Epidemiological Characteristics of *Acinetobacter baumannii* Infections at Phramongkutklao Hospital

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Objective: *To describe epidemiological characteristics of Acinetobacter baumannii infections and identify molecular patterns of A. baumannii isolated from the patients admitted in Phramongkutklao Hospital.*
Material and Method: *A retrospective study on previously isolated A. baumannii from the clinical specimens submitted to the microbiology laboratory of Phramongkutklao Hospital from January to March 2008 were carried out together with molecular typing using PCR-based method. Clinical data were obtained from IC surveillance and patients' records.*
Results: *114 A. baumannii were isolated from 80 patients. A. baumannii was a cause of healthcare-associated infection (90%, 72 of 80 cases), colonization (7.5%), and community-acquired infection (2.5%) with mortality rate of 50%. Majority of the patients from which A. baumannii were isolated were male (58.8%), age over 60 years (56.3%), diagnosed with lower respiratory diseases (26.3%), had A. baumannii ventilator-associated pneumonia (66.7%), and admitted in medical department (57.5%) with median length of hospital stay 35 days. PDR- and MDR- A. baumannii were accounted for 67.5% and 21.1%, respectively. All isolates showed sensitive to tigecycline and colistin. Using PCR-based typing was able to distinguish 6 molecular types among 114 A. baumannii isolates. Molecular type 2 was the most common type (47.4%) and widely spread in 14 wards. Spread of clonally related isolates was found in 14 cases admitted in 8 medical wards and ICUs.*
Conclusion: *Multiple clones of PDR- and MDR- A. baumannii were widely spread in the hospital. Clonally related A. baumannii infected 14 cases in 8 wards.*

Keywords: *Acinetobacter baumannii, Epidemiology, Molecular typing*

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Acinetobacter baumannii have continued to cause healthcare-associated infections worldwide because of their antibiotic resistance and persistence in the patient's environment[1]. Increasing incidence of healthcare-associated *A. baumannii* infections have been reported in the intensive care settings[2-4]. The emergence of multidrug resistance *A. baumannii* (MDR-AB) and carbapenam-resistant *A. baumannii* (CRAB) has caused hospital-wide outbreaks and threat in treatment[2,5-7].

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In Thailand, multidrug resistant (MDR) *A. baumannii* were involved in 77.3% of *A. baumannii*-VAP patients at Maharaj Nakhon Si Thammarat Hospital[8]. At Siriraj Hospital[9], 57% of *A. baumannii* isolates were pandrug-resistant (PDR) *A. baumannii*. Meanwhile, *A. baumannii* is the leading cause of nosocomial infection at Phramongkutklao Hospital. Recently, isolation of MDR *A. baumannii* in the hospital raised a concern in infection control measures[10]. The objective of this study was to describe epidemiological characteristics of *A. baumannii* infection and determine molecular types of *A. baumannii* isolated in the hospital by using PCR-based typing method.

Material and Method

One hundred and fourteen *A. baumannii* isolates from the clinical specimens of 80 patients admitted at Phramongkutklao Hospital from January to March 2008 were retrospectively recovered and confirmed their identification[11]. Antimicrobial susceptibility was determined with 15 antimicrobial agents, namely, amikacin, gentamycin, netilmycin, ceftazidime, cefotaxime, ceftriaxone, cefepime, ciprofloxacin, levofloxacin, imipenem, meropenem, ampicillin/sulbactam, tazocin, (piperacillin/tazobactam), tigecycline and colistin[12]. MDR-*A. baumannii* was defined as those resistance to 3 or more different classes of antibiotics including aminoglycosides, fluoroquinolones, beta-lactams, and 3rd generation of cephalosporin[13]. PDR-*A. baumannii* was defined as the isolates that were resistant to all tested antibiotics except colistin and tigecycline[14].

A total of 114 isolates were molecular typed using PCR-based technique described previously[8], with REP1, REP2 and M13 primers[15,16]. The PCR fingerprints visualized on gel were saved and analyzed on the basis of similarity in numbers and matching positions of all major bands. Similarity of patterns was performed by UPGMA (unweighted pair group method with arithmetic mean) clustering method (Geneious 2.5.2; Biomatters, New Zealand).

