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Original Research Article

To Combat an Unusually High Prevalence of Device Dwelling Nosocomial Microorganism, "Acinetobacter Baumannii" in the Intensive Care Unit (ICU) of a Tertiary Care, Teaching Hospital : An Observational Trial

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ABSTRACT

Introduction: The occurrence of nosocomial infections is a major problem in Intensive Care Units (ICUs). The main causes for these are severity of underlying disease, indiscriminate and excessive use of broad spectrum antibiotics and more frequent use of invasive interventions. The commonly isolated organisms are *Klebsiella pneumoniae, Pseudomonas aeruginosa, Escherichia coli, Staphylococcus aureus, Coagulase negative staphylococci, Citrobacter freundii, Acinetobacter baumannii, Enterobacteriaceae species*, in that order. Multidrug-resistant (MDR) *A. baumannii* has recently emerged as an important cause of endemic nosocomial infections and epidemic outbreaks of infection.
Materials and Methods: This observational study was carried out by analyzing the culture reports of sample tips taken from the various invasive devices from the critical ill patients admitted in ICU over a period of 24 months and was executed in two sets from January 2014 to December 2015.
Result: In our first set of study, out of 250 cultures from 175 patients (115 males and 60 females) microorganisms, isolated from 135 cultures taken from 105 patients (70 males and 35 females), the most frequently isolated organism were *K. pneumoniae* (36.29%), *A. baumannii* (23.70%) and *Pseudomonas aeruginosa* (17.77%) respectively.
A. baumannii was surprisingly found to be the second most common microorganism as 23.70% (32) cultures. After implementation of various sets of interventions, the second set of data was collected, over the 6 months, and total 150 cultures were taken from 100 patients (65 males and 35 females) and microorganism were positive in 100 cultures and *A. baumannii* was positive in 16% (16). Thus the prevalence of *A. baumannii* had dropped from 23.7% to 16% after the implementation of interventions.
Conclusion: *A. baumannii* is a very resilient and persistent opportunistic microorganism and appears to be spreading mainly by the airborne method as well as contaminated surface and hands of the care givers.

Key words: To combat, *Acinetobacter baumannii*, Unusually High Prevalence, Intensive Care Unit, Interventional measures, Observational trial.
Key message: Find out the causes responsible for and try to control, the high prevalence of *A. baumannii in* the ICU.

INTRODUCTION

Nosocomial infections are a common health related problem in intensive care units (ICUs) [1] and major causes for it are the severity of underlying disease, indiscriminate and excessive use of wide spectrum antibiotics and more frequent uses of invasive interventions. [1,2] The increasing

trend of using invasive procedures like insertions of urinary catheters, central venous catheters, endotracheal tubes, tracheostomy tubes and chest & pelvic drains have a direct relationship with rising incidence of nosocomial infections in ICUs. [3-5]

Some of the commonly isolated organisms from these devices in the ICU are *Klebsiella pneumoniae, Pseudomonas aeruginosa, Escherichia coli, Staphylococcus aureus, Coagulase negative staphylococci, Citrobacter freundii, Acinetobacter baumannii, Enterobacteriaceae species*, in that order as shown by the various studies. [6-10] *A. baumannii* is generally occurring at a relatively lower place in the sequence of pattern of organisms extracted as per the available evidence on reviewing literature. [6-10]

Acinetobacter baumannii is an aerobic, non-fermentative, gram-negative coccobacillus that is widespread in the natural environment. [11,12] *A. baumannii* can colonize the skin of healthy individuals and has a remarkable capacity for extended survival on environmental surfaces and the potential for airborne spread. [13-15] It has been cultured from healthcare workers' hands and nails, as well as from environmental surfaces and air samples in intensive care units (ICUs) and it is known to cause nosocomial infections worldwide. [16-22] Multidrug-resistant (MDR) *A. baumannii* has recently emerged as an important cause of endemic nosocomial infections and epidemic outbreaks of infection. [16,20,22] Risk factors for the acquisition of MDR *A. baumannii* infection during outbreaks have included, the indiscriminate use of broad-spectrum antibiotics, longer hospitalization duration, male sex, receipt of mechanical ventilation and more frequent use of invasive devices used in the ICU,. [18,20,21, 23 -25]

