33 Disaster surgery

- Management in the field
- Mobilising resources
- Necrotising fasciitis
- Organisation of emergency services
- Rescue operation
- SAMPLE SAMPLE
- SEQUENCE OF RELIEF EFFORTS AFTER A DISASTER Establ
- SEQUENCE OF RELIEF EFFORTS AFTER A DISASTER Establishing a chain of command
- SPECIFIC ISSUES
- Tetanus
- Triage

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Figure 33.7 Triage tags ((a) courtesy of TACDA & METTAG products, The American Civil Defense Association; Management Systems).

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First aid Care for patients with minor injuries involves cleaning and dressing wounds, suturing lacerations and splinting simple - fractures. Most of these ‘walking wounded’ can be sent away with antibiotics and simple pain relief. Damage control surgery Damage control surgery (DCS) is the concept that only life- and limb-saving surgery should be performed in field hospitals to allow safe transfer of a patient to a definitive treating facility . This will include ensuring that the airway is secure, haemor - rhage is under control and compartments are decompressed in the chest, skull, abdomen and the limbs. Devitalised tissue should be removed and any contamination prevented from developing into infection. DCS is explained in more detail, in the context of early management and other settings, through - out the chapters in Part 4. Emergency care for immediate life-threatening injuries There are many patients who may be saved by relatively simple measures, provided that these are taken urgently . Endotracheal intubation and tracheostomy may be needed to provide a secure airway . A needle thoracocentesis will relieve a tension pneumothorax and a chest drain will be needed before a patient with a significant chest injury is transferred by air. An open pneumothorax should be closed. Damaged major vessels

(b) courtesy of Disaster

to limbs should be repaired if possible. Fasciotomies will be needed for muscle compartments that are swelling from injury or from reperfusion. Amputation for clearly devitalised limbs and gas gangrene should be undertaken at field hospitals as delay will be fatal. Specific aspects of care are discussed in the relevant chapters elsewhere in this book. Initial care for non-life-threatening injuries Many patients sustain serious injuries that require prolonged care. These include compound limb fractures, degloving injuries, dislocations of major joints, major facial injuries and complex hand injuries. These patients will need specialised care requiring transfer to the appropriate facility . Replantations of amputated limbs and other extensive procedures should not Summary box 33.5 Principles of DCS /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF

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Any event that results in the loss of human life is disastrous, but most accidents, such as aeroplane and train crashes, are limited in the number of people involved. Conversely , natural disasters, such as earthquakes and tsunamis, leave in their wake massive destruction over large areas that can transcend national boundaries. All the apparatus of a society that responds to such disasters (the civil administration, emergency services, fire brigades and hospitals) may itself be involved and unable to Summary box 33.1 Common features of major disasters /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF - respond (Figure 33.1). Large numbers of people may require immediate shelter, clean water and food, in addition to any medical needs. A breakdown of communication is inevitable and can be accompanied by widespread panic and disruption of civil order. Access to the disaster area may be limited because of the destruction of bridges, a ff ecting road and rail links.

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Coordination with relief agencies

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A laudable aspect of globalisation is the outpouring of help from governments and non-governmental organisations in response to a disaster. Some, such as Rescue And Prepared - ness In Disasters (RAPID), deal with search and rescue, whereas others, such as the International Committee of the Red Cross and Oxfam, provide general disaster-related relief (Figure 33.6). The various United Nations agencies deal with medical care, food provision and refugees. Coordinating the e ff orts of these organisations is essential for optimal results, as medical aid in isolation is inadequate without the simultaneous provision of safe drinking water, food, clothing and shelter. Summary box 33.3 Sequence of the relief effort in major disasters /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF - /uni25CF /uni25CF /uni25CF /uni25CF

