INFECTIONS IN TRAUMATISED PATIENTS: A GROWING MEDICO-SURGICAL CONCERN

*P Mathur

**Abstract**

Accidents and trauma are a leading global cause of mortality in young adults. Infections are one of the most important causes of death in traumatized patients. This is because of factors related to host and those due to trauma itself. Trauma jeopardizes the host’s tissue integrity and immune effector mechanisms. Severely traumatized patients admitted to the ICUs are prone to get nosocomial infections due to open wounds and indwelling life saving devices. Massive blood loss also impairs the distribution of polymorphs, complement and antibiotics to the damaged tissues. Finally, diagnosis of infections in traumatized patients poses a challenge to clinicians due to various factors.

**Key words:** Infection, trauma, diagnosis, pathogenesis

Accidents and trauma are one of the world’s most serious but neglected health problem. The fast moving transportation systems, unprecedented and unplanned urbanisation and changing social patterns have contributed to the global increase in the incidence of trauma to human body. Traffic accidents are an endemic disease which affects mainly the young adults in the economically productive age groups and are the leading cause of death in persons under 44 years of age.[1-3] Globally, 26% of all deaths in the age group of 15-44 years in 2002 were due to injuries.[2] The national vital registration system registers around 18 million deaths annually due to injuries worldwide.[2]

In India, trauma is a major problem, due to a very high incidence of vehicular accidents (6% of global vehicular accidents), other accidental injuries, crime and violence.[4] Rising population, urbanisation, industrialisation and a drastic rise in vehicular transport has contributed to an annual increase in road traffic accidents by 3%.[5] An accident death was reported every 1.9 minutes in India,[6] in 1997 and 10.1 % of all deaths in India were due to accidents and injuries.[9] Despite this, trauma care is at a developmental stage in our country. Thus, there is a growing population of traumatised patients requiring highly sophisticated and specialised care in India and elsewhere. Because most of these patients are young adults, with no underlying illness, there is a greater concern to save them. Infections are one of the most common and fatal complications following trauma and complicate the recovery of a significant number of injured patients. 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.

**Infections in Traumatised Patients**

Infections 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.[1,7-11] This is mainly because the management of other major contributors of mortality like haemorrhage, circulatory collapse and respiratory failure has greatly improved with the application of sophisticated technical advancements.[1] Traumatised patients with infections have a 5-fold higher mortality compared to those without infection.[11] The overall incidence of infections following trauma varies from 9-36%.[11-14] This is much higher than the rates of nosocomial infection for general population.[12] 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.[13] 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.[11] The cost of caring for these patients will continue to increase with inflation, newer techniques, more sophisticated monitoring and the advent of new therapies.[14]

**Factors Predisposing Trauma Patients to Infections**

These can be related to the type of trauma or host factors. Host factors include the age, since geriatric and paediatric trauma patients are more prone to infections[12] and require more care and resources. Underlying immunosuppression, diabetes, malnutrition, and other underlying illnesses in the traumatized patient also predispose to infections.[14] Factors
associated with trauma include the mechanism of wounding, severity of injury, number and type of organs injured, contamination of wound with soil, presence of foreign bodies (clothings, bullet pieces etc.) in the wound, shock and requirement of blood transfusion.[7,12,14] Other factors like injury to the spine, chest and extremity, multiple trauma and hypotension are also more commonly found in patients developing infection.[12] Trauma by itself jeopardizes the host’s natural protective barriers by disrupting the integrity of skin and tissues.[11] Blunt or crush injuries which cause ischaemia and the presence of devitalized tissue, foreign bodies, haematoma or dead space predispose patients to infections since they provide a fertile culture medium for bacteria. In addition, the treatment modalities frequently circumvent the patients’ own defence mechanisms. This occurs due to various invasive procedures like insertion of devices, which traverse the sterile spaces, as part of diagnostic/therapeutic work up, acting as foreign bodies and increasing the chances of nosocomial infections.[1] In order to save the patient’s life, emergency procedures often neglect the precautions to reduce infections like gentle tissue handling, careful surgical preparation, obliteration of dead space and removal of haematoma.[7]