Patients' information was collected from patient records and IC surveillance reports. *A. baumannii* was determined as a cause of healthcare-associated infection (HAI)[17] or colonization and community-acquired infection. *A. baumannii* isolated from clinical specimens without clinical sign and symptom of infection at the site from which specimens were collected was considered as a colonized *A. baumannii*. Community-acquired *A. baumannii* infection was defined as an infection that *A. baumannii* were isolated from clinical specimens obtained less than 48 hours after admission to the hospital. This study was approved by the Ethical Committee of Phramongkutklao Hospital (809/2551).

Results

A. baumannii infections

Twenty five of 80 patients had submitted specimens more than once and 72 patients (90%) were classified as *A. baumannii* HAI, 6 cases (7.5%) of *A. baumannii* colonization and 2 cases of community-acquired *A. baumannii* infection (Table 1). Male patients accounted for 58.8% of all cases. The median age was 68 years old, with the range of 1-94 years old. They were admitted in 15 wards, 57.5% of the patients were in medical ward (37.5%) and medical ICU (20%). Regarding length of hospital stay (LOS), there were 3 patients still hospitalized while collecting the data. So the maximum LOS was considered until the date of data collection. The range of LOS was from 2 to 240 days and the median of 35 days. Mortality rate of *A. baumannii* infection was 50%. The most common primary diagnosis of these patients was lower respiratory diseases (26.3%), followed by carcinoma and benign tumor (13.8%), fracture and bone/joint diseases (11.3%) and cerebrovascular accidents (10%).

Among the patients with HAI (72 cases), ventilator-associated pneumonia (VAP) accounted for 66.7% of the cases, followed by nosocomial pneumonia (13.9%), blood stream infection and skin/soft tissue infection (5.6% each) (Table 2). *A. baumannii* device-associated HAI was mainly VAP-48 of 65 patients (73.8%) with mechanical ventilators. Four cases of *A. baumannii* causing blood stream infections (BSI) were found among 22 patients with central venous catheters (18.2%).

Antimicrobial susceptibility of A. baumannii

Fig. 1 shows the susceptibility of 114 *A. baumannii* isolates to the tested antibiotics. All of *A. baumannii* isolates (100%) were sensitive to colistin and tigecycline. Most of the isolates were resistant to cefotaxime (92.1%) and ceftriaxone (88.6%). PDR *A. baumannii* (resistant to all tested antibiotics but colistin and tigecycline) were found 67.5% (77/114)

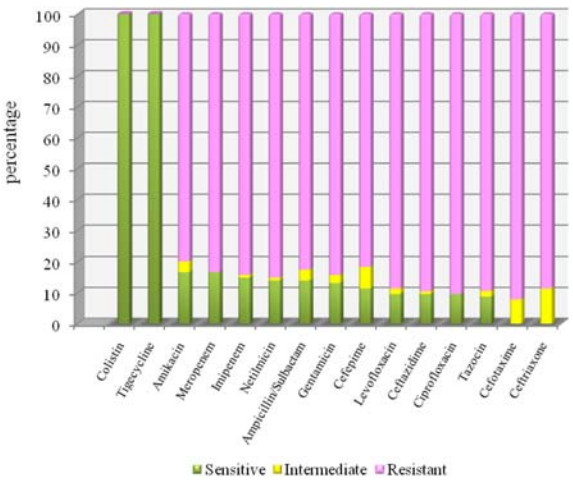

Fig. 1 The antibiotic susceptibility of 114 *A. baumannii* isolates

Table 1. Patient characteristics from which *A. baumannii* were isolated during January -March 2008

