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Infections in Traumatised patients

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Abstract

Infections are one of the most common and fatal complications following trauma and complicate the recovery of a significant number of injured patients. Traumatised patients with infections have a 5-fold higher mortality compared to those without infection.

Aim: This study was conducted with the aim to (1) Study the prevalence of pathogens in wounds due to trauma. (2) Analyze pathogen distribution according to wound type and site and (3) Determine the pattern of drug resistance.

Methods: The study included a total of 100 patients admitted to Orthopedics, General surgery and Neurosurgery departments of NRI General Hospital within 24 hrs of trauma over a period of seven months. After initial step of wound management, samples collected were subjected to both aerobic and anaerobic culture method's for identification of organisms and anti -microbial susceptibility testing was done.

Results: Of the hundred patients participated, majority were men [79%] and the average age of the patients was 46.8 yrs. The most common cause of trauma was Road Traffic Accidents [RTA](78%) ,followed by fall from height (6%), Occupational hazards (4%), Burns (2%) and other miscellaneous causes accounting for 10%.Lower extremities received highest number of wounds(52%) and have shown high rate of culture positivity. Of the wounds evaluated for culture (100), 28% were sterile and 72% were culture positive. Cultures have shown predominance of Gram negative bacilli (66.66%) than Gram positive bacteria (33.33%). Pseudomonas aeruginosa (P.aeruginosa) was the commonest organism (41.66%) followed by Staphylococcus aureus (S.aureus) (29.16%). Other organisms isolated belonging to different genera were of minor percentage. All the infections were monomicrobial except one. Distribution of pathogens according to wound site were more or less the same, the frequency of isolation of organisms was high in case of RTA and high rate of culture positivity was seen in Burns and occupational cases. Disinfection with commercial antiseptics soon after trauma prevented infection in case of minor trauma than major. Gram negative bacilli were sensitive to gentamicin, ofloxacin and ceftazidime; resistant to ciprofloxacin. Gram positive organisms were sensitive to gentamicin and ofloxacin; resistant to piperacillin and penicillin.

Conclusion: Understanding the epidemiology of infections and identifying patients at increased risk, is as important as management of wounds with appropriate antibiotics in establishing prompt diagnosis and management with subsequent decrease in infectious morbidity.

Keywords: Trauma, Infection

Introduction

In India, trauma is a major problem due to a very high incidence of vehicular accidents (6% of global vehicular accidents). Infections are one of the most common and fatal complications following trauma and complicate the recovery of a significant number of injured patients. They are second only to head injury as the leading cause of death beyond the first three to four days of trauma and are responsible for 80% of late deaths in adult trauma patients(Caplan and Heyt(1985),Caplan and Heyt (1981),Patel et al.,(2000).This is mainly because the management of other major contributors of mortality like haemorrhage, circulatory collapse and respiratory failure have greatly improved with the application of sophisticated technical advancement. Traumatised patients with infections have a 5-fold higher mortality compared to those without infection(Caplan and Heyt(1985). The overall incidence of infections following trauma varies from 9-36%(Patel et al.,(2000),Fabianet al.,(1994). This is much higher than the rates of nosocomial infection for general population. [Riddleet al.,(1967). In a large series of 10,308 trauma patients admitted to the Maryland institute for Emergency Medical Service systems between 1977 and 1984, 2310 infections were reported in 1407 patients. The overall mortality was 15%, with majority of death due to infections (Stillwell et al.,(1988).

Trauma by itself jeoparadises the hosts natural protective barriers by disrupting the integrityof skin and tissues.(Patelet al.,(2000).In patients of trauma, besides the mechanism of injury, other factors also contribute to the propensity to develop wound infection.The number of contaminating bacteria and their species correlate with the likelihood to develop infections. Additionally, a lower inoculum of bacteria can cause infection in the presence of haemorrhagic shock, foreign bodies and dirt(Fabianand Minard(1994),Rush et al.,(1988).

The financial implication of infection and sepsis following trauma are also staggering. Resource utilisation is prolonged in traumatised patients with infections, most of which is spent in the ICUs (Mathur et al.,(2008), Patel et al.,(2000). The cost of caring for these patients will continue to increase with infection, newer techniques, more sophisticated monitoring and the advent of new therapies (Duerden(1994). With the recent establishment of trauma care centres in India and a multidisciplinary approach to handle these patients, it is important to understand the epidemiology of infections, which will be the first step towards prevention and effective treatment.