In patients of trauma, besides the mechanism of injury, other factors also contribute to the propensity to develop wound infection.[14] The number of contaminating bacteria and their species correlates 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.[14,17]

Pathogenesis of Infections in Traumatised Patients

Major traumatic injuries cause profound pathophysiological changes, including multiple alterations of the immune system. In traumatised patients, both cellular and humoral immunity has been reported as being altered.[18] Defects in phagocytosis, bacterial killing, opsonisation and cytokine production have been reported after severe trauma.[19] The depression of innate immune system has been directly correlated with infections in these patients.[18,20] In patients of trauma, either a hyperactive or suppressed polymorphonuclear (PMN) response may be detected. Hyperresponsive changes can lead to systemic inflammatory response and multiple organ failure which can lead to death. Hyporesponsive changes can lead to infections and a variety of associated complications. [18] Studies done to determine the factors which predispose patients to infections after traumatic injury have found that a decrease in the expression of CD 11b, CD 11C, CD 16 and 18 on PMN correlates with systemic infections.[18] These receptors variously regulate the expression of heat shock proteins or are involved in the binding of PMNs. Since the percentage and absolute number of PMN expressing CD 11b and CD 16 correlates with the presence of infections and its response to treatment, it can be used for diagnostic and therapeutic purpose. Apart from the immunological consequences of trauma, hypoperfusion also significantly interferes with the ability to deliver oxygen, a critical factor contributing to bacterial killing.[19] the delivery of antibodies, polymorphs, macrophages, complement and antibiotics to the wound is also impaired in hypoperfused states and presence of devitalized tissue or haematoma.[17,21] Due to these immune alterations, immunotherapy in the form of G- CSF along with antibiotics has been shown to be beneficial for traumatised patients in some studies.[18]

Common infections in traumatised patients

Because traumatised patients have simultaneous injuries at multiple sites, infections at different foci with different organisms are common.[1] Infections in trauma patients can be acquired either exogenously from the environment at the time of trauma or nosocomially.[7,22] They may also be acquired from the patient’s endogenous flora because of the breakdown of patient’s own host barriers like skin and abdominal infections subsequent to hollow viscous injury.[1,13] However, the predominant infections in traumatised patients are nosocomial.[3,8,11]

Traumatic wounds

These are at an increased risk of infection due to environmental contamination. In general, Staphylococcus spp. and Streptococcus spp. are the likely early pathogens. However, the wounds rapidly become colonised with gram negative bacilli.[23] Traumatic wounds were found to be infected in almost 50% of polytrauma cases in a swiss hospital.[24] Water-related injuries can predispose a patient to Aeromonas spp. and Vibrio vulnificus infection.[8]

Clostridial myonecrosis (gas gangrene)

Tissue injury from crush/penetrating trauma exposes muscle and subcutaneous tissues to C perfringens and other clostridial species. In the perfect environment of tissue necrosis, low oxygen tension and adequate nutrients, clostridial spores germinate, multiply and produce potent toxins. The infection causes severe pain, red coloured discoulouration of skin, often accompanied by large haemorrhagic bullae, crepitation and a watery discharge with foul smelling odour, abundant Gram positive rods and few inflammatory cells.[17,25,26] The mortality rate is around 40-60% and slightly higher for infections involving abdominal wall.

Anaerobic streptococcal myositis

This soft tissue infection is caused by various species of anaerobic streptococci, which rapidly progresses along facial planes following penetrating trauma. The wound is often gangrenous and painful; a foul discharge containing numerous neutrophils and gram positive cocci are found. Clinical hallmarks include a slowly advancing cellulitis, fever and systemic toxicity.[26]

www.ijmm.org
Necrotising fasciitis

Originally associated with *Streptococcus pyogenes*, this syndrome can also be caused by anaerobic streptococci, *S. aureus*, *Bacteroides* spp. and mixed anaerobic-aerobic bacteria.[17,26] It is characterised by a rapidly spreading and sometimes gangrenous infection of the subcutaneous tissue.

