An outbreak investigation of extensively drug-resistant Acinetobacter baumannii cases in the intensive care unit of Al-Qatif Central Hospital, Saudi Arabia

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Abstract

Background: *Acinetobacter baumannii* has emerged as an extremely disturbing pathogen for several institutions worldwide. It is common in hospital environments, and outbreaks of Acinetobacter infections classically arise in intensive care units (ICUs). This investigation aimed to describe the extensively drug-resistant *Acinetobacter baumannii* (XDRAB) outbreak, which occurred in the intensive care unit (ICU) of Al-Qatif central hospital, Saudi Arabia.

Methodology: This is a cross-sectional study for all positive (XDRAB) reported cases in the ICU of Al-Qatif Central Hospital, Eastern region during August and September 2019. Investigation of cases was based on the patient's files, charts, lab records, interviewing the infection prevention and control team of the hospital, and the directorate. Microbiological and environmental samples were collected and tested for XDRAB.

Results: A total of nine patients tested positive. Eight of the cases were male, and only three of them were Non-Saudi. The age ranged from 21 to 82 years, the mean age was 48.6 ± 21.14 years, and the mean length of ICU stay was eight ± 5.75 days. The environmental samples and the swabs from the health care workers (HCW) hand results were negative for XDRAB. Eight of the nine affected patients were on a mechanical ventilator (OR 9.2, 95% CI:1.09-77.9, P = 0.029), and according to the control chart, there was a previous outbreak attack in early 2019.

Conclusion: The ICU of Al-Qatif hospital experienced an XDRAB outbreak in August, and it continued till September 2019. There was a previous outbreak with the same organism early in the same year, which required a strong adherence to the control and prevention measures and further analytical studies to find out the reasons behind the recurrent XDRAB outbreak.

Key Words: *Acinetobacter baumannii,* outbreak investigation, drug-resistance, Saudi Arabia.

Introduction

Acinetobacter baumannii organism is a gram-negative coccobacillus bacteria. It has become known now as a main cause of hospital- and community-acquired illnesses, and was, in the past, considered as a low type pathogen (1). *A. baumannii* can survive under a wide range of environmental conditions and persist for prolonged periods on surfaces, walls, and medical devices, which makes it a frequent cause of outbreaks and endemics, especially in health care settings (2). *A. baumannii* is widely distributed in various environments, including soil, water, vegetables, wastewater, and skin (animal and human). Besides, it has been isolated from different parts of the healthy human body, including the nose, throat, ear, trachea, conjunctiva, axillae, hands, groin, and toe webs. In the health facilities environment, *A. baumannii* inhabits beds, curtains, roofs, walls, medical machines, and equipment, tap water sinks, phones, doorknobs, hand disinfectants, as well as on the medical staff's belongings (3).

A. baumannii has the capability to infect not just admitted patients but also the general community. In hospital settings, 26% up to 43% of the mortality rate in the intensive care units (ICUs) is caused by *A. baumannii. A. baumannii* is the main-agent of ventilator-associated pneumonia and is responsible for almost 15% of the whole hospital-acquired infections and high morbidity and mortality rates, especially in the ICU. It accounts for nearly 50% of the overall use of antibiotics in the ICUs (4). *A. baumannii* has also been associated with community-acquired pneumonia, which is associated with mortality rates between 40% to 60% and often related to underlying host factors such as smoking, alcohol use, diabetes mellitus, and chronic obstructive pulmonary disease (COPD) (5).

ICU-acquired bloodstream infection caused by Acinetobacter was more than in other wards or departments (1.6% vs. 0.9%, respectively, in those locations), as a result of invasive techniques, either intravascular or respiratory (catheters, tubes, or cannulas). Furthermore, the mortality rate from Acinetobacter bloodstream infection was 34.0% up to 43.4% in the ICU compared to 16.3% outside the ICU (6).

