Research Article

Profile of micro-organisms in intensive care unit of a level-1 trauma centre: A retrospective study

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Abstract

Background: Patients with trauma usually require highly specialized care in ICU and many times their recovery is complicated by infections. Aim of this study was to determine the profile of pathogens and their impact on outcome among these patients. **Materials and Methods:** The clinical records of 101 consecutive patients who were admitted for more than 48-hrs in ICU during Jun-Dec 2007 were analyzed. **Results:** Total of 953 samples from blood, urine, BAL or pus/collection were subjected to cultures. From 276 samples, 299 organisms were isolated. Among pathogens *Candida* Spp. [89 (29%)] were the most common, followed by *Acinetobacter* Spp. [69 (23%)], *Pseudomonas* Spp. [63 (21%)], *Klebsiella* Spp. [31 (10%)], coagulase negative *Staphylococcus aureus* [16 (5%)], *E coli* [12 (4%)], *Enterobacter* Spp. [7 (2%)], *S aureus* [6 (2%)], *Enterococcus* Spp. [5 (2%)], *Citrobacter* Spp. [2 (0.6%)], *S maltophila* [1 (0.3%)] and *Providentia* Spp. [1 (0.3%)]. For gram negative pathogens drug-resistance rates were as follows: Fluoroquinolones, 76%; 3rd generation cephalosporins, 74%; aminoglycosides, 66%; β-lactams/β-lactamase inhibitors combinations, 64%; and carbapenems, 50%. Among these 27% of pathogens were resistant to all 5 classes of drugs. 58% of *Staphylococcus aureus* were methicillin-resistant whereas 85% of coagulase negative *Staphylococcus* were methicillin resistant. The mortality was higher among patients in whom pathogens were isolated [Odd's Ratio (OR) 0.185; 95% confidence interval (CI) 0.049-0.640; $P = 0.002$]. **Conclusions:** Isolation of multi-drug resistant pathogens is common among trauma patients admitted in ICU and is associated with increased mortality and could impact on the consumption of hospital resources. The importance of high rate of fungal isolation needs to be studied among these patients.

Keywords: Drug resistance, Intensive Care Unit, mortality, micro-organisms, nosocomial infection, trauma

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Introduction

Accidents and trauma are among the most serious but neglected health problems all over the world. The fast traffic, unprecedented and unplanned urbanization have contributed to the global increase in the incidence of both. Unfortunately, both of these primarily affect the young adults in their economically productive age. Data suggests that among persons under 44 years of age, accident and trauma are the leading cause of mortality.[1,2] Globally, 26% of all deaths in the age group of 15-44 years in 2002 were due to injuries, including road traffic accidents.[2] World health organization has reported that approximately 1.3 million people die and between 20-50 million sustain non-fatal injuries each year due to road traffic accidents.[2]

In India, trauma is a major problem, primarily due to a very high incidence of vehicular accidents (6% of global vehicular accidents), along with other accidental injuries, crime and violence.[3] Rising population, urbanization, industrialization and a drastic rise in vehicular transport all have contributed to an annual increase in road traffic

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accidents by 3%.[3,4] In 2010, it was estimated that there were approximately 1300 injuries and 440 deaths per day related to road traffic accidents alone.[2,5]

Trauma care is at developmental stage in India, however, number of patients requiring this highly sophisticated and specialized care is increasing each day.[3,4] It is true that the severity of injury and acute management are important factors determining the immediate outcome. However, in the later course, infections are important determinant of the final outcome. It has been reported that more than 80% of late deaths in adult trauma patients, across the globe, are due to infections.[6-8] It is important to understand the epidemiology of various pathogens prevalent in Indian trauma care settings, which may be the first step towards prevention and effective treatment. Therefore, this study was planned to describe the epidemiology of pathogens and their impact on various clinically important outcomes at our center.

Materials and Methods

This retrospective study included consecutive patients who were admitted for more than 48-hrs in ICU of a tertiary-care trauma center between Jun-Dec 2007. Data was retrieved by a retrospective review of the individual patient's medical records. Information collected included demographic data, type of injury, mode of injury, treatment given: Operative vs. conservative, duration of stay in hospital and ICU, and total no. of days spent on ventilator, if applicable. The information regarding the specimen source, date of isolation of the organism, and its susceptibility pattern were also recorded.