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Crush injury and syndrome

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A crush injury occurs when a body part is subjected to a high degree of force or pressure, usually after being squeezed between two heavy or immobile objects. Damage related to a crush injury includes lacerations, fractures, bleeding, bruising, compartment syndrome and crush syndrome (Figure 33.18). The London Blitz is the name given to the German air raids on London between 7 September 1940 and 17 May 1941, during which it is estimated that more than Blitzkrieg , which is German for 'lightning war'. 15 000 people were killed. Blitz is short for The association between crush injury , rhabdomyolysis and acute kidney injury was first reported in victims trapped during the 'London Blitz'. It is seen in earthquake and mining accident survivors and in battlefield casualties. Prolonged crushing of muscle leads to a reperfusion injury when the casualty is rescued. This releases myoglobin and vasoactive mediators into the circulation. It also sequesters many litres of fluid, reducing the intravascular volume and resulting in renal vasoconstriction and ischaemia. The myoglobinuria leads to renal failure from tubular obstruction. The treatment of crushed casualties should begin as soon as they are discovered. Rescuers must be alert to the presence of associated injuries (Figure 33.19). Aggressiv e volume- loading of patients, preferably before extrication, is the best treatment. After provision of first aid and starting intravenous fluids the patient should be catheterised to measure urine output. In adults, a saline infusion of 1000–1500 /uni00A0 mL/h should be initiated. This should be continued until myoglobin is no longer detectable in the urine. Mannitol administration can reduce the reperfusion component of this injury . Once a flow of urine is observed, a mannitol–alkaline diuresis of up to 8 /uni00A0 litres per day should be maintained, keeping the urinary pH greater than 6.5. An early fasciotomy can decompress muscle compartments and prevent severe loss of limb function. A late fasciotomy , when it is obvious that the muscles of that compartment must be dead, is only likely to cause a massive release of myoglobin, as well as potentially introducing infection into dead tissue. It is therefore best not to perform a fasciotomy in cases where entrapment has been for over 12 hours. Intensive care is required with close attention to fluid balance and renal dialysis if required.

(b) (c) Figure 33.18 (a–c) Extensive crush injury in a man trapped in a fallen house. The depth to which the soft tissues have been devitalised is seen clearly. Figure 33.19 Rescuers must be prepared for injuries to the spine. Treatment of crush syndrome should start before extrication.

Crush syndrome /uni25CF /uni25CF /uni25CF Compartment syndrome A compartment syndrome develops when the pressure within a muscle compartment starts to rise as a result of trauma (see Chapter 32). This occurs in muscles enclosed in a fascia such as the calf and forearm muscles and the intrinsic muscles of the hand and foot. A tight bandage or plaster, haemorrhage from a fracture or severe blunt trauma leads to a rise in pressure in the compartment until it exceeds venous drainage pressure. If the pressure rises further, it will cut o ff perfusion of the muscle. Passive stretching of the a ff ected muscle will cause extreme pain and this is diagnostic of the condition. If the condition is left unrelieved, then nerves passing through the compartment will cease to function and the muscle will die and then undergo fibrosis and shortening, producing a V olkmann’s ischaemic contracture. Removal of any constricting agent and, if necessary , a fasciotomy will relieve the pressure and muscle perfusion will restart. Pressure studies are not reliable; if in doubt, perform a fasciotomy . Summary box 33.11 Compartment syndrome /uni25CF /uni25CF /uni25CF /uni25CF

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DISASTER PLANS

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Damage assessment

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The first objective in disaster management is an assessment of the damage and the number of casualties. All sources of information must be employed. The 24-hour news services are frequently the first on the scene and can be an important source of information. Drones are now a quick and inexpensive option for a rapid view of a disaster area.