Acinetobacter is accountable for 4% of all meningitis; the majority of cases occurred in post-neurosurgical procedures. Clinical symptoms are similar to bacterial meningitis caused by other organisms, (e.g., *Streptococcus pneumonia, Neisseria meningitides,* or *Haemophilus influenza*), and include fever, decreased level of consciousness, headache, and convulsion. The mortality rate is not easy to estimate, but it may be as high as 70% (6). Acinetobacter is a known pathogen of burns units, and it is incredibly challenging for clinicians to treat due to multi-resistant strains, and it might require a debridement procedure. Wound healing delay leads to failure of the skin graft, and colonization of the wound site can progress to infection of the underlying tissue and subsequent systemic spread of the organism (5). Soft-tissue infections caused by *A. baumannii* have emerged as a significant problem in military personnel; its prevalence is more noticeable (32%). *A. baumannii* is not a frequent organism of urinary tract infections (UTIs); however, it can cause infection in old aged patients, especially those with a prolonged indwelling catheter in the ICU; it contributes 1.6% of the overall UTIs. Furthermore, it may cause endocarditis, and ophthalmitis following surgery, or using contact lenses (7).

Risk factors for developing hospital-acquired *A. baumannii* infection include extended hospital stays, old age, chronic diseases, immunity suppression diseases, massive trauma or burns, previous antibiotic usage, invasive procedure, mechanical ventilator, and urinary catheter. On the other hand, community-acquired Acinetobacter infection occurred in individuals with underlying health problems, such as diabetes mellitus, COPD, heavy smokers, or alcohol abusers. Despite that, it is not clear as to whether the host or the bacteria factors are responsible for the difference in disease presentation between the hospital or community-acquired infection (8).

The World Health Organization (WHO) has lately recognized antimicrobial resistance as one of the three most significant problems facing human health (9). In the USA, a report from the Centers for Disease Control and Prevention (Antimicrobial Resistance Threats in the United States), highlighted multidrug-resistant Acinetobacter as a serious risk that leads to almost 7,000 infections and around 500 deaths every year in the US (10). The presence of multidrug-resistant *A. baumannii* in Saudi Arabia has become a critical healthcare and economic problem and also a big challenge in several tertiary referral health hospitals. The findings of many studies conducted in different regions in Saudi Arabia confirmed that *A. baumannii* was becoming increasingly resistant to different categories of antimicrobial drugs (11).

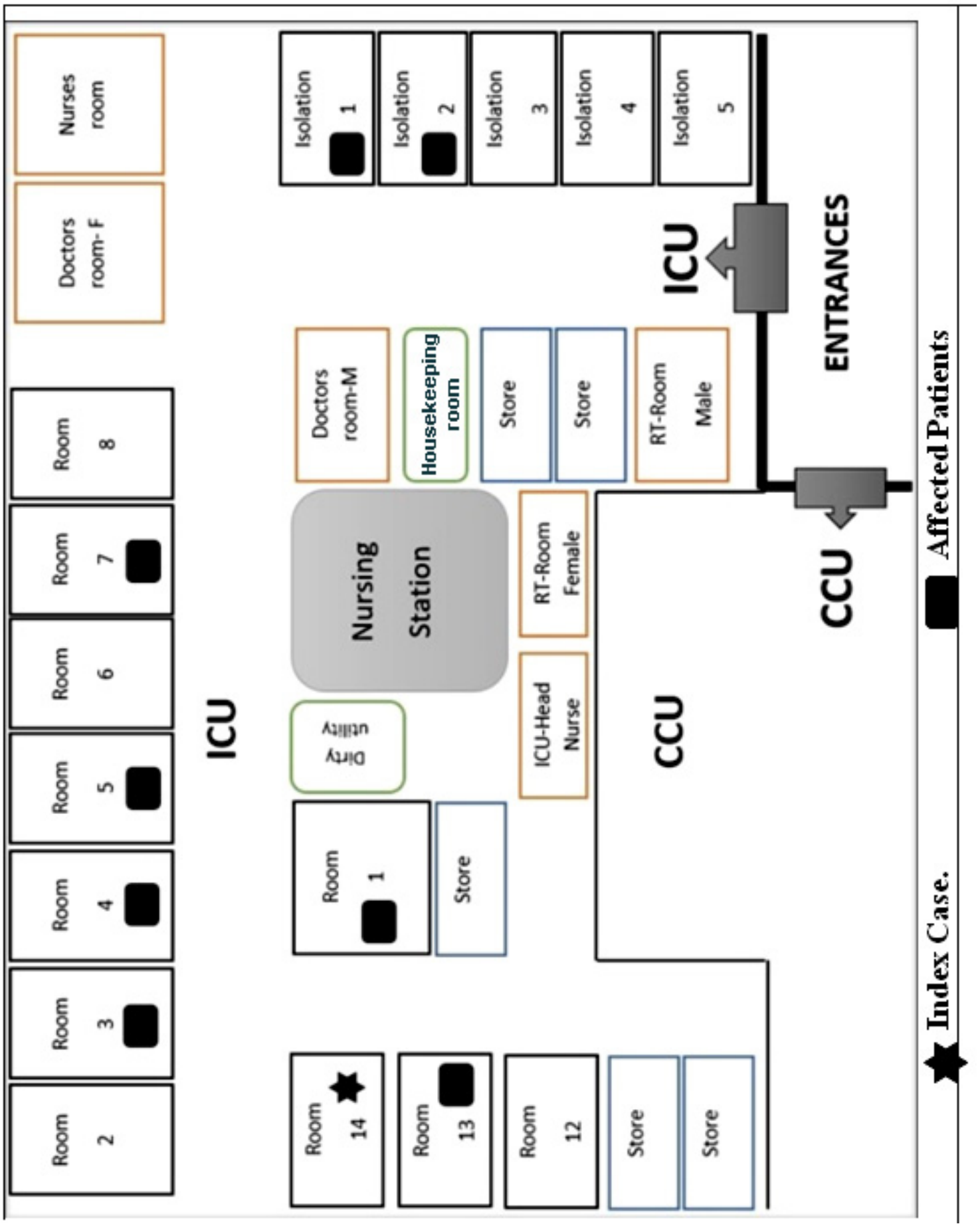
The aim of this investigation is to describe the outbreak of XDR *A. baumannii* in the ICU of Al-Qatif central hospital during August and September 2019, and to assess the control measures implemented to control the spread of this organism.

