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Antimicrobial Prophylaxis and Infection Control Precautions in Patients with Crush Injury

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Abstract

The majority of infection-related deaths following earthquake injuries are caused by nosocomial infections, particularly in those receiving hemodialysis. Central venous catheter-related blood-stream infections, deep wound infections secondary to fasciotomy, and ventilator-associated pneumonias ranked as the top 3 causes of sepsis and mortality. *Acinetobacter baumannii* and *Pseudomonas aeruginosa* are among the leading causes. It is of vital importance to protect patients from nosocomial infections, who are rescued from rubble. Avoiding unnecessary fasciotomy, using appropriate empirical/pre-emptive antimicrobial therapy, ensuring full compliance with infection control measures, and referring patients to appropriate centers are all critical for decreasing mortality. All components of infection control program must be strictly adhered to, clinical samples and colonization scans of the patients should be followed dynamically and the treatment protocols should be modified according to culture results and local epidemiology. Whether the wound is closed or open, all crush injuries are regarded as tetanus-prone wounds. Tetanus prophylaxis (vaccine + immunoglobulin, if necessary) should be administered to all patients at risk. For patients with closed wounds, 24-hour prophylaxis is recommended. Ampicillin-sulbactam is the best antibiotic for prophylaxis, with a potential coverage over environmental *Acinetobacter* strains. For patients with open wounds, all should be considered contaminated. Cultures (blood culture, wound culture, urine culture, and respiratory sample, if any) should be obtained after prompt wound cleaning and debridement. If the wound does not appear infected and cultures turn negative, a 5-day pre-emptive antibiotic therapy with ampicillin-sulbactam is sufficient.

Keywords: Antimicrobial prophylaxis, crush injury, ampicillin-sulbactam, blood-stream infection, infection control precautions

Introduction

Following natural disasters like earthquakes, infectious diseases become more prevalent. The main reasons for this include the deterioration of water and food safety due to poor sanitation, exposure to polluted air, dust, smoke, and gas, population movements that result in crowded environments, exposure to cold and heat, an increase in the population of flies and other insects, a lack of medical supplies and medical care due to the collapse of the health care infrastructure, and impaired immune status as a result of nutritional deficiencies, post-traumatic stress disorder, and sleep disorders.[1]

Skin infections, respiratory tract infections, and gastrointestinal infections (diarrhea) are the most common diseases in the aftermath of the earthquake which are all linked to the size of the affected population, the characteristics of the damaged infrastructure and overall disaster management. By ensuring the safety of water and food, creating opportunities for safe and hygienic shelter, providing ongoing health services including vaccination, and providing psychosocial support to all earthquake victims, it is achievable to significantly reduce the frequency, severity, and epidemic potential of infections.

The prevalence of Hepatit A Virus (HAV) and Hepatit E Virus (HEV) infections increased in particular in areas where infrastructure renovations for hygiene and sanitation were rather delayed, according to surveillance studies conducted in the months after the 1999 Marmara and Düzce earthquakes.[2,3] There have been outbreaks of *Giardia lamblia*, *Enterobius vermicularis*, gastroenteritis, oro-pharyngeal tularemia, and even epidemics.[4-6] In the post-earthquake period, outbreaks of cholera and tetanus were reported from several regions where huge earthquakes had occurred in the previous 20 years, including Haiti, Indonesia, and Pakistan, but not from our country.[7]

The majority of infection-related deaths following earthquake injuries are caused by nosocomial infections rather than community-acquired outbreaks. Post-earthquake infection-related deaths occur mostly due to severe healthcare-associated infections. In a study conducted after the 1999 Marmara earthquake—which resulted in over 17 000 fatalities and over 44 000 injuries—639 patients from 35 different centers were investigated. In the study, patients receiving hemodialysis had a significantly higher rate of infection than patients who were not receiving hemodialysis (42.5% vs. 12.3%, $P = .0001$), and patients with infections had a significantly higher mortality rate (19.3% vs. 13%, $P = .03$) than those who were not diagnosed with infections.[8] When the distribution of infections in individuals with renal disorders is analyzed, sepsis (18.9%), wound infections (8.3%), and pneumonias (6.4%) ranked as the top 3 infections. *Acinetobacter baumannii* and *Pseudomonas aeruginosa* were the leading causes, indicating the nosocomial sources of infections. The majority of the patients with wound infections and nosocomial sepsis had previous fasciotomies. In crush injuries, fasciotomy is performed to prevent compartment syndrome and muscle necrosis, particularly in the extremities. The pressure between the muscle planes is thus reduced and the development of necrosis is prevented, but

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because the closed wound is made open, the risk of nosocomial pathogen inoculation increases during the healing process and serves as a major source for sepsis.

Patients receiving renal replacement therapy through central lines due to crush syndrome are at high risk of developing catheter-related bacteremia. Avoiding unnecessary fasciotomy, using appropriate empirical/pre-emptive antimicrobial therapy, ensuring full compliance with infection control measures, and referring patients to appropriate centers are all critical for decreasing mortality.

