-acquired *Acinetobacter* infections that mainly affect patients with some form of comorbidity or are associated with heavy smoking and excess alcohol consumption. It is noteworthy that, although community-acquired *Acinetobacter* infections were caused by isolates that did not have a very resistant pattern, the mortality associated with such infections was considerable; in fact, it did not appear to be substantially different from that reported in some studies of hospital-acquired *Acinetobacter* infections. A major limitation in interpreting the reviewed evidence regarding community-acquired *Acinetobacter* infections is that species identification has been inadequate, especially in early studies of *Acinetobacter* infections.

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