Aims and objectives

This work has been conducted with the aim to (1) Study the prevalence of pathogens in wounds due to trauma. (2) Analyse pathogen distribution according to wound type and site and (3) Determine the pattern of drug resistance.

Materials and methods

The study included a total of 100 patients admitted to Orthopedics, General surgery and Neurosurgery departments of NRI General Hospital within 24 hrs of trauma over a period of seven months. Most of the patients were admitted directly from the place of trauma or followinga brief emergency care at another hospital.

A brief clinical history, wound site, duration and examination findings were recorded.The wound types included injuries due to road traffic accidents, burns,fall from height, occupational hazards and others. Injury characteristics were recorded on a pre-desinedproforma.

Specimen

The specimens included in the study were:

A. Superficial specimens

1. External skin swab
2. Exudates/Drainage

B. Invasive specimens

1. Aspirates
2. Tissue Biopsy

Sample collection

The initial step of wound management including surgical debridement to remove necrotic and foreign materials in traumatic wounds and drainage of pus was conducted. Before wound cleaning and dressing, an exudates sample was taken using cotton swabs. The area is sampled by simply rolling the tip of the swab on its side for one full rotation. Care was taken to avoid contamination by the normal skin flora. Each wound was swabbed with two different swabs.

Processing of samples

Of the two received swabs, one is used to inoculate media [Blood agar, MacConkey agar, Nutrient agar, Mueller Hinton agar, Robertson's cooked meat medium (RCM), Gentamicin blood Agar]and with other swab, smear was prepared and subjected to Gram's stain for direct microscopy. Two sets of plates were inoculated (aerobic and anaerobic culture.) For aerobic culture, plates were incubated aerobically overnight at 37^0c, and for anaerobic culture, swabs were inoculated into RCM at the point of collection itself and incubated at 37^0C for 48 hrs. Sub-culture from RCM was done onto the plates and were incubated in the anaerobic jar.(Anaropack Mitsubishi Corp., Japan).Gram's staining was done on the smears from the plates and a battery of biochemical tests were performed to identify the bacteria. Antibiotic sensitivity testing was done by Kirby-Bauer disc diffusion technique on Mueller Hinton agar.

Results

Hundred patients participated in the study. Average age of the patients is 46.5 years; majority (79%) were men. The most common cause of trauma was Road Traffic Accidents (78%), followed by fall from height (6%), Occupational hazards (4%), Burns (2%) and other miscellaneous causes which accounted for 10%. [Table 1].

Lower extremities received highest number of wounds (52%), followed by upper extremities (21%), trunk (16%) and head (11%)[Table 2].

Of all the wounds evaluated, 28 %wounds were sterile and 72% were culture positive.The highest rate of culture positivity was seen in lower extremity wounds (76.92%), followed by upper extremity wounds (71.42%), trunk wounds (68.75%) and wounds of the head (54.54%)[Table 5].

Cultures have shown predominence of Gram negative bacteria (GNB) (66.66%) than Gram positive bacteria (GPB) (33.33%)[Table3].GNB were significantly more common in lower extremity and in larger wounds thanin wounds of smaller size. P.aeruginosawas the most common organism in all wounds accounting 41.66% of the culture positive samples followed by S.aureus (29.16%), Proteus spp. (13.88%), Escherichia coli (11.11%), Aeromonas (2.77%) and Clostridium tertium(1.38%) [Table 3].

All the infections were monomicrobial except one, from which Escherichia coli and P.aeruginosa were isolated. Of all the 10 patients, 6 were found to be diabetic, out of which two were positive for P.aeruginosa,

two for S. aureus and one of them with a major trauma whose wound was sterile at the time of admission became infected with P.aeruginosa after a long stay in the hospital which may be due to mismanagement of diabetes.

Pathogen distribution according to wound site was more or less the same, except for the lower extremity which has shown variable organisms [Table 4].On the basis of etiology of wound most frequently isolated organisms were again P.aeruginosa and S.aureus. [Table 6]

Culture positivity on the basis of cause of trauma were, 100% due to burns and occupational hazards, 73% due to RTA, 66.66% by fall from height and 50% due to other miscellaneous causes [Table 7].