Chief of operations Evacuation Communications Helicopter Security Transport Search/ rescue Communications

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Limb injuries 95 95 100 Facial trauma Abdominal and chest trauma Head inju ry 55 1 month 2 weeks

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Taken from the French, meaning to ‘unleash or cut open’, debridement plays a crucial part in the management of trauma. Wounds sustained in disasters are often heavily contaminated, containing foreign bodies and non-viable tissues (Figure 33.9 Debridement reduces the chances of anaerobic and necrotis ing infections and can prevent systemic sepsis. The following principles of debridement apply to all contaminated wounds: /uni25CF After the administration of anaesthesia, the injured area is copiously irrigated with normal saline. Lavage using a pressurised system is controversial, with concerns over tis sue trauma and spread of debris (Figure 33.10). A water- jet based system that simultaneously clears the debris after debriding is very useful. The wound is palpated and all foreign matter removed. Dirt and debris enmeshed in soft tissues can only be removed by excision of those tissues. Open joints should be thoroughly irrigated and all foreign material removed. /uni25CF Wounds with extensive cavitation should be enlarged longitudinally to gain better access and allow full decom pression of the underlying muscles. This should be carried structures and allows the surgeon to gain proximal and distal control of vascular injuries and to identify severed ends of major nerves and tendons. /uni25CF The next step is excision of all dead and devitalised tissue. At this stage the tourniquet is let down to check the vas - cularity of the tissues. Skin excision is kept to a minimum and only the margins of the wound need be trimmed back to healthy bleeding edges. Excision of devitalised muscle should be undertaken generously . Muscle that is pale or). dark in colour, that does not contract on pinching and tha t - does not bleed on cutting must be removed. In patients with traumatic amputations, the bone ends are tidied, the skin and muscle edges trimmed to the lowest level possible and the wound left open. /uni25CF In patients with associated fractures, skeletal stabilisation - should be obtained before embarking on any repairs. External fixators are invaluable for this and make wound management much easier (Figure 33.11). /uni25CF In the acute setting, only vascular repairs are justified. For lacerated vessels the ends are trimmed and an anastomosis performed. In the case of loss of substance of the vessel wall, a vein patch or reversed vein graft may be employed. Silicone tubing may be used as a temporary bypass (stent) while vascular repair is being carried out in patients with - critically compromised distal circulation. /uni25CF Nerves and tendons should not be dissected out nor should any attempt be made at definitive repair in wounds with tissue devitalisation, as this leads to poor results. The key

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This is the first step in the planning for disasters. Most resource-rich countries already have such an agency , which can formulate policy at the national level and has the infrastructure to react quickly when the need arises. Areas near active volcanoes and geological fault lines are at risk from seismic disturbances, whereas regions along major rivers are liable to flooding. The urban centres of all countries are now potential targets for terrorist attacks. It is important to not only carry out threat assessments but also, if possible, set up an early warning system. Establishment of a national disaster management organisation

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Evacuation of casualties

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Decisions regarding the best destination for each patient need to be based on how far it is safe for them to travel and whether the facilities that they need for definitive treatment will be available. A quick retriage is very useful in this situation. The paramedics accompanying the casualties should be committed to preventing a ‘second accident’ (damage caused inadvertently by transport and treatment). An adequate supply of essentials such as intravenous fluids, dressings, pain medication and oxygen must be arranged (see Chapter 34). need so that resources can be allocated by good prioritisation. The process om the French Service

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Evacuation planning

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Good communication is critical for the authorities to respond quickly to a disaster. Wireless technology and satellite imagery have revolutionised the way in which real-time information can be obtained (Figure 33.2). Nonetheless, there is an inevi - table lag period between the occurrence of the disaster and the response from the establishment. The location of the disaster area has a bearing on relief e ff orts. In large cities emergency and medical services are bet - ter developed. Ho wever, these areas are densely populated and may have limited access by road and air. Disasters in remote areas can be particularly di ffi cult to manage because relief e ff orts are hampered by geographical isolation and the lack of infrastructure. The time frame in which a disaster occurs also impacts on the relief e ff orts. Earthquakes can unleash havoc in seconds but floods and hurricanes may continue for several days. Another esources of the country; important factor is the state of r Factors influencing rescue and relief efforts /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF disasters in poorer countries can seldom be managed without significant outside assistance

