Critical Care Medicine & Pain

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Critical review

Challenge of intensive care unit-acquired infections and *Acinetobacter baumannii* in developing countries

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Abstract

Introduction

Nosocomial intensive care unit-acquired infections and antimicrobial resistance are global problems, and many epidemiological studies are carried out, especially from developed countries. However, available data of patient population and characteristics of intensive care units are very limited in developing countries. The prevalence of infection and mortality rates are higher in countries with limited resources associated with the quality of care. Infection control strategies such as hand hygiene, rational antibiotic utilisation, continuous education and performance feedback demonstrated a significant reduction in the infection rates in these countries. *Acinetobacter baumannii* is common cause of nosocomial infections worldwide. In recent years, interest in infections caused by *A. baumannii* has gradually increased, and current studies indicate that this pathogen is more resistant and virulent, becoming a serious nosocomial threat. This critical review discusses the prevalence of A. baumannii and other intensive care unit acquired infections in developing countries.

Conclusion

Intensive care unit-acquired infections caused by resistant organisms, prominently A. baumannii, are a global challenge. Large scale studies of intensive care unit-acquired infections in developing countries and guidelines including globally applicable infection control strategies to reduce these infections are essential.

Introduction

Patients in intensive care units (ICUs) are a significant subgroup of all hospitalised patients, accounting for about 25% of all hospital infections. The prevalence of ICU-acquired infections is significantly higher in developing countries than in industrialised countries, varying between 4.4% and 88.9%. Furthermore, device-associated infection rates in developing countries, especially ventilator-associated pneumonia (VAP) followed by central venous catheter-related bloodstream infections (CRBSIs), occur at a higher frequency than in European countries and USA1–3. The major problems associated with increased nosocomial infections in these countries are low compliance of hand hygiene, excessive number of patients and work-load, inadequate staff and personal protective equipment, and late establishment of infection control programmes[4]. Increasing drug resistance and the spreading of multi drug-resistant (MDR) pathogens in the ICU environment, results in limited therapeutic options and prolonged hospitalisation. Consequently, ICU-acquired infections have been associated with significant morbidity, mortality and rising healthcare costs in developing countries with limited resources[5].

Acinetobacter baumannii is a common cause of nosocomial infections worldwide. In recent years, interest in infections caused by A. baumannii gradually has increased, and current studies indicate that the pathogen is more resistant and virulent, becoming a serious nosocomial threat[6]. The aim of this critical review is to assess the problems associated with infections caught prevalent in ICUs in developing countries.

Discussion

The authors have referenced some of their own studies in this review. These referenced studies have been conducted in accordance with the Declaration of Helsinki (1964) and the protocols of these studies have been approved by the relevant ethics committees related to the institution in which they were performed. All human subjects, in these referenced studies, gave informed consent to participate in these studies.

Characteristics of ICUs and spreading of infection

ICUs are specialised departments of hospitals looking after critically ill patients. Nosocomial infections affect about 30% of patients in ICUs. Increased risk of infection in the ICU patients is associated with severity of illness, underlying conditions, exposure to multiple invasive devices and procedures (endotracheal intubation, urinary catheters, etc.) and increased patient contact with healthcare personnel. ICU staff and the equipment used for patient care during the hospitalisation are the primary sources of cross transmission of nosocomial pathogens. Several invasive devices have been used on ICU patients to treat or monitor their care; nosocomial infections mostly VAP, CRBSI and catheter-associated urinary tract infections (CAUTI) are more common complications of care provided in ICU. The ICU mortality rate of infected patients was 25%, two times more than non-infected patients in an international study[7].

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FOR CITATION PURPOSES: *Ulu-Kilic A, Ahmed SS, Alp E, Doğanay M.* Challenge of intensive care unit-acquired infections and *Acinetobacter baumannii* in developing countries. OA Critical Care 2013 Mar 01;1(1):2.

Competing interests: none declared. Conflict of Interests: none declared.
All authors contributed to the conception, design, and preparation of the manuscript, as well as read and approved the final manuscript.
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Available data for patient population and characteristics of ICUs are lacking in developing countries. The prevalence of infection and mortality rates are higher in countries with limited resources associated with the quality of care[8]. Main problems in developing countries are understaffing, poor infrastructure in ICUs and overcrowding. Lack of injection and blood transfusion safety is still a problem in most African countries[9]. Risk factors of infections in critically ill patients are similar in all developed and developing countries including age, comorbid diseases, mechanical ventilation, duration of hospitalisation, length of ICU stay, immune suppression and greater disease severity. Improvement of ICU service and training of the staff and accountability are needed to provide a solution in these countries.