Abdominal infections

The incidence of intra abdominal abscess after penetrating abdominal trauma ranges from 3-50%, with the highest incidence associated with colonic injury.[15,27] Necrotising fasciitis of the abdominal wall and diffuse peritonitis are also common in these patients.[29] Other risk factors for abdominal infections include multiple organ injury, pancreatic or duodenal injuries and packing to control haemorrhages.[8,29,30] In patients with gun shot wounds, retained bullets that pass through colon can act as adjuvants to abscess formation. In abdominal trauma (especially crush and penetrating trauma to colon), life-threatening abdominal infections and abscess formation occurs due to the gut flora (predominantly *B. fragilis*, aerobic gram negative bacilli and enterococci).[8,13,14,17] This occurs due to the potentially serious synergistic invasion by aerobes and anaerobes. Colon has a very high count of bacteria (10¹⁰-10¹²/gm stool), predominantly consisting of anaerobes.[11] The aerobic bacteria lower the redox potential, aiding multiplication of anaerobes, which is also enhanced by ischemia or necrotic tissue.[14] The anaerobes produce potent, putrefactive enzymes, which digest tissues and promote further aerobic invasion. A higher risk if infection is seen if a colostomy is performed following injury.

Nosocomial infections

In both adult and paediatric trauma, the predominant nosocomial infections are pneumonia, followed by blood stream infections and urinary tract infections.[8,11,24]

Pneumonia

Of the three types of pneumonia (aspiration, haematogenenous, aerosolization), aspirational pneumonia is the most common in traumatised patients.[7,8] The risk factors include an Injury severity score >20, closed head injury, emergency intubation, systolic blood pressure <90 mmHg and blunt trauma causing injury.[8]

Blood stream infections (BSI)

These can be primary BSI, device associated or secondary to a focus of infection elsewhere in the body.

Line related infections

Because of the multitude of lines required in trauma patients, these infections are very common. They are one of the major contributors of bacteraemia. Line related infections can occur as suppurative or non suppurative thrombophlebitis.[1]

Urinary tract infections

Insertion of foley’s catheter in multiply traumatized patients is a major contributor to development of UTI. Gram negative bacteria predominate in these infections.

CNS infection

The most common manifestations of CNS infection are meningitis, ventriculitis or brain abscess due to dural disruption which results from blunt or penetrating trauma, craniotomy or ICU monitoring devices.[1,8,24]

Sinusitis

It usually occurs in the second week of hospitalisation and most commonly occurs due to nasal packing, nasogastric feeding, head trauma and sedation and causes undiagnosed fevers, especially in ICU patients.[1,8,24]

Empyema

Post traumatic empyema occurs in approximately 5% of trauma patients after both penetrating and blunt trauma. Risk factors include severe head/ chest injury, chest tube placement, unrecognised diaphragmatic perforation, residual pneumothorax, haemothorax, pulmonary contusion and pneumonia.[8,17]

Surgical wound infection

*Staphylococcus aureus* and gram negative bacteria most commonly cause this infection. The wounds behave like any other surgical wound.

Osteomyelitis associated with wound infection

Osteomyelitis may develop after inoculation of bone from a contiguous focus of infection. It may also develop subsequent to infection of an implanted plate/other device. It usually causes chronic non-healing ulcers.

Diagnosis

Infection in multiply traumatised patients presents a real diagnostic challenge.[1] Many factors impede the assessment of a trauma patient who is suspected to have an infection. Many seriously traumatised patients are often unable to communicate, therefore the history may not be obtainable. Physical examination is hampered by many devices and dressings, as is the ability to conduct diagnostic tests. Often, a portable chest X-ray film is obtained rather than PA and lateral view, which requires transporting a patient to radiology facility as is the case with CT scans. Bone scans and Indium scans are of limited value because they are difficult to interpret after recent trauma. Lumbar puncture is often contraindicated in head trauma because of elevated intracranial pressure.[8,14] In a patient with suspected infection, a complete blood count, with differential, two sets of blood cultures, chest X-ray, Gram stain and cultures
of wounds and urine should be obtained. CSF is collected from them every other day for Gram stain, culture, cell count with differential and glucose testing.

