Associated injuries and illnesses

Blast injuries

Explosives

- Explosions can occur in many settings: industry (coal mine, chemical plant); military (missile, hand grenade, bomb, land mine), criminal (terrorism, revenge, suicide bombing, illicit drug manufacture – methamphetamine 'factories'), and in the home (gas leak, fireworks)
- Low order explosives (LE) make a subsonic explosion without an overpressure wave. LE include gunpowder/black powder (fireworks, pipe-bombs), smokeless powder, and petroleum-based bombs (Molotov cocktail, fuel tanks of aircraft in WTC attack New York 2001)
- High order explosives (HE) make a supersonic blast or 'overpressure' wave on detonation that causes primary blast injury. HE include Semtex, TNT, nitroglycerine, dynamite, C-4, and ANFO (ammonium nitrate fuel oil, as used in Oklahoma City truck bomb 1998)
- Both HE and LE can create a 'blast wind' (forced superheated air flow) that accelerates people and objects through space
- Explosive devices may be 'manufactured' (mass produced for military use and subject to quality control; always HE based) or 'improvised' (using HE or LE or both)

Blast injuries

- Blast injuries are categorised as 'primary', 'secondary', 'tertiary' or 'miscellaneous'/'other'/'quaternary', depending on the mechanism
- Primary (type 1) blast injury is caused by the blast wave itself – and therefore associated only with HE-based explosions
- Primary blast injury affects gas/air filled organs (ear, lung, gut – particularly large bowel, eye, CNS)
- Primary blast injury (blast lung) is the commonest cause of death in immediate survivors of HE explosions
- Secondary (type 2) blast injuries (usually the most common) are penetrating or blunt trauma injuries caused by flying debris
- Tertiary (type 3) blast injuries are caused when people are displaced by the blast wind (eg thrown against a wall) – often skull # or long bone #
- 'Miscellaneous' includes all other explosion-related injuries eg smoke inhalation, burn, crush injury, exacerbation of existing condition, PTSD
- Patients may have injuries caused by more than one, or all four, mechanisms

Primary blast injury

Ear	**Lung**	**Abdomen**	**Brain**
Symptoms & signs	*Symptoms & signs*	*Symptoms & signs*	*Symptoms & signs*
Deafness	Breathlessness	May be none initially	Headache, fatigue, lethargy
Earache	Cough (+/- blood-stained fluid)	Abdominal pain, nausea, vomiting	Anxiety, depression, memory loss
Tinnitus or ringing in the ears	Chest pain	Haematemesis, rectal bleeding	May be no physical sign of injury
Bleeding or discharge from ear	Apnoea, hypotension, bradycardia	Hypovolaemia, shock, sepsis	
from	*from*	*from*	*from*
Tympanic membrane rupture	Blast lung	Perforated bowel (may be silent)	Concussion from blast wave (can mimic post-traumatic stress)
Haemotympanum	Pneumothorax (simple or tension)	GI haemorrhage	
Ossicular disruption	Haemothorax	Mesenteric ischaemia (air embolus)	**Eye**
Perilymphatic fistula	AV fistula causing air embolism	Testicular rupture	Ruptured globe

Key facts

- Injuries are more severe after an explosion in an enclosed space (in a building, down a mine, on a bus) or under water
- Injury severity increases with proximity to the explosion, to solid objects (eg walls), and any structural collapse
- Structural collapse +/- prolonged extrication increase the likelihood of crush injury, compartment syndrome and acute renal failure
- Some explosive devices cause specific injury patterns: eg fireworks – eye, face and hand injury; land mines – traumatic limb amputation
- Eye injuries: usually caused by penetrating debris, occur in up to 1 in 10 bomb survivors, are easily overlooked, and may present late
- Traumatic amputation is often associated with multi-system injury
- Blast lung usually presents early (within 4 hours); blast abdomen is rarer but presents late, often not until complications have developed
- Tympanic membrane rupture may indicate multi-system blast injury, but blast lung can occur in the absence of tympanic membrane rupture
- Air embolism can affect CNS (stroke), heart (myocardial infarct), spinal cord, gut mesentery, and extremities; hyperbaric oxygen treatment may help