Current situation and major reason of infections in ICUs

While the nosocomial ICU infections and antimicrobial resistance are global problems, there have been many epidemiological studies carried out especially in western countries. Such studies have provided valuable information about the prevalence and epidemiology of infection in critically ill European patients. Additionally, these studies emphasised that adherence to infection control measures significantly reduced the prevalence of these infections[7]. VAP, CRBSI and CAUTI are the most important nosocomial infections in the ICUs worldwide. Lack of data collection and absence of policies and guidelines of infection control are the major problems to estimate the burden of ICU infections and adherence to infection control measures in developing countries. Therefore, International Nosocomial Infection Control Consortium (INICC) aimed to provide surveillance data and gives performance feedback to reduce the infection rates focusing on education, hand hygiene and other basic infection control measures in developing countries.

INICC is an international nonprofit, open, multicentre, collaborative healthcare-associated infection control program with a surveillance system based on that of the US National Healthcare Safety Network. Several developing countries including Argentina, Turkey, Colombia, India, Mexico, Brazil, and Peru have participated in INICC. The surveillance data from academic teaching, private community and public hospitals get involved. By type of the ICUs, patients were mostly hospitalised in medical, surgical, coronary, paediatric and newborn units. According to the INICC data, device associated infection rates reported in ICUs in developing countries were 19.5 for VAP, 9.2 for CRBSI and 6.5 for CAUTI in 1000 device days. Compared with the National Nosocomial Infections Surveillance of USA, these rates were 3.1, 2.3 and 1.5, respectively[10].

The results of INICC studies also concluded that infection control strategies significantly reduced infection rates in developing countries. After multidimensional approach interventions (education, bundles, performance feedback, etc.), implemented reduction rates from the reported baseline were 55.8 % in VAP, 54 % in CRBSI and 37% in CAUTI[10–12].

Available information about epidemiology and surveillance of ICU-acquired infections in most African countries are still lacking and underestimated, reflecting the limited resources and serious economic problems of this continent. After the implementation of WHO's hand hygiene improvement strategy, favourable results were reported and demonstrated that these promotions are effective in low-income settings[9].

Major infectious agents in ICUs

The European Prevalence of Infection in Intensive Care study has mostly included data from western European countries. The most common site of infection was the respiratory system (64%), followed by abdomen (20%), bloodstream (15%) and genitourinary system (14%). The causative agents of infections were 47% gram- positive pathogens, 62% gram-negative pathogens and 19% fungal pathogens. *Staphylococcus aureus* (20%) was the most common gram-positive pathogens, while *Pseudomonas* species (20%) and *Escherichia coli* (16%) were the most common gram-negatives reported in patients[7]. This study also concluded that the infection rates were related to healthcare spending, with higher rates of infection reported in countries that had a lower proportion of gross domestic product devoted to healthcare. More recently, another study from Turkey reported changing prevalence and antibiotic susceptibility of pathogens in ICUs. *A. baumannii* (21.8%) was the most common gram-negative pathogen with an increasing carbapenem resistance. On the other hand, *S. aureus* is still the most prevalent gram-positive pathogen, but the incidence decreased from 18.6% to 4.8%. Methicillin resistance decreased in *S. aureus* from 96% to 54%[13].

Antibiotic resistance problems in ICUs

Antibiotic resistance rates among bacterial pathogens isolated in association with ICU infections represent major problem worldwide. Especially, treatment becomes more challenging in gram-negative organisms causing serious infections in ICUs including pneumonia, bloodstream infections, wound or surgical site infections, and meningitis. These organisms exhibit multidrug resistance, and therapeutic alternatives have declined due to stagnation in novel antimicrobial agents [14]. An update of Infectious Diseases Society of America in 2009 identified five gram-negative organisms as 'ESKAPE' including *Pseudomonas aeruginosa*, *A. baumannii*, *Klebsiella pneumoniae*, *E. coli* and *Enterobacter* species associated infections with

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significant morbidity, mortality and financial costs[15].