Patient characteristics	Total (n = 80)		HAI (n = 72)		Colonization (n = 6)		Community-acquired (n = 2)	
	No.	%	No.	%	No.	%	No.	%
Sex								
Male	47	58.8	40	85.1	5	10.6	2	4.3
Female	33	41.2	32	97.0	1	3.0	-	-
Age (years)								
0-15	5	6.2	4	80.0	1	20.0	-	-
16-30	9	11.2	8	88.9	-	-	1	11.1
31-40	3	3.8	2	66.7	1	33.3	-	-
41-50	5	6.2	4	80.0	-	-	1	20.0
51-60	13	16.3	12	92.3	1	7.7	-	-
> 60	45	56.3	42	93.3	3	6.7	-	-
Median = 68 years								
Ward								
Medical	30	37.5	28	93.4	1	3.3	1	3.3
Medical ICU	16	20.0	15	93.8	1	6.2	-	-
Emergency department	16	20.0	13	81.2	3	18.8	-	-
Surgical/Orthopedic/Rehabilitation	9	11.2	8	88.9	-	-	1	11.1
Surgical ICU	6	7.5	6	100.0				
Pediatric	2	2.5	1	50.0	1	50.0	-	-
Pediatric ICU	1	1.3	1	100.0				
Length of hospital stay (days)								
1-20	22	27.5	16	72.7	5	22.7	1	4.6
21-40	26	32.5	24	92.4	1	3.8	1	3.8
41-60	15	18.7	15	100.0				
61-80	6	7.5	6	100.0				
81-100	3	3.8	3	100.0				
101-200	3	3.8	3	100.0				
201-300	5	6.2	5	100.0				
Range = 2 - 240 days, Median = 35 days								
Outcomes								
Hospitalized	3	3.8	3	100.0				
Improved and discharged	37	46.2	30	81.1	6	16.2	1	2.7
Dead	40	50.0	39	97.5	-	-	1	2.5

HAI, healthcare-associated infection

and MDR *A. baumannii* 21.1%. Carbapenems resistance was detected 84.2% of the isolates. Less than 17% of the isolates were sensitive to each of the following antibiotics: amikacin (16.7%), meropenem (16.7%), imipenem (14.9%), netilmicin (14%), ampicillin/sulbactam (14%), gentamicin (13.2%), cefepime (11.4%), levofloxacin, (9.6%), ceftazidime (9.6%), ciprofloxacin (9.6%), and tazocin (8.8%). Antibiograms of 114 *A. baumannii* isolates showed 26 different patterns. PDR, designated as pattern 1, was the most common pattern (67.5%). Of 80 patients, 79 cases were taken antibiotics prior to the *A. baumannii* isolation. Interestingly, ceftriaxone and ceftazidime were the two most common antibiotics prescribed to these patients both before (48.1% and 27.8%) and after *A. baumannii* isolation (53.2% and 35.4%), respectively.

Molecular typing of A. baumannii

Six molecular types were established with 80% similarity (Fig. 2). Molecular type 2 was the most prevalence 47.4% (54/114) and was isolated from almost every ward in this study, except only orthopedic ward.