During the study period, all the patients received some form of treatment including systemic antibiotics, topical antibiotic creams, and / or treatment for comorbid disease such as diabetes. In case of minor wounds, disinfection with commercial antiseptics soon after trauma prevented infection whereas in the case of major trauma, disinfection soon after trauma and after being admitted in the hospital did not prevent infection.

Gram negative bacteria were sensitive to ofloxacin, gentamicin and ceftazidime; resistant to ciprofloxacin. Gram positive bacteria were sensitive to gentamicin and ofloxacin; resistant to piperacillin and penicillin. [Table 8]

Table 1: Etiology of Wounds.

Wound etiology	No. of patients	percentage
RTA	78	78%
Fall from height	06	06%
Occupational Hazards	04	04%
Burns	02	02%
Others	10	10%

Table 2: Distribution of Wounds.

Wound site	No. of patients	percentage
Head	11	11%
Trunk	16	16%
UE	21	21%
LE	52	52%

Table 3: Frequency of isolation of Organisms.

Organism isolated	Frequency	Percentage
P.aeruginosa	30	41.66%
S.aureus	21	29.16%
Proteus spp.	10	13.88%
E.coli	08	11.11%
Aeromonas	02	02.77%
Clostridium tertium	01	01.38%

Discussion

Infections are one of the most common and fatal complications following trauma and complicate the recovery of a significant number of injured patients. Traumatised patients with infections have a 5-fold higher mortality compared to those without infection (Pories et al., (1991).Traumatic wounds were found to be infected in almost 50%of polytrauma cases in a Swiss hospital (Algower and During 1980).

Various studies have shown 10%, 22%, 65% and 96% as incidence of infections following trauma.(Pories et al.,(1991), Patel et al.,(2000), Fabian and Minard (1994), Somprakash Basu et al.,(2009). In the present study, the overall infection rate was 72% which correlates closely with that of the above study. (Fabian and Minard 1994).

Any open wound is inevitably contaminated by microorganisms and when the host defense is overwhelmed or a critical bacterial load is reached, infection is established. Progressive bacterial invasion of the wound causes infection.

Table 4: Distribution of pathogens according to wound site.

Site of wound	Organism isolated	Frequency	Percentage
Head	S.auresu	02	2.77%
	P.aeruginosa	04	5.5%
Trunk	P.aeruginosa	03	4.16%
	S.aureus	05	5.55%
	Proteus spp.	03	4.16%
Upper extremity	S.aureus	09	12.5%
	P.aeruginosa	04	5.55%
	E.coli	02	2.77%
Lower extremity	P.aeruginosa	19	26.38%
	Proteus spp.	07	9.72%
	E.coli	06	8.33%
	S.aureus	05	5.55%
	Aeromonas	02	2.77%
	Clostridium	01	1.38%

Table 5: Culture positivity according to wound site.

Wound Site	No. of wounds	Culture positive	% of positivity
Head	11	06	54.54%
Trunk	16	11	68.75%
Upper extremity	21	15	71.42%
Lower extremity	52	40	76.92%

Table 6: Frequency of isolation of organisms on the basis of etiology of wound.

Etiology	Organism	Frequency
RA	Proteus spp	6
	Pseudo. aeruginosa	25
	Staph. aureus	17
	Esch. coli	6
	Clost.tertium	1
	Aeromonas	2
Fall From Height	Pseudo. aeruginosa	3
	Esch.coli	1
Occupational Hazards	Pesudo.aeruginosa	1
	Staph.aureus	1
	Esch.coli	1
	Proteus spp	1
Burns	Pesudo.aeruginosa	3
	Staph.aureus	2
Others	Proteus.spp	3
	Staph.aureus	2
		Total 72

Table 7: Culture positivity on the basis of cause of trauma.

Cause of Trauma	No. of patients	Culture positive	% of positivity
RTA	78	57	73%
Others	10	5	50%
Fall from height	6	4	66.66%
Occupational	4	4	100%
Burns	2	2	100%

Table 8: Antibiotics sensitivity pattern.