Methodology

Setting:
Al-Qatif Central Hospital in Al-Qatif governorate, on Dhahran-Jubail Highway, Eastern region. The 15-bed ICU is on the first floor of the hospital, arranged as single patient bed per room; five of them are negative pressure rooms used for airborne infected cases (Figure 1).

Study design:
This is a cross-sectional study including all inpatients of the Al-Qatif Central Hospital ICU, Eastern region during August and September 2019.

Figure 1: Map of the ICU of Al-Qatif Central Hospital



Data collection and field investigation:
A team from the Field Epidemiology Training Program (FETP) was constituted, composed of one resident and one supervisor (FETP staff). On September 30th, 2019, the team went to the Al-Qatif central hospital to investigate this outbreak. After arrival at the hospital, a meeting was conducted with coordinators from the directorate to obtain an overview of the current situation. Then we went to the infection control and prevention department of the hospital; we met the head of the department and the staff to get more details about the outbreak, including the number of cases, onset, and progression of the outbreak, control, and preventive measures. Then we visited the ICU (the place of the outbreak) as well as the laboratory department.

Confirmed cases were defined as an adult patient admitted to the ICU of Al-Qatif Hospital between August and September 2019 with a healthcare-associated infection caused by an XDRAB isolate identified as non-susceptible to all major classes of antimicrobial but 1 or 2 drugs (Colistin or Tigecycline).

For each case, demographic data, ICU admission date and causes, comorbidities and diseases, length of stay in ICU, surgery or intervention (including devices like central lines, ventilators, and urinary catheter) history, presence of colonization or infection, and the outcome were documented. Investigation of cases was based on the patient's files, charts, data from the departments, records, and results from the laboratory.

Microbiological investigation:
Samples and swaps (sputum, blood, urine and skin) were ordered for all ICU patients and health care workers to determine infection or colonization. Further, they were tested for the antimicrobial susceptibility by using the Phoenix and Vitek 2 automated systems. The antibiotics tested were Amikacin, Gentamicin, Imipenem, Meropenem, Cephalexin, Cefuroxime, Cefoxitin, Ceftazidime, Cefepime, Aztreonam, Ampicillin, Amoxicillin and Clavulanate Potassium, Piperacillin-tazobactam, Sulfaprim, Nitrofurantoin, Ciprofloxacin, Levofloxacin, Tobramycin, Ceftriaxone, Ticarcillin, Colistin, Ticarcillin-clavulanic acid, Tigecycline, Minocycline, and Ertapenem.