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FURTHER READING

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Facial injuries

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The management of facial injuries follows the same general principles of debridement and delayed closure as already outlined. Because of the functional and cosmetic importance of facial structures, skin and soft-tissue excisions are kept to a minimum. The face has a robust vascularity and a high ability to counter infection. Even in patients who present late with gross contamination, careful debridement followed by delayed primary closure can lead to good results (Figure 33.14). Facial injuries

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Field hospitals

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The decision to deploy field hospitals depends on the location, the number of casualties and the speed with which evacua tion can be organised (Figure 33.8). Whether the traditional tented structure or the modular type, housed in containers, is employed, the facility must be equipped with radiograph capability , operating rooms, vital signs monitors, sterilising equipment, a blood bank, ventilator s and basic laboratory facilities. Field hospitals

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Frostbite and immersion injuries (trench foot)

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Frostbite occurs when a part of the body freezes. The cells are disrupted and the tissue dies. It is in e ff ect a ‘cold’ burn and can be categorised according to the depth that it a ff ects in the same way as a conventional burn. Other mechanisms at play include vasoconstriction caused by cold, capillary sludging and reper fusion injury with the release of free radicals, which occurs on rewarming the part. It commonly involves the fingers, toes, cheeks, the tip of the nose and the ears. When frozen the tissue feels hard and cannot be indented. Immer sion injury is a cold injury that does not involve actual freezing of the tissue and is commonly caused by prolonged immersion in cold water (hence trench foot). The patient may also be hypothermic. Warming should be gentle as the heat used may actually cause a burn! Rehydration with warm fluids and use of non-steroidal anti-inflammatory drugs such as ibuprofen are beneficial. Richard von Volkmann , 1830–1889, Professor of Surgery , Halle, Germany . at this stage no surgery should be undertaken as there is often considerable deep recovery . The injured area should be kept clean and dry and e ff orts made to pre vent further injury , as well as to prevent infection. Definitive surgery to excise dead tissue can be left for many months. Recent developments, such as the use of tissue plasminogen activator and nerve blocks, show promising results in reducing amputations, but have to be started within 24 hours and are seldom possible in the field. Summary box 33.12 Frostbite /uni25CF /uni25CF /uni25CF /uni25CF

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Gas gangrene (clostridial myonecrosis)

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Gas gangrene is a dreaded consequence of late-presenting missile wounds and crushing injuries. It is a rapidly progressive, potentially fatal condition characterised by widespread necro sis of the muscles and soft-tissue destruction. The common causative organism is Clostridium perfringens , a spore-forming, Gram-positive saprophyte that flourishes in anaerobic condi tions. Other organisms implicated in gas gangrene include Clostridium bifermentans , Clostridium septicum and Clostridium sporogenes . Non-clostridial gas-producing organisms such as coliforms have also been isolated in 60–85% of cases of gas gangrene. C. perfringens produces many exotoxins but their exact role is unclear. Alpha-toxin, the most important, is a lecithinase that destroys red and white blood cells, platelets, fibroblasts and muscle cells. The phi-toxin produces myocardial suppres sion while the kappa-toxin is responsible for the destruction of connective tissue and blood vessels. Devitalised tissue or premature wound closure pro vides the anaerobic conditions necessary for spore germination. The usual incubation period is <24 hours but ranges from 1 hour to 6 weeks. A vicious cycle of tissue destruction is initiated by rapidly multiplying bacteria and locally and systemically act ing exotoxins. This causes spreading necrosis of muscle and thrombosis of blood vessels. The typical feature of this con dition is the production of gas that spreads along the muscle planes. Systemically , the exotoxins cause severe haemolysis and, combined with the local e ff ects, this leads to the rapid progression of the disease, hypotension, shock, acute kidney injury and acute r espiratory distress syndrome. Pain that rapidly increases in severity is the earliest symptom. The limb swells up and the wound exudes a serosanguineous discharge. The skin is involved secondary to muscle necrosis, turning brown and progressing to a blue–black colour with haemorrhagic bullae (Figure 33.17). The characteristic sickly sweet odour and soft-tissue crepitus appear with established infection but their absence does not exclude the diagnosis. These local signs are accompanied by pyrexia, tachycardia, tachypnoea and altered mental status. The diagnosis is made on the basis of history and clinical features. A peripheral blood smear may suggest haemolysis eals large Gram-positive and a Gram stain of the exudate rev bacilli without neutrophils. The biochemical profile may show metabolic acidosis and renal failure. Radiography can visualise gas in the soft tissues and is particularly useful in patients with - chest and abdominal involvement. Patients should be admitted to the ICU and treated aggressively with careful monitoring. High-dose penicillin G - , and clindamycin, along with third-generation cephalosporins should be given intravenously . Surgical treatment is the same as for necrotising fasciitis (see Necrotising fasciitis). In estab - lished gas gangrene with systemic toxicity , amputation of the involved extremity is life-saving and should not be delayed. No attempt is made at closure; amputation stumps are left open and the wound is lightly packed with saline-soaked gauze and then dressed. T he role of HBO is not as clear as in necrotising fasciitis. - However, considering the frequent catastrophic outcomes, it le. is recommended in severe cases if the facilities are availab