Results

There were 101 patients who were admitted to the ICU during the above specified period. The base line characteristics are summarized in Table 1.

Epidemiology of Infections

Specimens used for identification of pathogens

All patients were evaluated for the presence of infection. Various specimens used to identify the pathogen include blood, urine, bronchoalveolar lavage (BAL) and aspiration of collection located at any site. Total 953 samples were analyzed in the microbiology laboratory for culture. Among the specimens, urine [240 (25%)] was the most common, followed by blood [228 (24%)], BAL [225 (23.6%)], pus/tissue aspirate [130 (13.6%)], catheter tips [90 (35.5%)], cerebro-spinal fluid (CSF) [17 (18%)], catheter-drain fluids [14 (5.5%)], pleural fluid [4 (0.4%)], bile [3 (0.3%)] and peritoneal fluid [2 (0.2%)].

Table 1: Baseline characteristics of the cohort

Variables	Observations
Age [median (range), years]	36 (1-81)
Gender (male:female)	5:1
Type of injury (*n*)	
Road traffic accident	59
Non road traffic accident	42
Site of injury (*n*)	
Head	47
Abdomen	13
Blunt injury	10
Gun shot	2
Stab	1
Cervical spine	12
Chest	3
Blunt injury	2
Stab injury	1
Fracture	13
Poly-trauma	8
Quadriplegia	4
Traumatic PIVD*	1
Management (*n*)	
Surgical	84
Conservative	17

*PIVD: Prolapsed inter-vertebral disc

Microbiological profile

Among these 953 samples, 276 (28.9%) samples were positive for growth of pathogens, either bacteria or fungi. Total 299 organisms were cultured from these 276 samples [Table 2]. Among pathogens *Candida* Spp. [89 (29%)] were the most common, followed by *Acinetobacter* Spp. [69 (23%)], *Pseudomonas* Spp. [63 (21%)], *Klebsiella* Spp. [31 (10%)], coagulase-negative *Staphylococcus aureus* [16 (5%)], *E. coli* [12 (4%)], *Enterobacter* Spp. [7 (2%)], *Staphylococcus aureus* [6 (2%)], *Enterococcus* Spp. [5 (2%)], *Citrobacter* Spp. [2 (0.6%)], *Stenotrophomonas maltophila* [1 (0.3%)] and *Providentia* Spp. [1 (0.3%)].

Drugs sensitivity testing was done against various antibiotics used at our institute which included fluoroquinolones, 3rd generation cephalosporins, aminoglycosides, β-lactams/β-lactamase inhibitor combinations and cabapenems. The drugs resistance pattern of these organisms is depicted in the Figure 1. Notably, 27% of the gram negative bacteria were resistant to all drugs for which the drug-sensitivity was done. Among the isolates of *Staph aureus*, 58% were methicillin-resistant whereas 85% of coagulase-negative *Staphylococci* were methicillin resistant.

Impact of Isolation of Pathogens on Clinical Outcomes

Of the 101 patients, 52 (51.4%) had uneventful recovery without any complication. Forty-nine patients (48.5%) developed complications during their hospital stay [Table 3]. Overall there were 33 (32.7%) deaths among

Table 2: Pathogens isolated from various specimens

Organisms (total number of isolates)	Specimen [total number of isolates (%)]			
	Urine	Blood	BAL	Collection/pus
Candida spp (89)	41 (46.1)	27 (30.3)	21 (23.6)	Nil
Acinetobacter spp (69)	9 (12.1)	19 (27.5)	34 (49.3)	7 (10.1)
Pseudomonas spp (63)	8 (12.7)	17 (26.9)	29 (46.0)	9 (14.3)
Klebsiella spp (31)	8 (25.8)	5 (16.1)	18 (58.1)	Nil
Coagulase-negative *Staphylococcus* (16)	1 (6.2)	3 (18.6)	2 (12.7)	10 (62.5)
E. coli (12)	7 (58.3)	1 (8.3)	4 (33.3)	Nil
Enterobacter (7)	2 (28.6)	Nil	2 (28.6)	3 (42.8)
Staph aureus (6)	Nil	1 (16.7)	3 (50.0)	2 (33.3)
Enterococcus (5)	Nil	2 (40.0)	2 (40.0)	1 (20.0)
Citrobacter spp (2)	1 (50.0)	Nil	1 (50.0)	Nil
Stenotrophomonas maltophila (1)	Nil	Nil	1 (100)	Nil
Providentia spp (1)	Nil	Nil	1 (100)	Nil