Carbapenems are preferred antibiotics for severe infections of ICU-acquired infections caused by drug-resistant gram-negative bacteria especially for the extended spectrum beta-lactamase producers. Carbapenem resistance among *P. aeruginosa* and *A. baumannii* and recently *Klebsiella* species has emerged with increasing prevalence. These pathogens cause serious ICU infections, and clinicians need to use old drug alternatives such as 'colistin' in the treatment of serious infections due to MDR gram-negative bacteria. Clinical experience about colistin used in the treatment of Acinetobacter infections is mostly reported. Outcomes were favourable with a success rate of 83.8% and side effects (renal failure, seizures, etc.) reported with a rate of 4.6%[16].

Since *A. baumannii* is the most prevalent gram-negative pathogen, with increasing carbapenem resistance, tigecycline is a new option for the treatment of infections caused by this organism. Positive outcomes were reported 81% of patients, similar to colistin rates. Authors also reported better outcomes with this agent in the treatment of surgical site infections than VAP or bacteremia[17].

A novel acquired carbapenemase (class B), New Delhi Metalo-beta-lactamase-1 (NDM-1), which can be produced by *Enterobactericeae species,* was first identified and reported from Sweden in 2009 originating from India. Later, NDM-1 was detected in isolates obtained from patients in India and Pakistan, followed by the Middle East and Egypt, and later from several different countries from all continents. This pathogen is rapidly spreading worldwide, causing a global public health threat. Colistin and tigecycline seems to be effective *in vitro* against these isolates[18].

Methicillin-resistant *S. aureus* (MRSA) and vancomycin-resistant enteroccocus represent the most commonly reported gram-positive MDR pathogens in the ICU. MRSA causes community- and healthcare associated infections, and about 20% of the healthy subjects persistently have nasal colonisation with *S. aureus*. According to the European Antimicrobial Resistance Surveillance System (EARSS) reports[19], MRSA prevalence decreased from 41.9% in 2006 to 22.4% in 2012. Studies reported that decreased antibiotic consumption strategies (cephalosporins, quinolones) were associated with the decline of prevalence of MRSA[19]. Also, emergence and spread of resistant gram-negative pathogens seem to occur as global endemicity, causing a change in the epidemiology worldwide. During the last decade, vancomycin-intermediate S. *aureus* strains were reported in America as a result of long term and excessive use of vancomycin in hospitals. However, this do not currently seem to be a serious problem in Turkey, since a multicentre study determined no resistance or decreased susceptibility to vancomycin[20].

Annual proportion of vancomycin resistance among *Enterococcus faecium* in 2012 was reported to be the highest at 45% compared to previous years according to EARSS[19].

Emergence of resistant pathogens generates a global wave spreading between continents. Consequently, antibiotic resistance is a worldwide problem requiring co-ordinated international surveillance and infection control measures.

Acinetobecter infections, molecular epidemiology and drug resistance problem in ICUs

A. baumanni is an aerobic, non-fermentative gram-negative coccobacillus. *Acinetobacter* species have low virulence; however, they are opportunistic agents in hospitalised and critically ill patients, causing VAP, bacteraemia and urinary tract infections. *The bacterium is* strongly associated with environmental contamination. The pathogen is adapted to survive and colonise in the hospital environment, especially in ICUs, and is responsible for serious outbreaks[20]. Nosocomial pneumonia is the most common pathogens clinical presentation. *A. baumannii* is among the most common to cause late-onset VAP and the second most common pathogen to cause bloodstream infections acquired in hospitals[15,21]. Further, *A. baumannii* is responsible for various nosocomial infections including central nervous system, skin and soft tissue and bone infections[22].

MDR *Acinetobacter* isolate increase therapeutic difficulty and result in high mortality rates. *A. baumannii* has become resistant to almost all antimicrobial agents including cephalosporins, quinolones, aminoglycosides and broad spectrum β-lactams including carbapenems. Although carbapenems have been successfully used in treating most gram-negative nosocomial infections, emergence of MDR pathogens such as *A. baumannii* has menaced the use of this substantial class of drugs. Several studies have shown increased 'carbapenem resistance' throughout the world[15–17].

