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Impact and challenges of infection control in a public sector intensive care unit: Experience from a low resourced country

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Abstract

Impact of introducing infection control (IC) on Ventilator Associated Pneumonia (VAP) rates in a low resource public sector intensive care unit was investigated. The study was conducted in two parts; pre and post intervention periods. 285 patients admitted during the pre intervention period (July to December 2007) and 426 patients admitted during post intervention period (September 2008 to May 2009) were included. IC was implemented through educational sessions, introduction of a computerized surveillance program for recording data, and the establishment of a team responsible for monitoring and improving IC. VAP rate following the interventions was noted to be 3.5% (15/426), a significant decrease ($p<0.0001$) from the pre intervention rate of 13% (37/285). Case fatality reduced from 57% (21/37) to 53% (8/15) post intervention. 81% VAP causing organisms were multidrug resistant (resistant to ≥2 classes of antibiotics) in the post intervention period compared to 91% in the pre intervention period. Although stringent interventional measures were effective in reducing VAP rates, impact on antimicrobial resistance and on mortality was limited. Regular surveillance and team work were essential components that were required. Significant challenges encountered included the need of continuous education to modify behaviours and improve attitudes towards IC.

Key words

Nosocomial infections, hospital acquired infections, infection control, ventilator associated pneumonia, multidrug resistance.

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Introduction

Nosocomial infections (NI) affect millions of patients globally.[1] Studies have shown that the risk of acquiring NI is two to twenty times higher in hospital settings with limited resources than in hospitals of the developed world.[2] NI rates reported from such settings range from 8% to 22% with higher rates being reported from intensive care units (32%-77%).[3,4] Likewise mortality rates related to device associated infections are also several times higher in low than in high resource settings.[5,6]

A number of factors have been implicated as contributing to high NI rates in low resource settings including lack of Infection Control (IC) policies and inadequate resources for the implementation of these policies. The majority of healthcare facilities in Pakistan lack resources which are deemed necessary for providing appropriate healthcare. This is particularly true for government sector hospitals which cater to the healthcare needs for most of the population in Pakistan. Earlier studies from Pakistan have shown a grim picture of IC faced regularly by a low resource public sector hospital.[7,8]

In 2005, World Health Organization (WHO) launched its prevention of NI initiative under the banner 'Clean Care is Safer Care' as the first challenge of the World Alliance for Patient Safety. Three important objectives in the implementation of the global challenge included raising awareness about impact of NI, catalyzing a country's commitment and pilot testing of WHO recommendations.[9]

The objective of this study was to improve IC practices in a low resource public sector intensive care unit through interventions designed according to the recommendations by WHO. To monitor the impact of these interventions comparison of VAP rates between pre and post intervention periods was performed.

Methods

Study Setting and Population

This study was conducted in an eight bedded intensive care unit (ICU) of a tertiary care public sector hospital. This is a government run hospital of more than 1700 beds with around 2000 patients visiting the outpatient department every day. The infrastructure for monitoring and controlling NI is nonexistent in this hospital. This unit mostly admits post- operative patients from different surgical and gynaecological wards of the same hospital. This study was conducted in two parts; pre and post intervention.

Interventions

The intervention included efforts in improving surveillance, continuous education of ICU staff and formation of an IC team:

(a) Surveillance

Improvements in gathering infection related data was brought about by introducing a computerized program to document and analyze infection rates. Microsoft Access version 2007 was used to build a customized program for the ICU. This supplemented the daily paper sheet being used for recording day to day patient information. The daily data sheet was also improved so as to collect the necessary infection related information. Data collected included information about presence or absence of infection as well as its potential sources, ongoing antibiotics and the rationale for antimicrobial use prior to transferring in to the ICU. Any interventions conducted during the stay (catheterizations, intubation, etc) were also recorded. An earlier study indicated a high VAP rate in this unit;[7] therefore VAP rate was used as a measure to estimate impact of interventions.

(b) Infection Control Team

An IC team was set up comprising of resident doctors of the unit, a nurse, an IC expert (microbiologist) and a data manager. The team was responsible for collecting data from nosocomially infected patients and their inclusion in the computerized program. The team was also responsible for training of new doctors and staff regarding IC and conducting regular meetings to assess the impact of the interventions and the prevalent infection rates. The team further noted and attempted to address challenges and difficulties in implementation of IC in the unit.

(c) Educational Sessions

Monthly meetings were conducted by the IC team for training the ICU staff regarding IC. These sessions provided information on basic IC guidelines including hand hygiene, prevention of VAP through head

elevation, prophylaxis of peptic ulcer disease and deep venous thrombosis, daily oral care by Chlorhexidine and daily assessment for extubation. Information on prevention of other nosocomially acquired infections such as urinary tract infection, surgical site infection, blood stream infection, and proper waste disposal was also provided in the educational session. During the whole study period particular emphasis was given on regular hand washing through soap and water. Alcohol rub was used when available. Furthermore, the team met biweekly communicating the prevalent IC situation to the staff in the ICU.