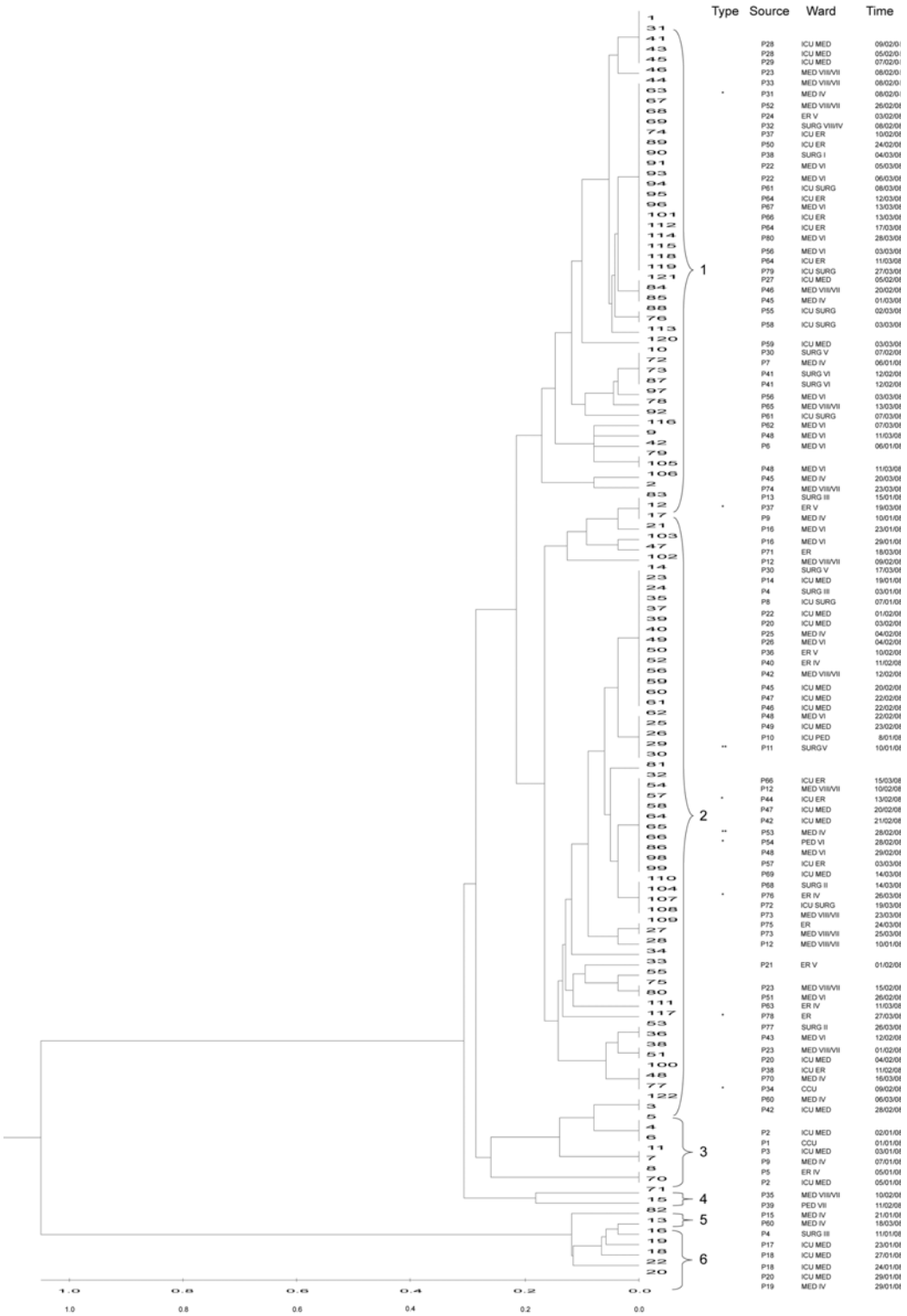

Fig. 2 Dendrogram showing similarity of *A. baumannii* isolates. Six molecular types were established with 80% similarity. The patient numbers were run according to occurrence of *A. baumannii* infection on the ward and date of sample collection, * colonization, ** community-acquired infection

Molecular type 1 was found 38.6% (44/114), followed by type 3 and type 6, 5.3% each, and type 4 and type 5, 1.8%, each. Medical wards and medical ICU had the highest burden of *A. baumannii* (62.3%, 71/114 isolates). All molecular types were isolated from the medical wards and medical ICU.

Table 3 shows spread of clonally related molecular type 2 in 14 cases admitted in 8 wards during January-February 2008. The first case was admitted in the surgical ward and the second was in surgical ICU 6 days later in the early of January. This clonally related type 2 was emerged again at the beginning of February in the medical ICU and then spread all over in other 5 wards till the 3rd week of February. Six cases were found in medical ICU and 4 of them were found within 4 days span (Feb 20-23). Infection with multiple clones of *A. baumannii* was observed in Patient #46. This patient was infected with molecular type 1 *A. baumannii* (Feb 20) when the patient was admitted in the medical ward and then was later transferred to the medical ICU where *A. baumannii* type 2 was isolated.

Table 2. Types of *A. baumannii* healthcare-associated infection among 72 patients

Healthcare-associated infections	Number (n = 72)	%
Ventilator associated pneumonia	48	66.7
Pneumonia	10	13.9
Blood stream infection	4	5.6
Skin/soft tissue infection	4	5.6
Surgical site infection	3	4.2
Gastrointestinal tract infection	2	2.8
Central nervous system infection	1	1.4

Discussion

A. baumannii caused healthcare-associated infections, mainly VAP, in 90% of the patients. Typical characteristics of the patients with *A. baumannii* infection or colonization were similarly observed in many studies[18,19]. Factors associated to increasing risk of pneumonia or colonization of the lower respiratory tract by *Acinetobacter spp* include advanced age, chronic lung disease, immunosuppression, use of antimicrobial agents, prolonged hospital stay of more than 2 weeks, use of invasive devices and respiratory equipment[18-20].