Wide range of resistance mechanisms are involved, such as (i) loss of outer membrane proteins (porin channels) causing decreased permeability to antibiotics, (ii) alterations in penicillin-binding proteins, (iii) overexpression of efflux pump proteins, further decreasing concentration of antibiotics within the cell and (iv) hydrolysis of β-lactams by β-lactamases encoded by either plasmids or chromosome[23]. Furthermore, combination of these mechanisms can cause high levels of resistance to carbapenems in *Acinetobacter* species. Carbapenem-resistant *A. baumannii* is associated with prolonged hospitalisation and a higher mortality rate.

Many β-lactamases have been characterised in *A. baumannii*; chromosomally-encoded (AmpC type) cephalosporinases are common and inactivate all cephalosporins. Class-A extended spectrum β-lactamases

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(ESBLs) conferring resistance against penicillins and cephalosporins have also been described, such as VEB-1 from Argentina and Belgium; PER-2 from Bolivia, Turkey, Romania, Argentina and Korea; SHV-12 from China, and CTX-M-2 and CTX-M-3 from Japan and Bolivia[23–25]. Metallo-β-lactamases (MBLs) belonging to class-B ESBLs are able to hydrolyse all β-lactams except aztreonam. MBLs such as IMP-1 are isolated from Japan, Korea and other Pacific regions, and VIM- and SPM-types are widespread in Korea and Latin America[26]. Class D OXA β-lactamases are strong penicillinases, able to hydrolyse extended spectrum cephalosporins and inactivate carbapenems. Plasmid-mediated OXA-58 is isolated from Iraq, Argentina, Greece, Turkey, Romania, Kuwait and western Europe[27–29]. Moreover, OXA-51 is chromosomally mediated and naturally present in *A. baumannii*. Other OXA-β-lactamases include OXA-23-like, OXA-24, OXA-25, OXA-26, OXA-27 and OXA-40, which are able to hydrolyse carbapenems[26].

Since carbapenem resistance has been reported world wide newer alternatives such as colistin, sulbactam, rifampicin and tigecycline and combinations of these antibiotics have arisen. Unfortunately, extensive use of colistin and tigecycline has resulted in resistance to these antibiotics; this has been increasingly reported. Development of resistance to colistin and tigecycline is the most serious problem in gram-negative infections including *Acinetobacter* in ICUs. This is because infections with a bacterium resistant to all FDA- approved antibiotics are in an incurable condition. Thereupon, these outcomes clearly reveal the importance of understanding the mechanisms of drug resistance in these bacteria.

Different combinations of colistin, carbapenems, sulbactam, aminoglycosides and rifampicin were studied to find a solution to the therapeutic limitation of MDR and pandrug-resistant Acinetobacter strains. *In vitro* synergy of colistin and rifampicin combination seems promising, requiring experience in clinical use[30]. Combination therapies are new therapeutic options to decrease resistance rates and advised for preventing emergence of colistin resistance during monotherapy. Optimum therapeutic alternatives for resistant *Acinetobacter* infections should be studied and clinical experiences with different combinations should be reported in future researches.

Infection control in ICUs is rationale

Although it is difficult to solve some problems associated with financial hardship in developing countries, most solutions are simple and not resource demanding. Hand hygiene is the most important component reducing the spread of infections in ICUs. In countries with limited resources, structured training in hand hygiene and hand hygiene promotion campaigns have been reported to improve the adherence among healthcare workers. Initial empirical therapy with broad-spectrum antibiotics is a life-saving strategy, which improves clinical outcome and minimise selection of resistant organisms. It is also recommended to de-escalate these antibiotics according to culture and antibiotic susceptibility results. Antibiotic cycling is also an effective approach to control antibiotic resistance. Strict antibiotic policies in ICUs prevent the use of long term, unnecessary antibiotics and shorten the duration of the antimicrobial therapy[4]. Conducting infection surveillance and control activities in ICUs and rational antibiotic utilisation policies are valuable measures for infection control. These measures provide current knowledge about antibiotic resistance patterns, early recognition and management of outbreaks, which is essential for infection control[31]. Several healthcare settings have succeeded in reducing the risk by implementing with these simple, low-cost interventions. Healthcare facilities should provide periodical educational programmes to ICU staff for infection control and evaluate for effectiveness. Surveillance activities, hand hygiene promotions, rational use of antibiotics and other isolation procedures need to be regularly supported and encouraged by good role models in institutions, local and governmental managers and other infection control organisations these should be extensively encouraged in developing countries[31].