The present study was, therefore, designed to find the causes and try to introduce the interventional means to combat with higher prevalence of a device dwelling, multidrug resistant nosocomial microorganism *A. baumannii*, isolates from critically ill patients admitted in intensive care unit (ICU) of a tertiary care teaching hospital in Malwa region of Punjab in India.

MATERIALS AND METHODS

This observational study was carried out in Adesh Institute of Medical Sciences and Research (AIMSR), Bathinda, Punjab, a tertiary care teaching center by the Department of Anaesthesiology and Intensive Care in collaboration with Department of Microbiology by analyzing the data from the culture reports of sample tips taken from the various invasive devices from the critical ill patients admitted in ICU, over a period of 24 months from January 2014 to December 2015. This was done in two sets,

I. Initially from January 2014 to June 2015
II. Later on from July 2015 to December 2015 (after implementing some specific interventions to combat and control the infection).

Data Collection

In this study, patients of all age groups, both sexes, who were critically ill, admitted in the ICU and underwent some invasive procedure like endotracheal intubation (with and without mechanical ventilation), tracheostomy tubes, central venous catheter, urinary catheter and chest and pelvic drains for more than 72 hours were included. The tips of endotracheal tube, tracheostomy tube, central venous catheter and urinary catheter were collected and sent for culture to the Microbiology department. Routine samples from the ICU, as per protocol also were sent for culture every weekly after the ICU sterilization. In addition samples were taken from the hands, nails and skin of the nursing staff and bed and the surroundings of the patients, who were positive for *A. baumannii*.

Data Analysis

The standard proformas were filled from various culture samples taken from the

invasive devices used in patients, hands, nails and skin of nursing staff and regular samples after sterilization in the ICU required data was collected, over the 24 months. Descriptive statistics were used to present demographics, infection rate, and isolation pattern of various microorganisms and their antibiogram were analyzed and then all intervention procedures had taken into action to combat the infection.

Interventions

Multiple sets of interventions were applied.

1. **Administrative:** The total administrative control of the was in the hands of consultant Anaesthesiologists on duty under the direct and continuous supervision of Professor, Head and In-Charge ICU, Department of Anaesthesiology and Intensive Care in regards with :-
    a. The decision-making about execution of interventions, especially, protocols for placements of endotracheal tubes, central venous catheters and tracheostomies.
    b. The time of proceeding for initiating and maintaining ventilation.
    c. Strict observation and supervision of the guidelines for weaning off as well as extubation.
2. **Precautionary and Preventive:** The Sister In-Charge and under supervision the nursing staff, was specifically re-indoctrinated with concepts of asepsis, disinfection and fumigation of the ICU
    a. Frequent washing of hands by nursing staff before and even after approaching individual patients.
    b. Use of antiseptic and hand sanitizer, every time before and after touching individual patients
    c. Changes of sterile water more frequently from the humidifiers of Oxygen flow meters.
    d. Strict observance of aseptic precautions while handling for suctioning and change of position
    e. Frequent changes of Scrubs (masks) by nursing staff.
    f. Frequent change of Gloves between the change-over from one patient to another.
    g. Fumigation of entire ICU cubicle on frequent basis, with aseptic collection of pre and post fumigation swabs.
3. **Logistical**
    a. Segregation of patients showing positive cultures for microorganisms and the high risk cases having chances of infection and clean cases.
    b. The staff nurse, nursing these patients had not been participating in care of other patients.
    c. The patients who had respiratory interventions scattered over entire ICU into various cubicles.
4. **Microbiological**
    a. Strict aseptic collection of samples in the labs.
    b. Immediate transportation and processing of specimen.
    c. Reporting specially of ICU patients done exclusively by the senior faculty.
    d. Settle plate method for microbiological sterility of air from vents in ICU.
    e. Microbiological profile of hands of medical personnel before and after use of disinfectants.
    f. Regular nasal and throat swab from medical personnel to detect carriers of microbes.
    g. Swab samples from humidifiers, ventilators and other equipment in ICU to detect microbes.
    h. Separate antibiotics policy for ICU patients.
5. **Therapeutic**
    a. No fishing around or haphazard permutation and combination, while prescribing the antibiotics to the patients with interventions.
    b. Upcoming empirical ladder approach was prohibited.
    c. A standard higher antibiotic regimen with a combination of broad spectrum anti-anaerobic drugs as per