Antibiotic	*S.aureus*	*P.aeruginosa*	*Proteus*	*E.coli*	*Clostridium*	*Aeromonas*
Ofloxacin	21 (100%)	26 (86%)	7 (70%)	8 (100%)	1 (100%)	1 (50%)
Gentamicin	19 (90.24%)	30 (100%)	6 (60%)	8 (100%)	1 (100%)	2 (100%)
Ceftadizidime	21 (100%)	10 (33%)	2 (20%)	6 (75%)	1 (100%)	--
Imipenem	--	24 (80%)	8 (80%)	8 (100%)	--	2 (100%)
Amikacin	16 (76%)	15 (50%)	6 (60%)	4 (50%)	--	--
Ceftazoxime	--	03 (10%)	3 (30%)	--	--	--
Amoxyclav	--	1 (3%)	7 (70%)	6 (75%)	--	1 (50%)
Ciprofloxacin	13 (62%)	3 (10%)	2 (20%)	2 (25%)	--	2 (100%)
Penicillin	03 (14%)	--	--	--	0 (0%)	--
Piperacillin	06 (28%)	--	--	--	0 (0%)	--

Worldwide, the number of people killed in road traffic accidents each year is estimated to be almost 1.2 million, while the number injured could be as high as 50 million (WHO 2004).The sideways accidents were found to be common, particularly of lower extremity followed by aberrations and lacerations and the commonest injury was fracture of bones.

In the present study, 73 % of the wounds were due to RTA. RTA patients are at in increased risk of infection due to environmental contamination. Due to the severe injuries in RTA, the wound size is bigger and the chance of getting infected is much higher. Prompt first aid treatment which includes cleaning of wound with antiseptics and removal of foreign bodies, blood clot or necrotic tissue if any at the time of injury may reduce or prevent the risk of infection depending upon the type of wound. This was quite evident in our study. In case of minor wounds, disinfection with commercial antiseptics soon after trauma prevented infection where as the case was not the same with major trauma. Impaired innate immunity at the site of injury, soling of the wound and long stay in the hospital is responsible for the high infection rate in wounds due to RTA.

In the present study, wounds due to burns and occupational hazards were also found to be highly prone for infection, thus showing high culture positivity. It is estimated that up to 75% of deaths following burn injury are related to infection (Revathi et al., 1998). Although exposed burned tissue is susceptible to contamination by microorganisms from the gastrointestinal and upper respiratory tracts (Vindenes et al., (1995), many studies have reported the prevalence of aerobes such as and P. aeruginosa, S. aureus, E. coli, Klebsiellaspp., Enterococcusspp.Candida spp.(Bariar et al., (1997).

Significant thermal injuries induce a state of immunosuppression that predisposes burn

patients to infectious complications. Local inflammation following injury is essential for wound healing and host defense against infection. However, trauma or burns of sufficient magnitude can incite a systemic inflammatory response, along a continuum from systemic inflammatory response syndrome through septic shock, which has the ability to cause significant cellular and end-organ damage (Bone (1996).The anti-inflammatory response and the subsequent immunosuppression following burn injury are characterised by a set of opposing cell types and cytokines. The production and release of monocytes / macrophages are decreased following burn injury and sepsis (Gamelli et al, 1994).Decrease macrophage and natural killer cell activation results in reduced levels of IFN-γ following burn injury (Collart et al.,(1986)). NK cell and(Rich et al.,(2001)Neutorphilfunction is diminished following significant thermal injuries. Several changes in the T lymphocyte population have also been observed. Total numbers ofT lymphocytes fall in proportion to injury severity during the first week after injury (Heideman et al., 1992) and there is a decrease in T-cell dependent immune functions (Kay et al.,(1957). Diminished T-cell proliferation in response to mitogens (Riddle et al.,(1967) is associated with, and may be the result of, decreased production of IL-2 and IFN-γ by monocytes (Wood et al., 1984). The production of immunoglobulin G (IgG) in response to T cell-dependent antigen is also impaired after serious injury and there is a decreased ratio of CD4 T helper cells to CD8 T suppressor cells (O'Mahonyet al., 1985). Due to the decreased Innate and Adaptive immunity of the host, burn wounds were more prone to infection.

Wounds due to falling from heights were 66.66 % culture positive. Falling from heights resulted in blunt and penetrating injuries which lead to soiling of wound and severity of the injury accounting for the infectivity of the wound. Wounds due to other miscellaneous causes were culture positive in 50% of the cases. The miscellaneous causes include communal clashes, fall from slippery floors and knife injuries etc. In these cases, the injury was small and the chance of getting infected was less due to various obvious reasons. The larger the wound, the higher is the chance of infection.