Environmental investigation:
This was carried out through taking swabs from the respiratory equipment, physiotherapy machine, medication trolley, glucometers, intubation boxes, room tables, ABG machine, storeroom boxes, ECG machine, U/S machine, and doorknobs. Environmental samples were also collected from the reception, including its surfaces, keyboards and telephones.

Infection control measures:
The following were investigated: Notification system of panic values; Documented Training of the ICU personnel; Monitoring IPC records; Hand hygiene compliance records; Committee meetings minutes; and Infection control bundles compliance.

Data analysis
Analysis of data was done by the Statistical Package for Social Sciences (SPSS version 23.0) in addition to Microsoft Excel 360.

Results

Outbreak description and patient characteristics:
During August and September 2019, the ICU of Al-Qatif central hospital admitted 78 patients. 61 (78.2%) of them were on medical devices, including a central venous catheter (CVC), endotracheal tube (ETT), mechanical ventilator (MV), and urethral catheter (UC). More specifically, 40 (51.2%) ICU patients were connected to a mechanical ventilator.

A total of nine patients among the ICU patients were positive with XDRAB (11.5%). The patients were defined as XDRAB based on microbiological features. Seven of them were Saudi (77.7%), and three were Non-Saudi, (Indian, Sudanese, and Pakistani) (33.3%). Eight out of nine were male, and only one patient was a female (8/9, 88.8%). Age of the affected patients ranged from 21 to 82 years old, where the mean age was 48.6 ± 21.14 years. The mean length of ICU stay was eight ± 5.75 days (Figure 2, and Table 1).

The control chart for the XDRAB from Jan-2019 to Oct-2019 shows that the number of cases in August and September exceeded the expected level; therefore, this was considered an outbreak. Also, the control chart detected a previously unreported outbreak of the same organism early in the same year (Figure 3). Eight of the nine affected patients were on a mechanical ventilator before they got infected with XDRAB (OR=9.25; 95%CI: 1.09 - 77.9; P= 0.029 - Fisher's Exact Test).

The index case was a 21-year-old, Saudi male, admitted to the ICU on August 2, 2019, as a case of SLE with a flare-up, Pulmonary edema, Metabolic acidosis, Ascites, and acute kidney injury. He was on a mechanical ventilator, Tracheostomy, connected to the central venous line, and a Foley catheter before being *A. baumannii* positive. XDRAB was isolated from a tracheal aspirate sample obtained on August 10, 2019, 8 days after hospitalization. On August 24, he developed a fever, and another sample was taken from the urine, and it was positive for XDRAB. The infection was treated with antibiotics (i.e., Tazocin, Amoxicillin, Meropenem, or Colistin). The patient improved, but he remained in the ICU.

The second case was a 40-year-old Indian male, known case of Diabetes mellitus (DM) admitted to the ICU on August 14, 2019, as a case of community-acquired pneumonia, Sepsis. He was on a mechanical ventilator, connected to the central venous line and Foley catheter. On August 19, XDRAB was isolated from a tracheal aspirate sample, nine days after XDRAB isolation in the index case. The infection was treated with Vancomycin, Tazocin, and Colistin. The patient improved and was transferred to the medical ward.

The third case was a 31-year-old Sudanese male, admitted through ER on August 16 with polytrauma as a result of a road traffic accident. XDRAB was isolated from the sputum (Tracheal Aspirate) on August 25. He underwent various surgical procedures, and he was on a mechanical ventilator. He developed a fever, and a blood sample was taken on August 28; the result was positive for XDRAB. The patient was treated with Tazocin, Meropenem, Vancomycin, Fluconazole for the infection, but unfortunately, he died because of his poor condition.

The fourth case was a 60-year-old, Saudi male, known case of DM, hypertension, transferred from the CCU to the ICU on August 21, as a case of Viral encephalitis, seizure. A positive XDRAB culture from the sputum was detected on August 25. This patient was on a mechanical ventilator, connected to a central venous line and Foley catheter. The infection was treated with Vancomycin, colistin, and the patient was transferred to King Fahad Specialist Hospital.