Summary box 33.9 Gas gangrene /uni25CF - /uni25CF /uni25CF - /uni25CF /uni25CF /uni25CF

Figure 33.17 Typical picture of spreading gas gangrene caused by a crush injury. Caused by C. perfringens Spores are present in the soil Thrives in anaerobic conditions and produces many exotoxins Treat with radical and regular surgical excision Give oxygen and penicillin Early amputation may be life-saving

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The medical aspect of disaster management does not involve a single short-term e ff ort. It requires a long-term commitment and involvement of various disciplines. Because of the large numbers of casualties, the initial treatment is directed towards the anatomical restoration of damaged structures. There are therefore numerous patients who will need secondary procedures for functional restoration. This second wave of patients is encountered 3–6 months after a major catastrophe and arrangements should be made to deal with this. HANDING OVER Follow-up and secondary problems

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Hospital reorganisation

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In hospitals receiving mass casualties some reorganisation of services is unavoidable. This includes transferring patients with non-urgent conditions to other facilities, augmenting surgical services, reorganising the specialist rota and redesignating medical wards as surgical care areas. An appeal for blood donations should be broadcast. Hospital reorganisation

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Introduction

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Natural disasters provide a constant reminder of the power and capricious nature of our planet. The depletion of the ozone layer and global warming mean that the future may hold in store calamitous events with even greater magnitude than those experienced before. National conflicts and ideological di ff erences have not lessened and the resultant ‘unnatural disasters’ have the potential to rival the natural ones in enormity (see Chapter 34). Disasters by their very nature are unpredict able and no two are alike. Nevertheless, there are numerous common elements and it has been shown that countries that invest in disaster preparedness are better equipped to cope with such catastrophes. Recent wars and disasters hav e highlighted the increasingly crucial role of surgeons in these scenarios.

Learning objectives

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To recognise and understand: The common features of various disasters • The principles behind the organisation of the relief effort • and of triage in treatment and evacuation Learning objectives

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Limb salvage

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The Mangled Extremity Severity Score (MESS) and its modi - fications are useful in deciding about limb salvage. Extensive tissue loss, neurovascular damage and loss of long fragments of bone are traditionally indications for amputation. Curr ently , wounds of any dimension can be covered with microvascular flaps and distraction osteogenesis and vascularised bone can be used to restore bony continuity . If performed in time, vascular repairs can salvage most acutely ischaemic limbs. Because of these developments the indications for amputation in trauma have undergone a paradigm shift and the majority of patients who reach a tertiary-care facility within 24 hours are candidates for limb salvage (Figure 33.13). This assumes ·0.5H O, which sets hard when water is added to it. 4 2 that debridement and, if required, vascular repairs have been performed in a field medical facility . A limb is unlikely to survive if the vascular repair of major limb vessels has been delayed for more than 4–6 hours.

(c) Figure 33.13 (a–d) Badly traumatised lower limb. Reconstruction has been performed using a microvascular rectus abdominis /f_l ap covered with a skin graft.