Risk factors of Acinetobacter infection are already known and acute vaccination and antibody-based immune therapies for patients at the risk of these infections looks promising to prevent infections and improve outcomes.

Conclusion

ICU-acquired infections and antibiotic resistance is a growing threat worldwide. Large scale studies of ICU-acquired infections in developing countries are needed for understanding the magnitude of the problem. Furthermore, guidelines including globally applicable infection control strategies that constitute an effective solution to reduce these infections are essential.

References

1. WHO. Health care associated ınfections fact sheet: World Health Organization, 2011.
2. Tutuncu EE, Gurbuz Y, Sencan I, Ozturk B, Senturk GC, Kilic AU. Device-associated infection rates and bacterial resistance in the intensive care units of a Turkish referral hospital. Saudi Med J. 2011 May; 32(5):49–94.
3. Leblebicioglu H, Rosenthal VD, Arikan OA, Ozgultekin A, Yalcin AN, Koksal I, et al. Device-associated hospital-acquired infection rates in Turkish intensive care units. Findings of the International Nosocomial Infection Control Consortium (INICC). J Hosp Infect. 2007 Mar; 65(3):51–7.
4. Alp E, Leblebicioglu H, Doganay M, Voss A. Infection control practice in countries with limited resources. Ann Clin Microbiol Antimicrob. 2011 Oct; 10:36.
5. Alp E, Kalin G, Coskun R, Sungur M, Guven M, Doganay M. Economic bur-