Pre Intervention Period

Using VAP as a measure of infection, records of all patients that had been on the ventilator during the six month period from July to December 2007, prior to the above mentioned interventions were screened to assess VAP rate. Patient records of 285 patients admitted during this period were reviewed, and VAP related data recorded on standardized forms.

Post Intervention Period

A period of eight months (January to August 2008) was used to develop a computerized program for recording surveillance data and making the above mentioned interventions. From September 2008 to May 2009 all patients admitted to the unit and on the ventilator were included in the study. The patients were closely monitored for developing VAP, which was used as an indicator of IC. VAP rates observed during this period were compared with VAP rates of pre intervention period to study the impact of the IC interventions. A total of 426 patients were included in the study during post intervention period following consent from the next of kin.

Operational Definitions

Ventilator associated pneumonia (VAP)

VAP was defined, as per CDC criteria, as any patient showing clinical, radiographic and microbiological evidence of chest infection after 48 hours of being on a ventilator.[10] The same definition was used to identify patients during both pre and post intervention periods. Microbiologic evidence was obtained through tracheal aspirate and blood cultures.

Infection and Mortality Rates

VAP rates were calculated during both pre and post intervention periods and compared for assessing impact of intervention. Post intervention period VAP rate was also calculated by NNIS criteria.[11] Due to non availability of reliable surveillance data, this criterion could not be used in the pre intervention period and only the crude rates were calculated. Mortality rates were also calculated for both study periods and compared.

Clinically Significant Organism

Respiratory isolates obtained, mainly from tracheal aspirates, were considered clinically significant if there were ≥100,000 organisms isolated on quantitative culture in the presence of clinical signs. Susceptibility testing was performed according to the Clinical and Laboratory Standard Institute (CLSI standards).

Multidrug Resistant (MDR)

Multidrug resistance was defined as resistance to two or more of the antimicrobial drugs or drug classes to which a particular organism is not intrinsically resistant. The drug classes included *beta* lactam antibiotics and carbepenems (including penicillin, cephalosporin and imipenem), macrolides, trimethoprim sulfamethoxazole, tetracycline, ofloxacin, aminoglycoside and chloramphenicol.

Analysis

All data collected manually in the pre intervention period and on the computerized program in the post intervention was entered in SPSS version 16 and descriptive analysis was done. Chi square test was carried out as a test of significance between pre and post intervention data.

Results

The profiles of the patients admitted to the study are described in table I. VAP rate decreased from 13% (37/285) in the pre intervention period to 3.5% (15/426) post intervention ($p<0.0001$). Case fatality rate amongst the 37 VAP patients during the pre intervention period was 57% (21/37) as opposed to 53% (8/15) during the post intervention period.

Additionally, it was determined through improvement in surveillance of infections during the post intervention

Table I: Profile of patients admitted to ICU during pre intervention and post intervention periods

	Pre intervention VAP patients (n=37)	Total patients in pre intervention period (n=285)	Post intervention VAP patients (n=15)	Total patients in post intervention period (n=426)
Gender (%)				
Male	20 (54)	128 (45)	8 (52)	183 (43)
Female	17 (46)	157 (55)	7 (48)	243 (57)
Mean Age (±SD) years	33.8 (14.5)	34.6 (14.7)	23.1 (6.9)	33.4 (14.6)
Outcome (%)				
Discharged Alive	16 (43)	223 (78)	7 (47)	315 (74)
Mortality	21 (57)	62 (22)	8 (53)	111 (26)
Mean Length of Stay (±SD) days	6.5 (4.2)	2.7 (3.9)	11.7 (6.7)	2.5 (4.4)
Source of Referral (%)				
Surgery	19 (51.3)	130 (45.6)	7 (46.7)	179 (42)
Gynaecology	8 (21.6)	94 (33)	3 (20)	142 (33.3)
Medicine	2 (5.4)	4 (1.4)	5 (33.3)	20 (4.7)
Neurosurgery	2 (5.4)	24 (8.4)	-	29 (6.8)
Orthopaedics	-	12 (4.2)	-	7 (1.6)
Vascular Surgery	-	4 (1.4)	-	8 (1.9)
ENT	1 (2.7)	8 (2.8)	-	23 (5.4)
Outside	5 (13.5)	7 (2.5)	-	13 (3.1)
Other	-	2 (0.7)	-	5 (1.2)

period that nearly 30% (129/426) of the patients were already infected prior to being admitted in the ICU. Overwhelming majority (98%) of these patients had been referred from different wards of the same hospital where IC activity was less strictly enforced.

During both the study periods the predominant organisms isolated from tracheal aspirate cultures of VAP patients included *Acinetobacter* species and *Pseudomonas aeruginosa*. *Acinetobacter* species were isolated from 28 of the 37 (76%) VAP patients in the pre intervention period and 11 of the 15 (73%) VAP patients in the post intervention period. Similarly, *P. aeruginosa* was isolated from 43% (16/37) of the pre intervention and 40% (6/15) of the post intervention period VAP patients. 67% (25/37) of the specimen cultures in the pre intervention period yielded a growth of more than one clinically significant organism compared to 40% (6) in the post intervention group.