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Management in the field

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Field hospitals principally function in three main areas (Table 33.2). Summary box 33.4 Essentials of casualty evacuation /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF

Retriage to upgrade priorities among the injured Select appropriate medical facilities for transfer Choose appropriate means of transport Prevent the ‘second accident’ during transfer Ensure an adequate supply of materials to accompany the patient

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The next step is mobilisation of human and material resources appropriate to the extent of the disaster. Although all modes of transport need to be considered, helicopters provide the quick est access for the first responders (Figure 33.4). The teams that make up the initial response must include experienced sta ff who can assess the situation and who have the authority to take immediate decisions. Mobilising resources

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Necrotising fasciitis

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Necrotising fasciitis is a rapidly spreading infection that produces necrosis of the subcutaneous tissues and overlying skin. It is caused by β -haemolytic streptococci and, occasionally , Staphylococcus aureus , but may take the form of a polymicrobial infection associated with other aerobic and anaerobic patho gens, including Bacteroides , Clostridium , Proteus , Pseudomonas and Klebsiella . It is termed Fournier's gangrene when it a ff ects the perineal area and Meleney's gangrene when it involves the abdominal wall. The underlying pathology includes acute inflammatory infiltrate, extensive necrosis, oedema and throm bosis of the microvasculature. The area becomes oedematous, painful and very tender. The skin turns dusky blue and black secondary to the progressive underlying thrombosis and necrosis (Figure 33.16). The area may develop bullae and progress to overt cutaneous gangrene. It spreads contiguously but occasionally produces skip lesions that later coalesce. It is accompanied by fever and severe toxicity . Renal failure may occur as a result of hypovolaemia and cardiovascular collapse caused by septic shock. The rate of progression is dramatic and unless aggressively treated it leads to serious consequences with mortality approaching 70%. The diagnosis is made on clinical grounds. Creatinine kinase levels may show enormous elevation and biopsy of the fascial layers will confirm the diagnosis. Patients should be admitted to the ICU and trea ted with careful monitoring of volume derangements and cardiac status. Oxygen supplemen tation is beneficial and endotracheal intubation is required in patients unable to maintain their airway . High-dose penicillin G along with broad-spectrum antibi otics, such as third-generation cephalosporins and metr onida zole, are given intravenously . The cornerstone of management Theodor Albrecht Edwin Klebs , 1834–1913, Professor of Bacteriology , successively at Prague, Czechoslovakia; Zurich, Switzerland; and then the Rush Medical College, Chicago, IL, USA. Jean Alfred Fournier , 1832–1915, syphilologist, the Founder of the V enereal and Dermatological Clinic, Hôpital St Louis, Paris, France. Frank Lamont Meleney , 1889–1963, Professor of Clinical Surgery , Columbia University , New Y ork, NY , USA. - - - - - is surgical excision of the necrotic tissue. The devitalised tissue - is removed generously , going beyond the area of induration. - The wound is lightly packed with gauze and dressed.

(b) (c) Figure 33.16 (a) Necrotising fasciitis at presentation and (b) rapid progression seen after 24 hours. (c) Typical bullae and induration.

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Organisation of emergency services

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Emergency services such as the fire brigade, police and ambu lance service must have defined roles and areas of responsibility to ensure a coordinated response during a crisis. Members of these teams must be included in the planning phase to ensure that the final plan is practicable and reflects the situation on the ground. Summary box 33.13 Disaster planning /uni25CF /uni25CF /uni25CF Identification of hospitals able to take large numbers of casu - alties and the location of areas that can be used for patient holding and triage in case of mass casualties is important. Hospitals that o ff er specialised services should be identified and their role during a major crisis defined. Suitable hospitals in the surrounding areas m ust be designated as overflow hospitals in the eventuality of a very large volume of patients.