Management

- Check with the Incident Command Team at the site for information about associated radiation/chemical/toxic hazards: if in doubt, wear PPE and check cases for radioactivity with survey meter, decontaminating them (and yourself) if necessary. In a radiation incident, treat life-threatening injury first, then decontaminate; if no life-threatening injury, decontaminate first, then treat
- Standard triage and treatment for penetrating and blunt trauma, shrapnel (treat as low velocity gun shot), burns, fractures, and smoke inhalation
- All cases: urinalysis, examine lungs, abdomen and ears (otoscopy and, if possible, audiometry), check tetanus status
- If chest signs or wheeze: CXR (repeat if needed), ABG, DIC screen, consider inserting chest tubes prior to anaesthesia or air transport
- Abdominal pain +/- vomiting: erect and supine abdominal X-rays or abdominal CT scan; admit, observe, NBM, group & save or cross match
- If TM rupture or ear signs but no other injury: check CXR (for characteristic butterfly pattern of blast lung) and observe for at least 4 hours. If CXR normal and case asymptomatic, discharge with urgent ENT appointment, ear care advice (keep dry, no neomycin) and written instructions to return if dyspnoea or vomiting or abdominal pain
- If no apparent significant injury, normal vital signs and examination: observe for 4 hours, discharge with instruction to return if dyspnoea/pain

See also

- Personal protective equipment, decontamination, emergency contacts, radiation facts, acute radiation syndrome

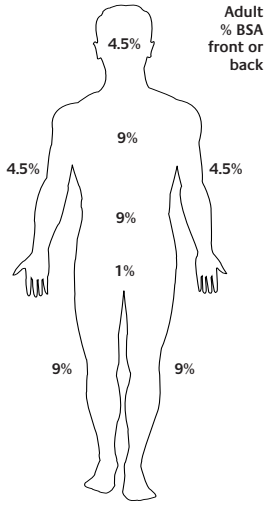
Burns

Overview

- Can be caused by heat (most common: thermal burns, flash burns, scalds, steam burns); electricity, chemicals or ionising radiation
- Severity of effects depends on burn depth and the proportion of total body surface area (BSA) burned
- Burns are categorised by depth as: erythema, superficial (first degree); partial thickness (second degree); or full thickness (third degree)
  - **Erythema** inflammatory response only, tender, minimal swelling, no blisters, resolves quickly
  - **Superficial** (epidermis only) burn: erythema, painful to touch, minimal swelling, no blisters
  - **Partial thickness** burn (epidermis + patchy involvement of dermis): very painful erythema, blistering, swelling, and, if deep, sluggish capillary return and dry or white surface
  - **Full thickness** burn (epidermis and all the dermis): charred, brown or white skin (can see coagulated blood vessels underneath), painless and hard to touch – though the patient may feel pain because of gradation in burn depth towards the edge of the burn. Devastating burns extending beyond the dermis into underlying tissues (bone and muscle visible) are sometimes called 'fourth degree' burns.
- Burn depth tends to be underestimated on parts of the body where the skin is thinner (eg eyelids, anterior wrist)
- Oedema, ischaemia, or infection can convert a partial thickness burn to a full thickness burn
- Morbidity and mortality are increased in children, the elderly, and patients with major trauma, smoke damage, or a pre-existing medical condition
- High voltage electrical burns can cause much more extensive deep tissue injury than is apparent from the extent of skin injury
- Chemical burns will continue to progress until the chemical is removed by decontamination
- Think of radiation if patient with a burn has no history of exposure to heat or chemicals – especially if history of nausea/vomiting 2-3 weeks earlier