After that, the infection spread throughout the ICU, involving three more patients (patients 5-7) who were hospitalized in the ICU in the same period. All of them had serious medical conditions, such as Ogilvie syndrome, ischemic heart disease and stroke. Except for the sixth case, who was still in the ICU, the Fifth and seventh cases improved after appropriate therapy, and one of them was discharged from the ICU.

Twelve days after the XDRAB detection from the seventh case, A. baumannii infection appeared again in the ICU. The eighth case, who suffered from perforated sigmoid, perforated gastric ulcer, perforated viscus, was admitted to the ICU on September 7, 2019. This case underwent gastric surgery and remained in the ICU. The ninth case was a 52-year-old, Saudi male, a known case of diabetes, hypertension. He was admitted because of lower limb ischemia. A blood sample and rectal swap were taken, and; they were positive for XDRAB. Several surgical procedures were done, but he arrested in the recovery room after the operation and died there.

Microbiological investigation

All isolates obtained from the nine patients during this outbreak were determined as A. baumannii. Antibiotic-resistant profiles showed that they were extensively drug-resistant strains. All of them were susceptible to Colistin and Tigecycline. Furthermore, the lab results for the ICU patients during August and September revealed the following organisms: Klebsiella pneumoniae (16.6%), Escherichia coli (7.7%), Pseudomonas aeruginosa (5.1%), and Staphylococcus aureus (5.1%).

Environmental investigation:

A total of 29 samples were collected from the ICU environment, and all of them were negative for XDRAB. Also, the swaps from the health workers hand and the housekeeper were negative for XDRAB.

Infection control measures:

After the confirmation of the outbreak, a series of plans were applied to control the infection as follows:

(1) Notifying the hospital infection prevention and control committee.
(2) Giving optimized antimicrobial therapy.
(3) Perform Proper and adequate cleaning of the equipment and environmental surface.
(4) Perform terminal cleaning and fumigation to the room after the patient's discharge.
(5) Hand hygiene campaign done, strictly executing hand hygiene protocols by all medical staff. (6) Maintain contact precaution for all positive patients.
(7) Changing the open suction system to the closed system for every patient.

Table 1: Clinical characteristics of patients with an extensively drug-resistant *Acinetobacter baumannii* infection, ICU of Al-Qatif central hospital during August and September 2019.

No.	Sex	Age (Y)	Reason for admission	ICU stay prior to infection (days)	XDRAB isolate date	Invasive procedures	Outcome
1	M	21	SLE, Pulmonary edema, Metabolic acidosis, Ascites, Acute kidney injury.	8	10-Aug-19	MV, CVC, UC, TRACH, ETT	Improved, still in ICU
2	M	40	CAP, Sepsis	5	19-Aug-19	MV, CVC, UC, ETT	Improved, transferred
3	M	31	Polytrauma, Road Traffic Accident	9	25-Aug-91	MV, CVC, UC, ETT	Death
4	M	60	Viral encephalitis, seizure	4	25-Aug-19	MV, CVC, UC, ETT	Transferred to KFSH
5	M	82	Ogilvie syndrome, septic shock	7	1-Sep-19	MV, CVC, UC, ETT	Improved
6	M	67	Ischemic Heart Disease, stroke	17	5-Sep-19	MV, CVC, UC, ETT	Still in ICU
7	M	23	Hypoglycemia, Seizure	6	15-Sep-19	MV, CVC, UC, ETT	Improved
8	F	62	Perforated sigmoid, perforated gastric ulcer, perforated viscus	20	27-Sep-19	MV, CVC, UC, ETT	Still in ICU
9	M	52	Chronic right lower limb ischemic, disturbance of consciousness	4	30-Sep-19	CVC, UC, ETT	Death

CVC: central venous catheter; ETT: endotracheal tube; F: female; ICU: intensive care unit; M: male; MV: mechanical ventilation; TRACH: tracheostomy tube; UC: urethral catheter