Competing interests: none declared. Conflict of Interests: none declared.
All authors contributed to the conception, design, and preparation of the manuscript, as well as read and approved the fi nal manuscript.
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den of ventilator-associated pneumonia in a developing country. J Hosp Infect. 2012;81(2) Jun; 128–30.
6. 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. 2007 Jan; 13(1): 97–103.
7. Vincent JL, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, et al. International study of the prevalence and outcomes of infection in intensive care units. JAMA. 2009 Dec;302(2):2323–9.
8. Dunser MW, Bataar O, Tsenddorj G, Lundeg G, Torgersen C, Romand JA, et al. Differences in critical care practice between an industrialized and a developing country. Wien Klin Wochenschr. 2008 Sep;120(1920):600–7.
9. Bagheri Nejad S, Allegranzi B, Syed SB, Ellis B, Pittet D. Health-care-associated infection in Africa: a systematic review. Bull World Health Organ. 2011 Oct; 8(10):757–65.
10. Rosenthal VD, Maki DG, Mehta A, Alvarez-Moreno C, Leblebicioglu H, Higuera F, et al. International Nosocomial Infection Control Consortium report, data summary for 2002-2007, issued January 2008. Am J Infect Control. 2008 Nov; 36(9):627–37.
11. Rosenthal VD, Alvarez-Moreno C, Villamil-Gomez W, Singh S, Ramachandran B, Navoa-Ng JA, et al. Effectiveness of a multidimensional approach to reduce ventilator-associated pneumonia in pediatric intensive care units of 5 developing countries: International Nosocomial Infection Control Consortium findings. Am J Infect Control. 2012 Aug ;40(6):497–501.
12. Rosenthal VD, Todi SK, Alvarez-Moreno C, Pawar M, Karlekar A, Zeggwagh AA, et al. Impact of a multidimensional infection control strategy on catheter-associated urinary tract infection rates in the adult intensive care units of 15 developing countries: findings of the International Nosocomial Infection Control Consortium (INICC). Infection. 2012 Oct;40(5):517–26.
13. Alp E, Kiran B, Altun D, Kalin G, Coskun R, Sungur M, et al. Changing pattern of antibiotic susceptibility in intensive care units: ten years experience of a university hospital. Anaerobe. 21 1 Dec 1;17(6):422–5.
14. Rahal JJ. Antimicrobial resistance among and therapeutic options against gram-negative pathogens. Clin Infect Dis. 2009 Aug; 4(Suppl 1):S4–S10.
15. Boucher HW, Talbot GH, Bradley JS, Edwards JE, Gilbert D, Rice LB, et al. Bad bugs, no drugs: no ESKAPE! An update from the Infectious Diseases Society of America. Clin Infect Di. 2009 Jan;48(1): 1–12.
16. Paksu MS, Paksu S, Karadag A, Sensoy G, Asilioglu N, Yildizdas D, et al. Old agent, new experience: colistin use in the paediatric Intense Care Unit – a multicentre study. Int J Antimicrob Agents 2012 Aug;40(2):140–4.
17. Metan G, Alp E, Yildiz O, Percin D, Aygen B, Sumerkan B. Clinical experience with tigecycline in the treatment of carbapenem-resistant Acinetobacter infections. J Chemothe. 2010 Apr;22(2):110–4.
18. Kumarasamy KK, Toleman MA, Walsh TR, Bagaria J, Butt F, Balakrishnan R, et al. Emergence of a new antibiotic resistance mechanism in India, Pakistan, and the UK: a molecular, biological, and epidemiological study. Lancet Infect Ds. 2010 Sep;10(9):597–602.
19. ECDC. Antimicrobial resistance surveillance in Europe. Annual report of the European Antimicrobial Resistance Surveillance Network (EARS-Net). Stockholm, 2012.
20. Hota B. Contamination, disinfection, and cross-colonization: are hospital surfaces reservoirs for nosocomial infection? Clin Infect is. 2004 Oct;39(8):1182–9.
21. Alp E, Esel D, Yildiz O, Voss A, Melchers W, Doganay M. Genotypic analysis of Acinetobacter bloodstream infection isolates in a Turkish university hospital. Scand J Infec Dis. 2006 Jan;38(5):335–40.
22. Metan G, Alp E, Aygen B, Sumerkan B. Acinetobacter baumannii meningitis in post-neurosurgical patients: clinical outcome and impact of carbapenem resistance. J Antimicrob Cheother. 2007 Jul;60(1):197–9.
23. Poirel L, Nordmann P. Carbapenem resistance in Acinetobacter baumannii: mechanisms and epidemiology. Clin Microbiol Infect. 2006 Sep;12(9):826–36.
24. Celenza G, Pellegrini C, Caccamo M, Segatore B, Amicosante G, Perilli M. Spread of bla(CTX-M-type) and bla(PER-2) beta-lactamase genes in clinical isolates from Bolivian hospitals. J Antimicrob Cemother. 2006 May;57(5):975–8.
25. Nagano N, Nagano Y, Cordevant C, Shibata N, Arakawa Y. Nosocomial transmission of CTX-M-2 beta-lactamase-producing Acinetobacter baumannii in a neurosurgery ward. J Clin Mcrobiol. 2004 Sep;42(9):3978–84.
26. Turton JF, Kaufmann ME, Glover J, Coelho JM, Warner M, Pike R, et al. Detection and typing of integrons in epidemic strains of Acinetobacter baumannii found in the United Kingdom. J Clin Microbiol. 2005 Jul;43(7):3074–82.
27. Pasteran F, Rapoport M, Petroni A, Faccone D, Corso A, Galas M, et al. Emergence of PER-2 and VEB-1a n Acinetobacter baumannii Sstrains in the Americas. Antimicrob Agents Chemother. 2006 Sep;50(9): 3222–4.
28. Vahaboglu H, Ozturk R, Aygun G, Coskunkan F, Yaman A, Kaygusuz A, et al. Widespread detection of PER-1-type extended-spectrum beta-lactamases among nosocomial Acinetobacter and Pseudomonas aeruginosa isolates in Turkey: a nationwide multicenter study. Antimicrob Agents Chemother. 1997 Oct;41(10):2265–9.
29. Yong D, Shin JH, Kim S, Lim Y, Yum JH, Lee K, et al. High prevalence of PER-1 extended-spectrum beta-lactamase-producing *Acinetobacter* spp. in Korea. Antimicrob Agens Chemother. 2003 May;47(5):1749–51.
30. Li J, Nation RL, Owen RJ, Wong S, Spelman D, Franklin C. Antibiograms of multidrug-resistant clinical Acinetobacter baumannii: promising therapeutic options for treatment of infection with colistin-resistant strains. Cin Infect Dis. 2007 Sep;45(5):594–8.
31. Alp E, Ozturk A, Guven M, Celik I, Doganay M, Voss A. Importance of structured training programs and good role models in hand hygiene in developing countries. J Infct Public Health. 2011 Jun;4(2):80–90.

Competing interests: none declared. Conflict of Interests: none declared.
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