Community-acquired *A. baumannii* usually found in the patients presenting with lower respiratory tract infections and soft tissue infection and have underlying conditions such as chronic obstructive

Table 3. Spread of clonally related molecular type 2 *A. baumannii* in 14 patients admitted in 8 wards during January-February 2008

Date*	Patients with clonally related molecular type 2 *A. baumanni*							
	S□	S-ICU	M-ICU	MED 1	MED 2	T	MED 3	MED 4
JAN								
1	Pt 4□							
7		Pt 8						
FEB								
1			Pt 22					
3			Pt 20					
4				Pt 25	Pt 26			
10						Pt 36		
11						Pt 40		
12							Pt 42	
20			Pt 45					
22			Pt 46, Pt 47					Pt 48
23			Pt 49					

* Isolation date of *A. baumannii*

□ S-surgical ward; S-ICU, surgical ICU; M-ICU; medical ICU; MED, medical wards; T-trauma ward

□ Pt 4-patient number 4

pulmonary disease, renal failure, diabetes mellitus, heavy smokers, excessive alcohol consumers[21,22]. In our study, community-acquired *A. baumannii* infections were found in two cases. The first case had diabetes with *A. baumannii* infected bedsore at the hip area and was discharged as improved. Another case was an immunocompromised host with *A. baumannii* pneumonia. However, these two cases might not be a definite case of community-acquired *A. baumannii*, since our definition was not considered the aspect that the patient was frequently in and out of the hospital. The patients had underlying diseases that caused them to hospitalize frequently and there was a possibility of acquiring *A. baumannii* during the previous admission.

Mortality rate of the patients was quite high (50%) in this study. The reason underlying high mortality rate could be due to PDR/MDR-*A. baumannii* infection and severity of underlying diseases[23,24]. In order to reduce mortality rate, clinicians should be aware of patients with poor prognostic factors and initiate appropriate strategies in case management and antimicrobial therapy[24] .

The prevalence of PDR- and MDR-*A. baumannii* (a total of 88.6%) in the present study were higher than 57.6% of previous report in 1996-1997 at Siriraj Hospital[25], indicating an increasing problems of MDR- *A. baumannii* infections. The prevalence of PDR-*A. baumannii* worldwide is about 20% of all *A. baumannii* infections[26,27]. Imipenem previously was the most effective against this microorganism, with the increasing use of carbapenems, amikacin, and ciprofloxacin have resulted in increasing incidence of MDR-*A. baumannii* infection and progressive emergence of PDR-*A. baumanni*[5,7,20]. In this study, all isolates were susceptible only to colistin and tigecycline. Hence, they are two of the most frequently used antibiotics for MDR-*A. baumannii* infection[3]. Antibiotic resistance of *A. baumannii* probably originates from resistant genes that are transferred between bacterial species[1,28,29]. High proportion (19.3%) of co-isolation *A. baumannii* and *Pseudomonas* in the clinical specimens (data not shown) could provide opportunity for gene transfer and hence the high isolation rate of PDR/MDR- *A. baumannii.*

Molecular typing by using PCR-based method with REP-1, REP-2 and M13 primers was able to distinguish *A. baumannii* isolates into 6 molecular types that circulated in the hospital. Molecular type 1 and 2 *A. baumannii* accounted for 38.6% and 47.4% of all isolates, respectively. These 2 types were perhaps endemic strains and widely disseminated in several wards and ICUs of the hospital during the studied period. Multicenter study involved 7 laboratories in 6 European countries using standardized protocols and reagents for evaluation of reproducibility of PCR-based fingerprinting of *Acinetobacter* spp. The independently produced PCR fingerprints can be obtained reproducibly for *Acinetobacter* spp. at the practical level if quality-controlled reagents, standardized extraction of DNA, and standardized amplification conditions are used[30]. In addition, spread of clonally related molecular types were demonstrated with type 2 over 8 wards from medical wards and ICUs. Since the patient's care of these risk patients were involved many healthcare staff, using multiple devices and long hospital stays. Contact transmission could happen easily if infection control measures were not strictly implementing.

Antibiogram of microorganism may alert us to the emergence of a MDR *A. baumannii* outbreak, but distinction between strains with slight differences in resistant profile as observed in this study (pattern 1-16) may be difficult. Moreover, antibiogram typing results should be interpreted with caution, since unrelated strains may exhibit the same antibiogram and change in sensitivity may occur during episodes of infection[4]. The antibiogram might change overtime, if they acquired resistant genes. In this study the most prevalent molecular type 2 (47.4%) showed 16 antibiogram patterns, ranging from the pan-drug resistant pattern to the most sensitive pattern, *i.e.* sensitive to all but intermediate reaction to ceftriaxone and cefotaxime (data not shown). It was possible that some of the resistant genes might be located on plasmids.