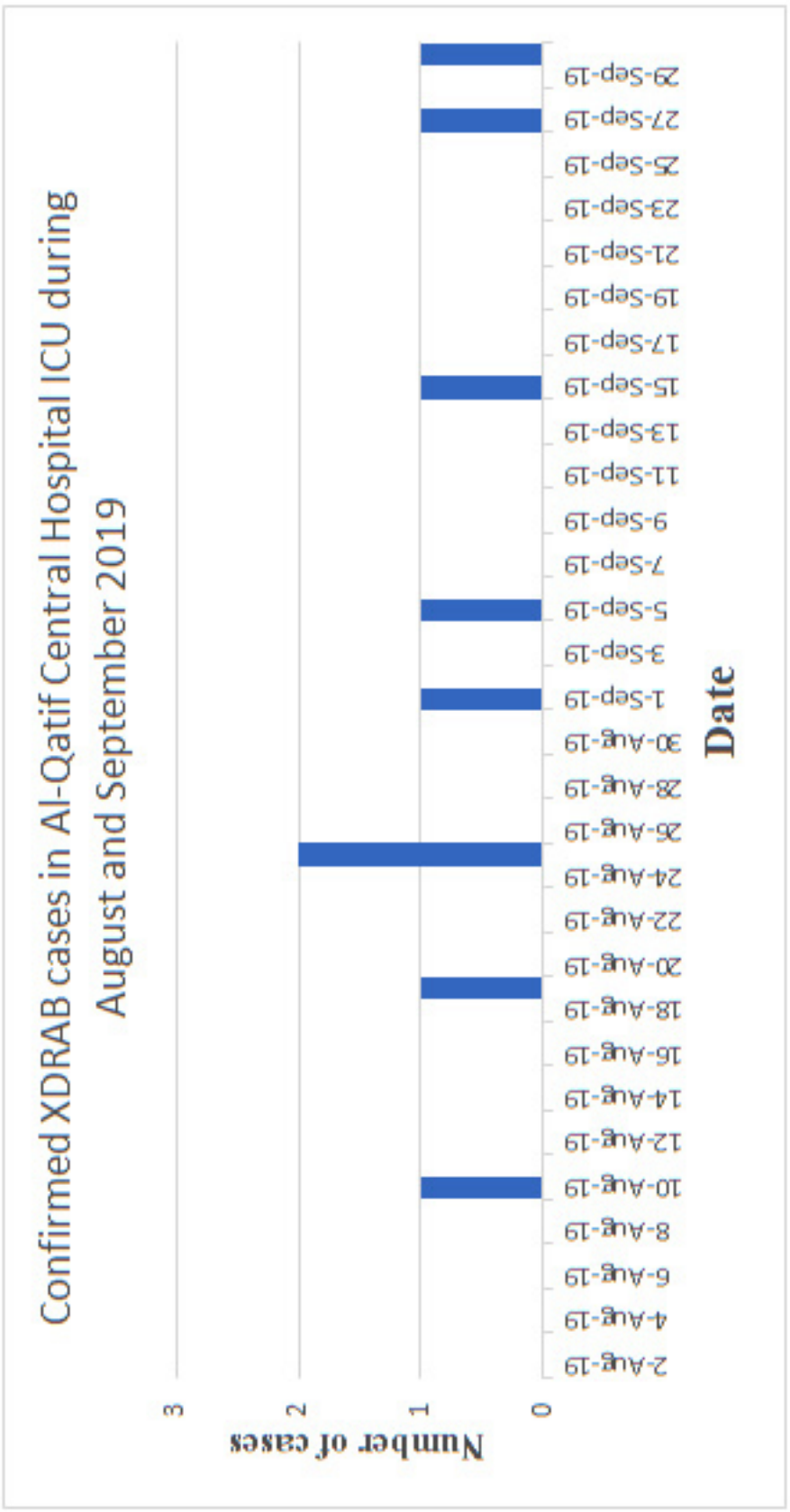