BAL: Bronchoalveolar lavage

Table 3: Complications observed during hospital stay

Various complications *n* (%)	Incidence
Sepsis	12 (24.4)
Pneumonia	11 (22.4)
Thrombocytopenia	11 (22.4)
Acute renal failure	10 (20.4)
Rhabdomyolysis	1 (2.04)
Fat embolism	1 (2.04)
Hyperbilirubinemia	1 (2.04)
Gastro-intestinal bleed	1 (2.04)
Empyema	1 (2.04)

this cohort. The causes of death were septicemia [10 (33%)], head injury [14 (40%)], hemorrhagic shock [5 (15%)], and asphyxia and electrocution [2 (6%)] each.

Isolation of pathogen/s has significant impact on mortality, duration of stay in hospital and ICU and number of days spent on ventilator [Table 4]. The mortality was higher among patients who grew pathogen/s from any sample as compared to absence of growth [Odd's Ratio (OR) 0.185; 95% confidence interval (CI) 0.049–0.640; $P = 0.002$]. We also found that isolation of pathogens from all three specimens had worse outcome [Table 4]. The mortality among patients in whom all three samples grew pathogens was also higher than patients in whom pathogen/s were isolated from two samples (OR 0.222; 95% CI – 0.016-2.478; $P = 0.152$) or only one sample (OR 0.108; 95% CI 0.014-0.639; $P = 0.003$).

Discussion

The final outcome in patients with trauma is determined, besides the type and severity of the injury, by the quality of acute care as well as the occurrence of complications. This retrospective study has shown that multi-drug resistant pathogens are commonly isolated from various anatomical sites among patients admitted with trauma and are associated with adverse prognosis. Our study has shown that 59.1% of the patients had

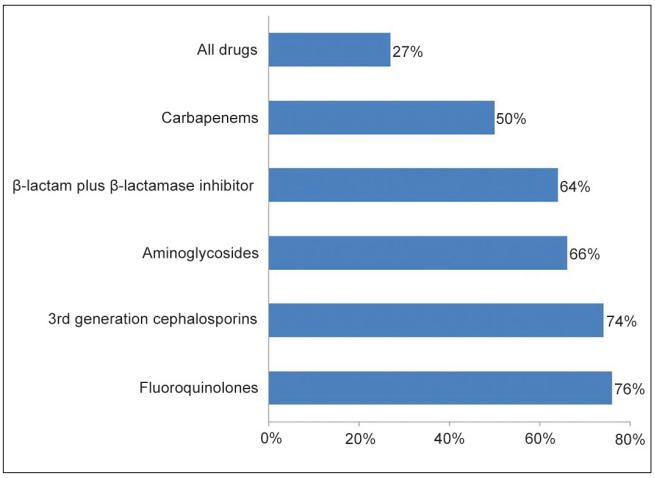

Figure 1: Drug resistance profile of the organisms isolated from various specimens

grown a pathogen, at least from one site which seems quite high. There are studies from different parts of the world which have reported infection rate among these patients as high as 50%.[9-13] However, the rate of nosocomial infection among patients with trauma is much higher than observed in its absence.[14-17] There are many factors such as disruption of skin and tissue integrity and placement of multiple invasive devices which make the trauma patients vulnerable to infections by allowing the immediate bacterial access to previously sterile body sites.[18] Wound factors such as degree of tissue trauma, ischemia, foreign material deposition or hematoma formation impair local host defenses. Systemic factors such as blood transfusion, hypotension and hypoxia are also among important contributors to the increased risk of infections.[1,19] Along with these factors major traumatic injuries also cause profound patho-physio-immunological changes, including alterations in both cellular and humoral immunity which might be an important contributor for the increase in rate of nosocomial infections among these patients.[20,21]