the individual patient's requirement, after reviewing antibiotic sensitivity culture reports given by the Microbiology department.

RESULTS

In our first set of study, out of 250 cultures from 175 patients (115 males and 60 females) sent for cultures, microorganisms were isolated from 135 cultures taken from 105 patients (70 male and 35female). Out of the 135 cultures, 7 cultures were positive for Gram-positive bacteria (GPB) and 128 were positive for Gram-negative bacteria (GNB). The specimens assessed were: Endotracheal tube tip (35), urinary catheter tip (35) and tracheostomy tube tip (44). Central venous catheter tip (14), Thoracic and pelvic drain tip (7), accounted for 1 specimen each.

In first set, the most frequently isolated organism were *Klebsiella pneumoniae* (36.29%), *Acinetobacter baumannii* (23.70%) and *Pseudomonas aeruginosa* (17.77%) respectively and the infection pattern of organisms and number of different samples were given in Table 1.

Table 1: Frequency of microorganism isolated from patients admitted in ICU before applying the interventions. (These findings were presented in our previous study. [26] They are mentioned here for the sake of mere comparison).

No.	Microorganism	Type	Frequency (No of positive cases)
1	Klebsiella pneumoniae.	GNB	36.29% (49)
2	Acinetobacter baumannii	GNB	23.70% (32)
3	Pseudomonas aeruginosa	GNB	17.77% (24)
4	Escherichia coli	GNB	11.85% (16)
5	Staphylococcus aureus	GPB	4.44% (6)
6	Klebsiella species	GNB	2.96% (4)
7	Citrobacter freundii	GNB	1.48% (2)
8	Coagulase negative staphylococci	GPB	0.74% (1)
9	Enterobacteriaceae spp.	GNB	0.74% (1)
Total			**100% (135)**

A. baumannii was surprisingly found in a very high ratio as the second most common microorganism at 23.70%. The cultures showed positive result for *A. baumannii* out of total 135 patients in first set of our study. When compared to other studies in the available literature, this data was high in terms of prevalence, where as in most of other studies, the prevalence of *A. baumannii*, isolated as device dwelling nosocomial microorganism in the ICU was less than 10%. This data of such high prevalence in our ICU had been published in an international journal. [26]

After getting these dramatic and unusual results and a deep thought process and implementation of various sets of interventions, the second set of data was collected by the same pattern over the 6 months, after interventions had become well established. Total 150 cultures were taken from 100 patients (65 males and 35 females). Out of 150 cultures, microorganism was positive in 100 cultures and out of these 100 positive cultures 16% (16) were positive for *A. baumannii* as mentioned in the Table 2.

Table 2: Frequency of *A. baumannii* isolated from patients admitted in ICU after applying intervention measurements

No.	Microorganism	Type	Frequency (No.)
1	Klebsiella pneumoniae.	GNB	36.00%(36)
2	Pseudomonas aeruginosa	GNB	19.00%(19)
3	Escherichia coli	GNB	17.00%(17)
4	Acinetobacter baumannii	GNB	16.00%(16)
5	Staphylococcus aureus	GPB	5.00%(5)
6	Klebsiella species	GNB	3.00%(3)
7	Citrobacter freundii	GNB	2.00%(2)
8	Coagulase negative staphylococci	GPB	1%(1)
9	Enterobacteriaceae spp.	GNB	1%(1)
10	Total		100%(100)

Thus the prevalence of *A. baumannii* had dropped from 23.7% to 16% after the implementation of interventions.