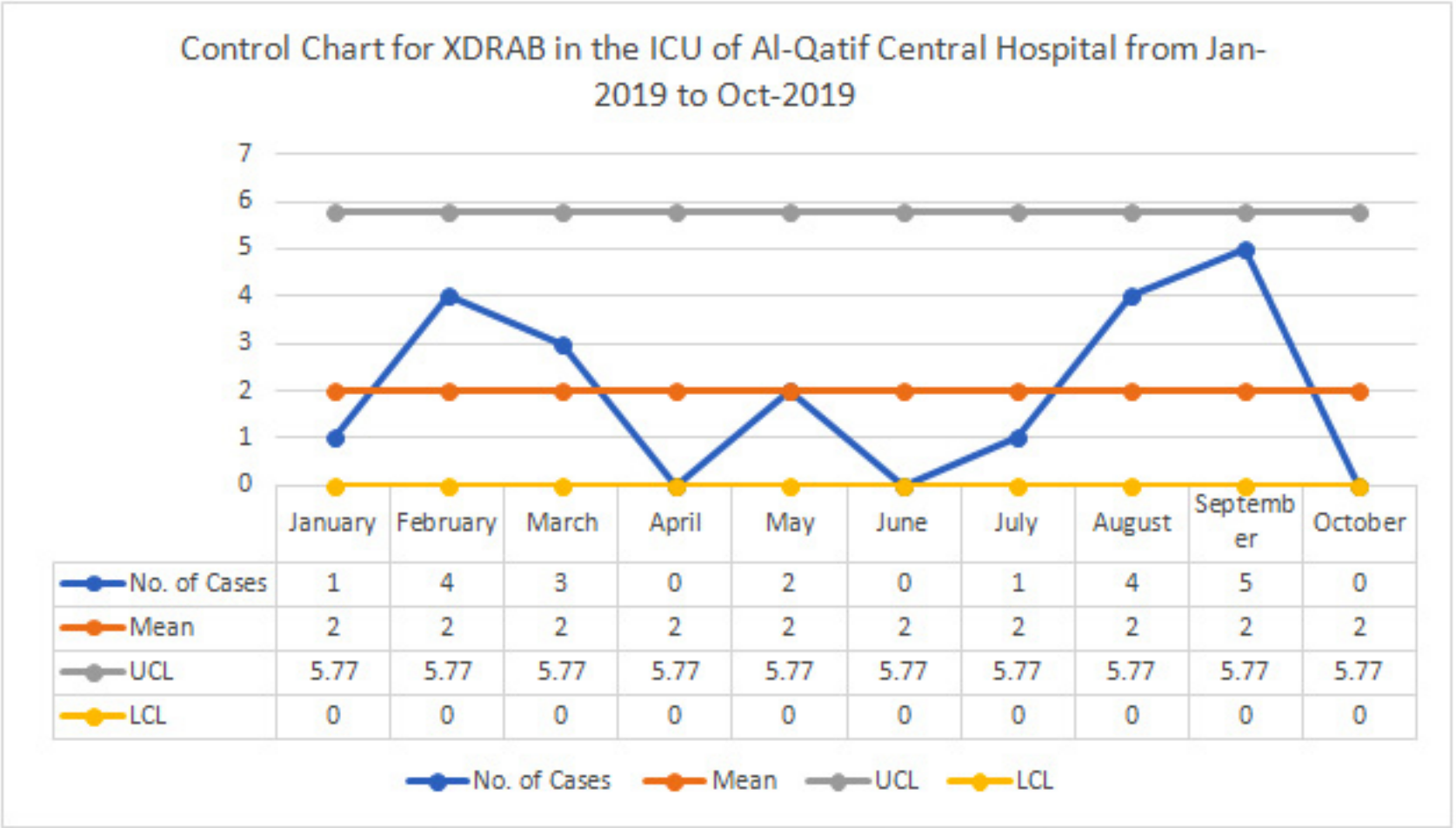