In suspected chest infections, BAL/tracheal aspirates or induced sputum should be examined microbiologically. Intraabdominal infections can present as low grade fever, anorexia, ileus, wound dehiscence and pus from intra-abdominal drains. Laboratory investigations may reveal leucocytosis, with positive blood cultures for polymicrobial etiology/anaerobic bacteria or Enterococcus spp. Central and peripheral catheter line tips should be sent for culture in all suspected febrile patients and should be cultured using the semi-quantitative method.

The diagnosis of osteomyelitis should be considered in any chronic wound that does not heal despite optimal treatment or in any wound that can not be probed to bone. Plain X-ray of the affected area should be the first line of investigation. Although MRI and ⁹⁹Tc bone scan are more sensitive than plain X-ray, it can be difficult to differentiate osteomyelitis from chronic soft tissue infection. The diagnosis of chronic or subacute osteomyelitis secondary to trauma is often difficult due to the indistinction between fracture instability and an implant-associated infection due to compromised image quality in patients having implants using MRI and CT. The current imaging modalities to diagnose osteomyelitis secondary to trauma include three-phase bone scanning, indium ¹¹¹ labeled leukocytes (referred to as the gold standard of infection imaging), gallium ⁶⁷ scintigraphy, ⁹⁹Tc bone marrow scintigraphy, and use of ⁹⁹Tc labeled monoclonal antibodies against granulocytic surface antigens and chemotactic peptides. The FDG-PET scan is also extremely useful for distinguishing between non union and infection since metallic implants generate very few artifacts by this technique.

Management

The main approach to treatment of severely traumatised patients should be to maintain haemodynamic, metabolic and pulmonary functions which lessens the likelihood of infections in post traumatised patients. Traumatic soft tissue injuries should be managed aggressively. Blood, necrotic skin and soft tissues must be debrided thoroughly. Foreign materials such as soil, clothings, shot gun waddings and other debris should be promptly removed. Irrigation, especially with povidone-iodine and antibiotics may have a role in prevention of infection. Mechanical debridement may significantly reduce the bacterial inoculum and make infection less likely. In addition, foley’s catheters are removed as soon as possible. The IV lines inserted in admitting area under emergency conditions are removed within 24 - 36 hours. Peripherial lines are changed every four days either over a guidewire and left at the previous site or moved to a new insertion site.

Prophylactic and Therapeutic Antibiotics in Traumatised Patients

In trauma patients, the first principle of prophylaxis (before contamination) is violated since contamination has already occurred, by the time patients reach a hospital. Therefore, the only conditions where antibiotic prophylaxis is recommended are blunt or penetrating abdominal trauma, compound orthopaedic injuries and open head injury or cerebrospinal rhinorrhea or otorrhoea. The choices in abdominal trauma are based on the assumption that the gastrointestinal tract has been disrupted by either penetrating or blunt injury. 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. Trauma patients tend to be under-dosed because antibiotics are lost through haemorrhage 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 superinfection with other organisms as well as reduces cost and side effects. 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 multiply traumatised patients.

Conclusions

Infections are common and potentially fatal in traumatised patients due to their vulnerable condition, disruption of tissue integrity and invasive devices. Understanding the epidemiology of infections will aid in its prompt diagnosis and management. 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 colonising the wounds. In the initial management of traumatic wounds, broad spectrum antimicrobials like third generation cephalosporins, imipenem, aztreonam have no place. As the length of hospitalisation increases and the patient develops nosocomial infections, these newer agents play an important role in treatment.

References


5. Sethi AK, Tyagi A. Trauma untamed as yet. Trauma Care 2001;11:89-90.


Source of Support: Nil, Conflict of Interest: None declared.