Antibiotic Prophylaxis in Cases with Crush Injury

Crush injuries are high risk injuries in terms of infection development and they are affected by variables such as the time spent under the rubble, the type and depth of the injury, whether it contains foreign bodies and the degree of environmental pollution. First and foremost, it is critical to wash the wound with sterile distilled water or saline solution, if these are not found; it can be done with clean drinking water (bottled water). After washing the wound, foreign objects should be removed and then the first dressing should be made with skin antiseptics. Whether the wound is closed or open; all crush injuries are regarded as tetanus-prone wounds. Tetanus prophylaxis (vaccine + immunoglobulin, if necessary) should be administered to all patients at risk.

For patients with closed wounds, 24-h prophylaxis is recommended. Prophylaxis can prevent the severe microbial load on the skin from causing blood or tissue invasion. Under this prophylaxis, patients can undergo procedures including laparotomies and fasciotomies without the requirement for additional surgical prophylaxis. Ampicillin-sulbactam is the best antibiotic for prophylaxis.

For patients with open wounds, all should be considered as contaminated. Cultures (blood culture, wound culture, urine culture, and respiratory sample, if any) should be obtained after wound cleaning and debridement. If the wound does not appear infected and cultures turn negative, a 5-day pre-emptive antibiotic therapy is sufficient.[8] Antibacterial treatment is administered according to culture results, cultures are repeated if there is an indication clinically, and pre-emptive treatment is discontinued in 5 days in cases with no signs of infection.

In cases complicated with infections, cultures should be obtained and empirical treatment can be extended or modified upon consultation with infectious diseases specialist. In the selection of empirical treatment, the previously detected colonization of the patient, the results of Gram stain examination of clinical specimens, and the environmental and hospital microbial flora should be taken into consideration.

Ampicillin-sulbactam (4 × 1-2 g) would be the best option for both prophylaxis and pre-emptive treatment due to its efficacy against gram-positive, gram-negative, and anaerobic bacteria, as well as sulbactam's possible efficacy against environmental Acinetobacter strains. If ampicillin-sulbactam is not available, cefazolin (3 × 1-2 g) may be administered. Clindamycin (3-4 × 600 mg) can be used in individuals who have a history of severe beta-lactam allergy (anaphylaxis/angioedema).

In cases with open bone fracture in addition to soft tissue contusion, ampicillin-sulbactam or sefazolin plus ciprofloxacin can be used. If there is abdominal injury, ampicillin-sulbactam alone can be used as well as ceftriaxone + metronidazole or non-beta-lactam broad-spectrum antibiotics such as tigecycline, moxifloxacin can be preferred. There is no need for additional surgical prophylaxis when surgical procedure is to be performed to a patient receiving ampicillin-sulbactam treatment. Prophylactic treatment is recommended not to exceed 24 hours and pre-emptive treatment (in an open wound) not to exceed 5 days in order to prevent collateral damage and selection of resistant strains.

In a patient with findings of necrotizing skin-soft tissue infection empirical antimicrobial therapy should be initiated after obtaining blood and deep tissue cultures. Piperacillin tazobactam + teicoplanin + clindamycin would be a good combination for empirical therapy.

In the management of intensive care unit (ICU) patients, rectal colonization scans (Carbapenem resistant (CRE) and Vancomycin resistant (VRE)) can guide both in the selection of empirical treatment and in isolation precautions. Dynamic changes in the cultures of clinical samples should not be overlooked in the follow-up of patients. Initial tracheal aspirate samples from intubated patients (if possible) should be collected for culture.

Empirical carbapenem use in cases without suspicion of sepsis is not an appropriate approach because of the selection of carbapenem-resistant gram-negative bacteria.

Infection Control Measures in the Patient Presenting with Crush Injury

In a patient brought in with a crush injury after an earthquake, the skin is considered to be heavily contaminated with the environmental microbial load, albeit it depends on many factors such as the type of the injury, the time spent under the rubble. After stabilizing the patient, meticulous skin cleansing should be performed, especially before central catheter placement. For this, sterile distilled water, physiological saline, and then antiseptics can be used. Wound infection and catheter-induced sepsis are the most common causes of infection-related mortality in these patients.[8]

Prevention of Central Venous Catheter-Related Bloodstream Infections

The need for hemodialysis is common due to acute kidney injury in patients presenting with crush syndrome. The following precautions should be implemented in patients who have a central line placed for hemodialysis or other medical purposes:

1. The femoral region should not be preferred. if it is used compulsorily, it should be switched to subclavian vein as soon as possible. Jugular vein is safer than femoral vein. Subclavian vein can be preferred over jugular vein to minimize contamination risk with oral content and improve patient comfort.
2. Catheters placed in emergency conditions without following aseptic technique should be properly replaced as soon as possible (within 24 hours).
3. The catheter site should be thoroughly cleaned; After cleaning with sterile saline, 2% chlor-hexedine for 1 minute or 10% povidone iodide for 2 minutes can be applied from the center to the periphery. Then a second wiping can be done with a solution containing 70% alcohol. Maximum barrier precautions (wide sterile drape, surgical gown, mask, cap, sterile gloves) should be taken and the catheter should be inserted by an experienced team, if possible, in a clean room or operating room reserved for this procedure.
4. Multiple insertion attempts should not be made with the same catheter.
5. If possible, transparent, antiseptics-soaked catheter covers can be used after insertion. Sterile gauze is preferred in case of sweating, bleeding or leakage at the catheter site. If gauze is used, it should be checked daily and regular dressing should be performed aseptically.