Figure 2: Epidemic curve of confirmed XDRAB cases in the ICU of Al-Qatif Central Hospital during August and September 2019.



UCL: Upper control level. LCL: Lower control level

Figure 3: Control Chart for XDRAB in the ICU of Al-Qatif Central Hospital from Jan-2019 to Oct-2019.

Discussion

Acinetobacter baumannii has emerged as a leading hospital-acquired infection pathogen, particularly in critically ill patients presenting multiple risk factors for colonization or infection (12). The reported incidence of institutional outbreaks has significantly increased throughout the past years, mainly in ICUs (13). The management of *A. baumannii* outbreaks can be difficult because of its ability to acquire multi-drug resistance and to spread epidemically between patients (14); also, the effective eradication from the environment might need numerous interventions and organizational actions (15).

Nine patients were positive for XDRAB in the ICU of Al-Qatif hospital between August 10 until September 30, 2019. Eight of them were male, and the age ranged from 21 to 82 years. Most of the involved patients in this outbreak were on a mechanical ventilator, which is a major predisposing risk factor for *A. baumannii*. In a study conducted by El-Saed in Saudi Arabia, *A. baumannii* is the most responsible bacteria for ventilator-associated pneumonia in the ICU (26.5%). Also, as ICU patients with so many morbidities, they were exposed to more prolonged ventilation times, which increases the opportunity for the *A. baumannii* outbreaks (16). Before this outbreak, the open suctioning system was applied, and the environmental contamination may be facilitated by the droplets spread through the opening of the respiratory circuit of ventilators (17). After that, it has been changed to a closed system and used for every patient in the ICU.

Prior antibiotic treatment within the last 90 days before admission is a significant risk factor for *A. baumannii* outbreaks, with almost seven times more risk in drug resistance to *A. baumannii* compared to non-drug resistance isolates (18). Other risk factors, including underlying comorbidities such as diabetes mellitus, renal insufficiency, COPD, malignancy, and surgical interventions, were also found to be a risk for developing an *A. baumannii* infection (19).

A. baumannii outbreaks could be a result of contaminated hands of the health care workers (HCW) after contact with positive cases or environmental sites (19). To prevent this situation, extensive educational sessions regarding infection control measures, hand hygiene, and personal protective equipment (PPE) required for outbreak control should be going on, especially for the new staff members who have just been hired and assigned to the ICU. In this outbreak, swaps of the physicians' and nurses' hands who were involved in patient care were not colonized with XDRAB. The visitors, the trainer residents, and interns from other departments of the hospital who had contact with the patients were not also screened for *A. baumannii.* So, a weak commitment to hand hygiene guidelines may enhance the spread of the outbreak (20).

Environmental contaminated sources include gloves of the staff, respiratory equipment, contact objects of infected patients, as well as other items like trolleys, doorknobs, telephones, table surfaces, and floor, are verified as vital risk factors for *A. baumannii* outbreaks (22). Hospital conditions, include the humidity in the ICU. It was at a high level and almost reached 70 %. This hot and moist climate forced the nurses to place portable fans inside patient's rooms. *A. baumannii* can survive in such conditions for an average of 20 days (21). Enhanced environmental cleaning and decontamination with hypochlorite solutions must be done to eliminate the organism from the ICU environment (23,21).

This investigation has some limitations. There were no records for other HCWs outside the ICU who contacted the affected patients and no swabs were taken from them. Also, this investigation was carried out in a descriptive manner; further analytical studies are recommended to discover the reasons and risks for XDRAB acquisition.

Conclusions

The ICU of Al-Qatif Central Hospital experienced an XDRAB outbreak in August and it continued till September 2019, with a total of nine cases. Eight of them were on medical devices, especially the mechanical ventilator, and most of the isolates were from the tracheal aspirates. Therefore, the open suction system has been changed to the closed system to prevent the droplets spreading through the opening of the respiratory circuit of ventilators. There was a previous outbreak with the same organism early in the same year, which required a strong adherence to the control and prevention measures and further analytical studies to find out the reasons behind the recurrent XDRAB outbreak. All cases were treated with the proper antibiotics, and two died because of their preexisting conditions.

Recommendations

Based on findings of the present study, continued educational sessions about hand hygiene and PPE, with competency test are recommended, especially for the new staff from the private hospital. Furthermore, close observation regarding their practice, and screening of any new patient entering the ICU for A. baumanii is required, moreover, to intensify the terminal cleaning using hydrogen peroxide in all units that have patients with positive XDRAB. Daily review of medical supply stock in the ICU should be undertaken to avoid zero stock. Daily recording for the humidity and temperature should be undertaken in addition, to restricting the ICU visitors to first degree relatives only and emphasizing to the security not to allow anyone (workers or visitors) to enter ICU before performing hand hygiene.

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