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Rescue operation

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Early coordination of the rescue e ff ort allows optimal use of resources. The first priority is to prevent further damage from occurring, both to people and to the infrastructure. The types of injuries encountered by rescue workers depend on the delay between the onset of the disaster and their arrival. Patients with head injuries and abdominal and thoracic trauma will either have been treated or have succumbed to their injuries within 48–72 hours of a disaster. After the first week, the only trauma and infected wounds (Figure 33.5).

100 90 80 55 70 65 60 85 50 Percentage 40 15 30 15 20 20 10 10 10 10 5 5 0 12 hours 24 hours 48 hours 1 week Figure 33.5 Time line showing the type of injuries encountered at different times in a disaster.

Rescue operation

Early coordination of the rescue e ff ort allows optimal use of resources. The first priority is to prevent further damage from occurring, both to people and to the infrastructure. The types of injuries encountered by rescue workers depend on the delay between the onset of the disaster and their arrival. Patients with head injuries and abdominal and thoracic trauma will either have been treated or have succumbed to their injuries within 48–72 hours of a disaster. After the first week, the only trauma and infected wounds (Figure 33.5).

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SEQUENCE OF RELIEF EFFORTS AFTER A DISASTER Establ

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There is no injury that is peculiar to disasters and the whole spectrum of external injuries from minor cuts and compound fractures to amputations is seen. Internal organ damage is frequent and, unless immediate help is available, this accounts for the majority of early mortality figures. People trapped under fallen buildings may su ff er crush injuries and crush syndrome Plaster of Paris is a white crystalline powder, calcium sulphate hemihydrate CaSO - - Summary box 33.6 Principles of debridement and initial wound care /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF if the duration is prolonged. Crush injuries and missile injuries cause extensive tissue damage and gross contamination, both favourable conditions for anaerobic and microaerophilic infections.

(b) Figure 33.12 (a, b) Use of low-pressure vacuum therapy in preparing a wound for secondary closure. Obtain generous exposure through skin and fascia Identify neurovascular bundles Excise devitalised tissue Remove foreign bodies Repair major vessels Obtain skeletal stabilisation with external /f_i xators Only tag tendons and nerves that have been cut Leave the wound open and delay primary closure Avoid tight dressings Elevate the injured limb

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Tetanus

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This potentially fatal condition, also called ‘lockjaw’, is caused by Clostridium tetani , a Gram-positive spore-forming bacillus occurring naturally in the intestines of humans and in the soil. It enters the body through a wound and replicates, thriving on the anaerobic conditions present in devitalised tissues. It produces tetanospasmin, an exotoxin that binds to Hans Christian Joachim Gram , 1853–1938, Professor of Pharmacology (1891–1900) and of Medicine (1900–1923), Copenhagen, Denmark, described this method of staining bacteria in 1884. the neuromuscular junctions of the central nervous system neurones, rendering them incapable of neurotransmitter release. This leads to failure of inhibition of motor reflex tion and generalised contractions responses to sensory stim ula of agonist and antagonist muscles produce tetanic spasms. The median incubation period is 7 days, ranging from 4 to 14 days. Early symptoms are painful spasms of the facial muscles, resulting in risus sardonicus (Figure 33.15). The spasms spread to involve the respiratory and laryngeal m usculature. Spasms of the paravertebral and extensor limb musculature produce opisthotonus, an arching of the whole body . Laryngeal muscle spasm leads to apnoea and, if prolonged, to asphyxia and respi - ratory arrest. The spasms can be brought on by the slightest of sensory stimulus. The diagnosis is obvious once it is fully manifest. There are three aspects of management: /uni25CF Prevention . Wounds contaminated with soil can har - bour tetanus spores, and active immunisation is indicated by administering 0.5 /uni00A0 mL of tetanus toxoid intramuscularly . Patients with gross contamination of cavitating w ounds should also receive 250–500 /uni00A0 U of human anti-tetanus globulin (ATG) intramuscularly to provide passive immuni - sation and to neutralise the circulating toxin. In full-blown