6. Hand hygiene must be performed in every single contact to the catheter, nonsterile gloves should be worn for aseptic procedures, the catheter insertion site should be wiped with alcohol gauze (if not available, alcohol-based hand antiseptic can also be used) or ready-to-use disposable wipes with alcohol. Wiping the catheter site with alcohol at every contact is critical for catheter care.
7. Catheters should not be changed on regular basis. If they are inserted properly and protected with strict adherence to infection control procedures, they can be used for weeks unless functional problem develops.
8. Catheter requirement should be assessed on daily basis and removed without delay once the medical indication disappears. It should be noted that each additional day in which the catheter is in place increases the risk of bloodstream infection.

Contact Isolation Precautions

Intensive care unit patients with crush injury should be followed up with contact isolation precautions until colonization screening culture results are obtained. For this, the isolation precautions guidelines prepared by the hospital infection control committees must be followed.[9] Asepsis-antisepsis is important in wound dressings, protective gowns should be worn during dressings, hand hygiene should not be neglected before putting on gloves and after removing them.

Prevention of Ventilator-Associated Pneumonia

It is recommended to send the first tracheal aspirate to clinical microbiology laboratory for Gram stain examination and culture in order to have information about respiratory tract microbial colonization and infection risk in patients intubated upon indication. Afterwards, if purulent secretion is detected, culture can be repeated. During oral cleaning and aspiration of tracheal secretions, aseptic techniques must be applied. Instructions for the prevention of ventilator-associated pneumonia must be followed.

Prevention of Catheter-Related Urinary Tract Infections

Patients with crush syndrome frequently have an indwelling catheter to follow up the urine output. The following precautions should be taken to prevent catheter-associated urinary infections:

1. The use of urinary catheters should be avoided as much as possible and should be removed immediately once urgent indication is over.
2. If possible, condom catheter should be preferred in male patients, and patients should be regularly checked if there is any lesion or necrosis on meatus. Proper catheter care should be ensured.
3. Catheters should not be changed routinely, unless there is clinical indication such as adhesion or occlusion.
4. Before and after any procedure related to the urinary catheter, hands should be washed or hand rub with alcohol should be performed according to "Instructions for Hand Hygiene and Use of Gloves."
5. When inserting an indwelling catheter, especially in women and those with fecal incontinence, the perineum and meatus area should be cleaned with soap and water and meatus should be wiped with an antiseptic solution such as 10% povidone iodine, aseptic technique, sterile equipment, sterile disposable gels, and sterile surgical drapes should be used during catheter insertion.
6. In cases where aseptic technique cannot be maintained, the procedure should be repeated using new sterile catheter equipment.
7. Maintenance of continuous urine flow from the catheter to the urine collection bag should be ensured. The catheter and urine collection bag should be kept below the level of the bladder and the bag should not touch the ground.
8. Since the bacteria can be carried to the upper levels by air bubbles, formation of curls and air bubbles in the indwelling urinary catheter should be avoided.
9. During patient transport, the urine collection bag should not be lifted higher than the bladder level, the bag should be emptied and the connections should be closed.
10. Before the patient's bath/cleaning, the urine bag should be emptied and its connections should be closed.
11. The connection between the catheter and the urine collection bag should not be disrupted, the urine must be emptied from the spout at the bottom of the urine collection bag.
12. For microbiological examination, urine sample should be obtained from available port or from the proximal site of the catheter with the thinnest syringe, following aseptic technique. Urine cultures are not routinely recommended for patients with catheters. Urinary catheter tips (even foley or silicone) are not acceptable samples for microbiological examination. For nonmicrobiological urine analysis, sample is obtained from the bag's drain valve following aseptic procedures.
13. Meatus should be cleaned with soap and water as long as indwelling urinary catheter remains, catheter indication should be questioned on daily basis and removed immediately (with bladder exercise) once indication is over.

Conclusion

Nosocomial infections may develop in patients with crush injuries due to many risk factors such as prolonged hospitalization, ICU stay, use of central venous catheters, hemodialysis, and surgical interventions. It is of vital importance to protect patients from nosocomial infections, who were rescued from rubble. For this purpose, all components of infection control program must be strictly adhered to, clinical samples and colonization scans of the patients should be followed dynamically and the treatment protocols should be modified according to culture results and local epidemiology.

Patient's comorbidities, immunosuppressive therapy and disease histories, test results that are indicative of patient's immune status (total blood count, anti-Human Immunodeficiency Virus (HIV), Purified protein derivative standard (ppd), and antibody levels) should also be taken into consideration. Apart from common bacterial pathogens, it is of critical importance for patient management to consider fungal, viral, mycobacterial, and parasitic agents in relevant cases.

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