A retrospective study of medical records and IC records (secondary data) had some limitations due to incomplete data on some of the studied variables. Only the patients that *A. baumannii* was isolated and identified from their clinical specimens were included in the study. Possible cases of *A. baumannii* colonization were missed due to unavailable specimen. So we could underestimate the prevalence of *A. baumannii* colonization. Moreover, not all *A. baumannii* isolates were included in the study because of incomplete patient data. Nevertheless, this study had demonstrated the problems of PDR/MDR-*A. baumannii,* the widely spread of clonally related molecular types in several wards, and some epidemiological information of *A. baumannii* infections in the hospital.

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ลักษณะทางระบาดวิทยาของการติดเชื้อ *Acinetobacter baumannii* ในโรงพยาบาลพระมงกุฎเกล้า

ลาวัลย์ เอี่ยมสะอาด, พรพรรณ ดีระพัฒน์, เฟื่องฟ้า อุตรารัชต์กิจ, สุดาลักษณ์ ธัญญาหาร, ฤดีวิไล สามโกเศศ, กนกรัตน์ ศิริพานิชกร

วัตถุประสงค์: *เพื่อศึกษาระบาดวิทยา และแบบแผนทางโมเลกุลของเชื้อ Acinetobacter baumannii ที่แยกได้จากผู้ป่วยในโรงพยาบาลพระมงกุฎเกล้า*

วัสดุและวิธีการ: *ศึกษาย้อนหลังของเชื้อ A. baumannii ที่แยกได้จากผู้ป่วยที่มารักษาระหว่างเดือนมกราคม ถึงเดือนมีนาคม 2551 ณ โรงพยาบาลพระมงกุฎเกล้า นำมาจัดกลุ่มทางอณูวิทยาด้วยวิธี PCR รวบรวมข้อมูลของผู้ป่วยจากเวชระเบียนและบันทึกการเฝ้าระวังของหน่วยป้องกันและควบคุมโรคติดเชื้อ*

ผลการศึกษา: *พบ A. baumannii 114 ไอโซเลต จากผู้ป่วย 80 ราย โดย A. baumannii เป็นสาเหตุของโรคติดเชื้อในโรงพยาบาลร้อยละ 90 (72/80) ของผู้ป่วย, เชื้อเพิ่มจำนวนในผู้ป่วยแต่ยังไม่แสดงอาการร้อยละ 7.5 ก่อการติดเชื้อจากชุมชนร้อยละ 2.5, และอัตราป่วยตายร้อยละ 50 ลักษณะของผู้ป่วยที่แยกเชื้อ A. baumannii ได้ส่วนมากคือเป็นชาย (ร้อยละ 58.8), อายุมากกว่า 60 ปี (ร้อยละ 56.3), เป็นโรคระบบทางเดินหายใจส่วนล่าง (ร้อยละ 26.3), เป็นโรคปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจ (ร้อยละ 66.7), รักษาในแผนกอายุรกรรม (ร้อยละ 57.5), และมีค่ามัธยฐานจำนวนวันที่อยู่ในโรงพยาบาล 35 วัน พบ A. baumannii ดื้อยาปฏิชีวนะหลายชนิดแบบ PDR ร้อยละ 67.5 และ MDR ร้อยละ 21.1 เชื้อทุกตัวไวต่อยาไตกีไซคลินและโคลิสติน การจัดกลุ่มทางอณูวิทยาของเชื้อด้วยวิธี PCR สามารถจำแนกเชื้อได้ 6 ไทป์ ไทป์ที่พบมากที่สุดคือ ไทป์ 2 ร้อยละ 47.4 แพร่กระจายอยู่ใน 14 หอผู้ป่วย และพบการติดเชื้อไทป์ 2 โคลนที่คล้ายคลึงกันในผู้ป่วย14 รายที่รักษาในหอผู้ป่วยอายุรกรรมและ ICU รวม 8 แห่ง*

สรุป: *การแพร่กระจายของ A. baumannii ที่ดื้อยาปฏิชีวนะหลายชนิดในโรงพยาบาลมีหลายโคลน พบผู้ป่วย 14 รายติดเชื้อ A. baumannii โคลนที่คล้ายคลึงกันใน 8 หอผู้ป่วย*