In the present study lower extremities received the highest number of wounds (52%), also were most contaminated and have shown high culture positivity [76.92], followed by Upper extremity wounds (71.42%), Trunk wounds (68.75%) and wounds of the head (54.54%). The lower extremities are prone for infection because of their proximity to soil which is the main source of infection. Also the injuries received by lower extremities are large and were severe which resulted in the exposure of the soft tissue and low blood perfusion. Hence the infection rate is higher when compared to wounds at other sites.

Diabetes was a risk factor. Mismanagement of diabetes and poor wound care resulted in the infection of wounds.

Of the wounds evaluated [100], 28% were sterile and 72% were culture positive. P.aeruginosawas the most common bacteria isolated among GNB, especially in the lower extremity wounds followed by, Proteus spp., E. coli, Aeromonassp.andamong GPB S.aureus was the commonest followed by Clostridium tertium.

Aerobic pathogens such as S.aureus, P.aeruginosa, and beta-hemolytic streptococciare recognized for their ability to produce potentially destructive virulence factors (Heggers et al.,(1998) and the clinical effects associated with clostridialexotoxins (Duerden et al.,(1994) are also widely acknowledged.Our study correlates well with the results conducted by other studies. (SomprakashBasu et al.,(2009), Pories et al.,(1991), Fabian and

Minard(1994).In general, Staphylococcus sp. and Streptococcus sp. are the likely early pathogens. However, as the length of the hospital stay increases the wounds rapidly become colonised with Gram negative bacilli. (Healy and Freedman (2006).

Majority of wound infections are polymicrobial, involving aerobes and anaerobes. Aerobic pathogens such as S.aureus, P.aeruginosa and beta-hemolytic streptococci have been most frequently cited as the cause of delayed wound healing and infection [Healyand Freedman(2006).

However in our study all the infections were monomicrobial, except one, from which E.coli and P.aeruginosa were isolated. Eventhough they were monomicrobial, the organisms isolated were the most problematic bacteria in traumatic, surgical and burn wound infections.

With regard to the frequency of the organisms isolated, again P.aeruginosa and S.aureus were the commonest. Both acute and chronic wounds are susceptible to contamination and colonization by a wide variety of aerobic and anaerobic microorganisms. The only anaerobe isolated in our study was Clostridiumtertium. Failure to isolate anaerobic bacteria may be due to delay either in the collection, transport or processing of the samples.

According to the site of wound, the distribution of pathogens were more or less the same. On the basis of etiology of wound, the frequency of isolation of organisms was high in case of RTA. All the patients received some form of treatment for comorbid disease.

Gram negative bacteria were sensitive to ofloxacin, gentamicin and ceftadizidime; resistant to ciprofloxacin.Gram positive bacteria were sensitive to gentamicin and ofloxacin; resistant to piperacillin and pencillin.Relatively simple antibiotics are effective in trauma patients because the bacteria causing infections are community acquired. After several days of hospitalisation, drug resistant hospital acquired bacteria start colonizing the wounds.In the initial management of traumatic wounds, broad spectrum antimicrobials like third generation cephalosporins, imipnem, azetronam have no place. As the length of hospitalization increases and the patient develops nosocomial infections, these newer agents play an important role in treatment.(Mathur et al.,(2008)]

Therapeutic antibiotics should always be administered based on culture and sensitivity report. The dosage should take into account the blood loss along with depressed cardiac, renal and hepatic functions in multipletraumatised patients.(Mathur et al.,(2008).

The goals of prophylaxis in a trauma care settings are to give antibiotics intravenously as soon as possible to achieve adequate tissue levels of the antibiotics and to choose antibiotics directed against the predominant pathogens causing a specific injury (Classen et al.,(1992).Trauma patients tend to be under-dosed because antibiotics are lost through hemorrage and significant fluid shifts, such as from volume resuscitation. Therefore, an additional dose may be considered for patients who have been massively resuscitated. Also, early peak levels may be more important than the duration of administration. So the emphasis is on high dose, short course therapy that allows the agent to be efficacious, yet minimises development of resistant organisms and super infection with other organisms as well as reduces cost and side effects (Altman et al.,(1977).

Conclusion

Providing optimal wound care, in addition to appropriate antibiotic treatment of the infection, is crucial for healing. Identifying patients who are at increased risk for infection may allow for early intervention and subsequent decrease in infectious

morbidity.Culture & sensitivity have an important role in the management of the wounds and will help the clinician in establishing early diagnosis and treatment with appropriate antibiotic.

Conflict of interest: None.

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