Table 4: Impact of infection/s on various outcomes

Outcomes	All sterile (*n*=33)	Culture positivity			*P* value
		1 of 3 positive (*n*=49)	2 of 3 Positive (*n*=8)	All 3 positive (*n*=11)	
*LOS in hospital [mean±SD, days]	20.94±19.4	36.41±25.17	40.39±20.18	46.27±28.81	0.004
LOS in ICU [mean±SD, days]	7.22±6.00	14.88±11.35	20.80±5.88	22.09±18.01	<0.001
Duration of ventilator requirement [mean±SD, days]	5.64±3.64	14.98±9.98	22.09±10.01	19.55±10.59	0.002
Mortality [*n* (%)]	4 (12.2)	16 (32.6)	4 (50)	9 (81.8)	<0.001

*LOS: Length of stay; ICU: Intensive care unit

The microbiology of the nosocomial infections (NI) is important factor which may affect the overall prognosis. In 1980s gram positive pathogens were the predominant culprit responsible for the mortality and morbidity in ICU.[1,6,18] However, more recently gram negative pathogens along with fungal infections (*Candida* spp) have taken over as the leading cause of NI among patients admitted to ICU.[22,23] Our study has shown *Candida* spp as the most common pathogen accounting for 29% of all isolates. There are studies which have shown that during recent times *Candida* spp has emerged as an important NI in ICU associated with significant mortality and morbidity globally.[24-27] Importantly the incidence of this infection is showing a rising trend.[28] The critically ill patients admitted in ICU are at risk of developing fungal infections due to various risk factors such as need for surgery, total parenteral nutrition, colonization by fungi, need for renal replacement therapy, presence of infection/sepsis, need of mechanical ventilation and high APACHE score.[29] Our cohort had several of these risk factors. Notably, other studies on NI among patients admitted in medical ICU from northern India have not described *Candida* as a major pathogen.[16,17] The plausible explanations for this may be differences in patient profile such as demographic profile, severity of illness, underlying disease, local practices such as antibiotic/antifungal use policies and the indication for admission to ICU i.e., medical or surgical or trauma. Our study results indicate that trauma *per se* might put these patients at risk of fungal infections due to various factors described above. This argument is further substantiated by the fact that a study from a medical ICU from the same institute did not report occurrence of *Candida* infection.[16] This finding needs further evaluation with the help of prospective studies to determine its clinical importance among patients admitted with trauma. The spectrum of gram negative pathogens which include *Acinetobacter*, *Pseudomonas*, and *Klebsiella* was similar to other studies.[16,17]

Another important and alarming observation of this study was the isolation of pathogens which were resistant to all five classes of commonly used drugs (27%) and carbapenems (50%). Drug resistance concerns every critical care physician across the world [27, 30-32] particularly in the context of the prospect of limited additions to the antibiotic armamentarium. There is an interplay of multiple factors such as antimicrobial use (both appropriate as well as inappropriate), hygiene policy, and virulence and adaptation characteristics of pathogens that are important factors for the emergence of drug resistance. However, the most important and modifiable factor is the inappropriate use of antimicrobials. Strategies suggested by various healthcare authorities should be adapted to local needs to curtail bacterial resistance.[33]

Among critically ill patients NI are important determinant of the prognosis which is also true for trauma patients where these infections may be responsible for five-fold increase in mortality compared to those without infection.[18] In our study isolation of pathogens from multiple anatomical sites was associated with increased mortality. These findings are consistent with prior studies which have shown that multiple site infections carry worse prognosis than those confined to a single site.[34,35] In this context our study results are not surprising in showing that isolation of pathogens from multiple sites are associated with five to six times the mortality rate of localized infections.

There are a few limitations of our study. First, this was a retrospective with its inherent limitations and the fact that the data indicate sites of microbial isolation rather than infection. However, retrospective data analysis are useful first steps toward further studies. Secondly, this was an experience from a single center and the results may not be generalizable.

Conclusions

This single center, retrospective study from a level-1 trauma care center found that multi-drug resistant isolates are quite common among these patients and are

associated with high mortality and could lead to excess consumption of hospital resources. Further, the fact that the commonest isolate was *Candida* needs further studies designed to determine its clinical importance.

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