(d)

clinical tetanus, 3000–10 /uni00A0 000 /uni00A0 U of ATG should be admin - istered. Wound manipulation should be avoided for 2–3 hours after ATG administration to minimise tetanospas - min release. /uni25CF Local wound care . This includes a thorough wound debridement to eliminate the anaerobic environment. 6 Intravenous administration of 10–24 /uni00A0 ×/uni00A0 10 U per day /uni00A0 of penicillin G should be continued for 10–14 days. The wound should be closed using the delayed primary or sec - ondary closure techniques. /uni25CF Supportive care for established disease . These patients are nursed in an intensive care unit (ICU) environ - ment, free from strong sensory stimuli. Diazepam is use - ful in preventing the onset of spasms but, if these become sustained, the patient is paralysed, intubated and placed on a ventilator. The patient is then gradually weaned o ff the ventilator under cover of anticonvulsants. The o verall mortality rate is around 45%, prognosis being determined

(c) Figure 33.14 (a–d) Late-presenting facial injury with gross contami nation. A thorough debridement followed by delayed primary closure has yielded good results. Figure 33.15 Risus sardonicus of 'lockjaw' (courtesy of Dr Samira Ajmal, FRCS). (d)

tom to the first tetanic spasm. In general, shorter intervals indicate a poorer prognosis. Recently , intrathecal antitoxin administration has been used for spasm control to avoid ventilatory support. Nev ertheless, without access to me chanical ventilation the mortality remains high and even those who survive may require several weeks of hospital isation. Summary box 33.7 Tetanus /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF

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Triage

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Derived from the French verb trier , triage means ‘to sort’ and is the cornerstone of the management of mass casualties. It aims to identify those patients who will benefit the most by being treated the earliest, ensuring ‘the greatest good for the greatest number’. Numerous studies show that only 10–15% of disaster casualties are serious enough to require hospitalisation. By sorting out the minor injuries, triage lessens the immediate burden on medical facilities. Deciding who receives priority when faced with hundreds of seriously injured victims is a daunting prospect. Triage should be undertaken by someone senior, who has the experience and authority to make these critical decisions. To keep pace with the changing clinical picture of an injured person, triage needs to be undertaken in the field, before evacuation and again at the hospital. Triage areas For e ffi cient triage the injured need to be brought together into any undamaged structures that can shelter a large number of wounded. A good water supply , good lighting and ease of Triage is the earliest e xample of clinical risk management. This is done on the basis of was first used in 1792 by Baron Dominique Jean Larrey , Surgeon in Chief to Napoleon’s Imperial Guard. The concept of triage emerged fr de Santé des Armées so that resources could be used to the optimum – ‘most for the most’. holding, emergency treatment and decontamination (in the event of discharge of hazardous materials). Practical triage Emergency life-saving measures should proceed alongside triage and can actually help the decision-making process. The assessment and restoration of airway , breathing and circulation are critical and are discussed in Chapter 27 . Vital signs and a general physical examination should be combined with a brief history , taken by a paramedic or by a volunteer worker if one is available. Documentation for triage Accurate documentation is an inseparable part of triage and should include basic patient data, vital signs with timing, brief details of injuries (preferably on a diagram) and treatment given. A system of colour-coded tags attached to the patient’s wrist or around the neck should be employed by the emergency medical services. The colour denotes the degree of urgency with which a patient requires treatment (Figure 33.7). Triage categories All methods of triage use simple criteria based on vital signs. A rapid clinical assessment should be made taking into account the patient’s ability to walk, their mental status and the presence or absence of ventilation or capillary perfusion. A commonly used four-tier system is presented in Table 33.1 .

TABLE 33.1 Triage categories. Priority Colour Medical need Clinical status First (I) Red Immediate Critical, but likely to survive if treatment given early Second (II) Yellow Urgent Critical, likely to survive if treatment given within hours Third (III) Green Non-urgent Stable, likely to survive even if treatment is delayed for hours to days Last (0) Black Unsalvageable Not breathing, pulseless, so severely injured that no medical care is likely to help

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