DISCUSSION

The available evidence shows that the most frequently isolated organisms from these devices in the ICU are *Klebsiella pneumoniae, Pseudomonas aeruginosa, Escherichia coli, Staphylococcus aureus, Coagulase negative staphylococci, Citrobacter freundii, Acinetobacter*

baumannii, Enterobacteriaceae spp. generally in that respective trend. [6-10]

In our first set of our study, we found the incidence as *K. pneumoniae* (36.29%), followed by *A. baumannii* (23.70%), *P. aeruginosa* (17.77%), *E. coli* (11.85%) *and Staphylococcus aureus* (4.44%) respectively. Whereas *K. pneumoniae* was the predominant organism isolated from other studies too. [10,13] Thus the isolation pattern of organisms appears to vary with time and hospital settings. Our data showed that here were more Gram-negative bacteria than Gram-positive isolates, but this is not surprising since the former are known to develop resistance more rapidly and extensively than the latter. [14,15]

Whereas, in our study the occurrence of *A. baumannii* as the second most common microorganism (23.70%), was ironically not as common in other studies (<10%). [10,13] So, to find out the cause of this happening, a set of interventional measure as mentioned, had been pressed into action and again data was analyzed over the period of 6 months. In the second set of our study we found *K. pneumoniae* (36%), followed by *P. aeruginosa* (19%), *E. coli* (17%), *A. baumannii* (16%), and *S. aureus* (4%) respectively

So, there was good response to the interventions and prevalence of *A. baumannii* decreased from 23.70% to 16%. So we found that common modes of transmission of this microorganism most probably were;

1. Airborne pathway
2. Contact of the care givers with the contaminated surfaces.

Airborne transmission of *Acinetobacter* species was seen in a study where sterile settle plates were placed near patients with colonized skin and respiratory tract infections; the plates were positive for *Acinetobacter* species and indicated the species was transmitted there by an airborne pathway. [27]

Coming in contact with contaminated surfaces was a major source of *A. baumannii* transmission, notably from the hands of health care workers. [27,28] Studies show that 19% to 29% of hospital personnel hands were colonized by this species. [27-29] One outbreak was contributed to a health personnel's negligence to remove their contaminated gloves between patients while another was due to a contaminated hands of the therapist touching respiratory equipment. [27,30,31] Other contamination sources were linked to ventilators only being cleaned between patients (not before), sink traps, floors, and patient skin. The latter contributes to contamination of the hubs and lines of central venous catheters. [31,32]

After application of all interventions as mentioned, we found a decrease in the prevalence of *A. baumannii* in the critical ill patients admitted in the ICU in our second set of study. One can draw an inference that the major cause of high prevalence of A, baumannii was lacunae in our ICU as follows:

1. The source of contamination was hands and nails of the nursing staff taking care of positive patients act as reservoir for the *A. baumannii*
2. Water of the oxygen flow meters as a reservoir for the *A. baumannii*
3. Airborne infection by close proximity of the *A. baumannii* positive patients.

Limitations of the study

This is a basically a observational study, with a relatively smaller sample size. So some biases and pitfalls may have been left while designing and executing the study trial.

CONCLUSION

It appears that, *A. baumannii* is a very resilient and persistent opportunistic microorganism. It is becoming more prevalent device dwelling nosocomial microorganism in the Intensive Care Units. Although emergence of the MDR species of this is a major problem, conventional methods of intervention like precautions, intuitive patient management, and observance of strict precautions of sterility

and disinfection may actually bring down the overall incidence. It appears to be spreading mainly by the airborne as well as contaminated surface/hands of the care givers.

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