100% sensitivity was noted to polymyxin B amongst *Acinetobacter spp* of both the study periods while nearly all (94%) *P. aeruginosa* in the pre intervention group and 100% in the post intervention group were sensitive to piperacillin/tazobactam (Table II). Overall, amongst the clinically significant organisms isolated, MDR rate in

Table II: Antimicrobial resistance of the most common clinically significant organisms isolated from VAP patients during pre intervention and post intervention periods.
*** The denominator is the number of organisms tested for the particular antibiotic. Numerator is the number of organisms found resistant.**

Antibiotics	*Acinetobacter spp* n (%)		*Pseudomonas aeruginosa* n (%)	
	Pre intervention	Post intervention	Pre intervention	Post intervention
Ampicillin/ sulbactam	*18/25 (72)	-	-	-
Aztreonam	-	-	6/15 (40)	2/5 (40)
Amikacin	21/27 (78)	11/11 (100)	7/16 (44)	1/6 (17)
Ceftazidime	16/18 (89)	10/11 (91)	7/16 (44)	3/6 (50)
Gentamicin	24/26 (92)	11/11 (100)	9/15 (60)	3/6 (50)
Cefepime	19/26 (73)	3/3 (100)	7/14 (50)	1/5 (20)
Polymyxin B	0/26	0/11	-	-
Meropenem	22/26 (85)	11/11 (100)	4/16 (25)	2/6 (33)
Tazobactam/ piperacillin	17/26 (65)	9/10 (90)	1/16 (6)	0/6
Ofloxacin	-	9/9 (100)	10/16 (62)	3/6 (50)
Co trimoxazole	21/24 (87)	10/11 (91)	-	-
Ceftriaxone	26/27 (96)	11/11 (100)	-	-
Tetracycline	10/21 (48)	7/11 (64)	-	-

the pre intervention period was 91% (62/68) opposed to 81% (17/21) in the post intervention group (p=0.24).

Discussion

This study shows a promising impact of an IC strategy based on WHO recommendations on NI rates in the studied unit. An earlier study in this unit showed little impact of education as a sole means of controlling NI.[7] It was felt that comprehensive yet sustainable interventions were needed to produce an impact on the NI rates. We introduced an IC team, a system for improving surveillance of infection and continuous education of staff as a multi pronged approach of controlling NI. As a result of these interventions we were able to bring down considerably the VAP infection rates (used in this study as a marker for transmission of NI). Despite this decrease however, post intervention VAP rate at 16/1000 ventilator days remained higher than the recommended NNIS benchmark.[12]

Most of the patients admitted to the ICU were referred from other wards within the same hospital. It is possible that at the time of referral, a number of these patients had already been colonized by nosocomially acquired organisms due to a lack of IC infrastructure in other units of the hospital.[8] This increased the risk of spread of drug resistant nosocomial organisms, thus posing a challenge to IC. Such patients made control of infections within the studied unit more challenging. The research team played a supervisory role by highlighting and communicating the best possible approach which would help decrease infection rates in ICU. Particular attention was given to hand hygiene which was carried out through a close liaison with senior doctors and nursing staff. A continuous need of reinforcing simple IC methods, such as hand washing and the importance of communication regarding IC matters between different staff members was a challenge in implementing the IC strategy. It was felt that many of the staff members considered IC a responsibility of the IC team. Instilling a sense of participation within the unit staff was a challenge. Without a complete sense of participation from all the staff in ICU, further improvements remained an uphill struggle. Furthermore, efforts at improving knowledge and awareness amongst staff were required to be supplemented by regular updates and refresher sessions. This led us to acknowledge a deficiency in the basic undergraduate training of doctors and nursing staff in our area regarding IC. This deficiency might also be responsible for the general lack of responsibility amongst the unit staff towards IC.

High rates of multidrug resistance were observed from the respiratory isolates in our study. This most likely can be a result of indiscriminate and injudicious antibiotic usage within the healthcare facility. Although correct choice of early empiric antibiotic therapy is recognized to reduce infection related mortality rates,[13,14] formulating a focused and relevant antibiotic policy was difficult in the absence of local antimicrobial resistance information. Our study, therefore, further highlights the need to introduce surveillance for antimicrobial resistance in such settings.

National guidelines for IC in the country were published in 2006.[15] However, little has been achieved as far as implementation is concerned. Hospital based IC and antibiotic use policy is yet to be developed in public sector facilities in the country. We strongly feel that efforts are needed at establishing an "Infection Control Culture" in low resource settings. IC teaching is not part of health care education in many parts of the world. Placing emphasis on IC training at the undergraduate and post graduate level is essential. We believe this deficiency results in a lower sense of commitment. Without such commitment IC will continue to pose a challenge in settings such as ours.

Limitations

The study period after the interventions was nine months. Results from this period showed considerable improvements; however, despite all efforts we were not able to bring further improvements in the IC situation. This was due to the earlier discussed challenges faced by the IC team. After the nine month study period the research team handed over the IC team to the unit. The sustainability of the IC in the ICU after exit of the research team needs to be studied. The IC team was able to focus on one type of NI that is VAP. This was due to the fact that the available resources warranted a step wise approach to improvement in IC and only sustainable interventions were carried out.

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