Estimating the % BSA affected

- In adults, the **'rule of nines'** is a useful guide for estimating the size of large burns
  - Head and neck: front: 4.5% BSA; back: 4.5% BSA
  - Arm: front: 4.5% BSA; back: 4.5% BSA
  - Perineum: 1% BSA
  - Upper torso: front 4.5% BSA; back: 4.5% BSA
  - Lower torso: front 4.5% BSA; back 4.5% BSA
  - Leg: front 9% BSA; back: 9% BSA
  - Include superficial, partial and full thickness burns but not erythema when calculating fluid replacement
- The patient's **palm ~1% BSA** – useful for estimating the size of smaller burns (< 10% BSA)
- Children have relatively larger heads and smaller legs than adults: use a **Lund and Browder chart** to estimate burn area. If no chart is available, then, for children less than 1 year, head and neck = 18% BSA (9% front, 9% back) and each leg = 14% BSA (7% front, 7% back). For each year over the age of 1, add 0.5% to each leg and decrease estimate for head by 1% up to the age of 10 years
- 'Critical' burns include burns to face, hands, feet, perineum, genitals, circumferential burns of thorax or extremities



Management

- If a patient has been burned as the result of an explosion, ensure that there is no risk of chemical or radioactive contamination and that either the patient has been decontaminated or that you are wearing PPE appropriate to the risk
- **Stabilise airway, give supplemental OXYGEN** (keep O_2 saturation > 90%, pulse oximetry unreliable in carbon monoxide poisoning)
- Suspect inhalation injury if: patient found unconscious at scene, or in a confined or smoke-laden environment; burns to face/neck; singed facial or nasal hair; sooty sputum; intraoral blisters or erythema or oedema; hoarse voice/voice loss, stridor or wheeze: CXR and fibreoptic assessment
- Have a very **low threshold for early intubation** as oedema may later make intubation very difficult
- Thermal burns: prevent further damage by removing constricting clothing/jewellery; if clothing smouldering or hot to touch, gently cool burned tissue with saline or water-soaked towels (do not use ice or gel packs), then wrap in clean dry sheets (high risk of hypothermia – do not prolong cooling, or wrap in wet sheets or space blankets). Household chemical burns: irrigate with 0.9% saline or clean water until agent removed
- Hydrofluoric acid burns: monitor ECG; check for, and correct, hypocalcaemia (tetany, fitting, cardiac arrest) with calcium gluconate IV or calcium chloride IV; treat burns with calcium gluconate gel (2.5%) rubbed gently into affected area for at least 30 minutes; if gel not available use 10% calcium gluconate solution or 25% magnesium sulphate solution
- **Establish large-bore IV access,** away from burned area where possible (hard to secure line safely if sited on burn; oedema may dislodge line)
- Assess extent and depth of all burns and estimate % BSA involved; estimate body weight
- **Early accurate fluid replacement** and **monitoring of urine output critical,** particularly if % BSA burn more than 15%

  Use local protocol, or, for adults, Parkland formula:
  - 4 mL x kg body wt x % BSA burn = fluid (Ringers lactate) in first 24 hrs post burn, half given over first 8 hours, half given over next 16 hours
  - Adjust to maintain urine output of 30-50 mL/hour (adult or child > 50kg) or 1mL/kg body weight/hour (child < 50kg)
  - May need more fluid if: inhalation injury, delayed resuscitation, child, or glycosuria. If hypovolaemic, check for hidden trauma
- Ix severe burns: urinalysis, FBC, DIC screen, full biochemistry, ABG and carboxyhaemoglobin, group & save; if electrical burns, CPK and urine myoglobin
- Adequate **analgesia** (IV opiate if needed); assess tetanus status; assess and monitor peripheral pulses (Doppler): escharotomy or fasciotomy may be needed for developing compartment syndrome, especially if deep circumferential burns on extremities or thorax
- Refer to burn centre if: inhalation injury; child more than 10% BSA burn; adult more than 15%-20% BSA burn; 'critical' burns, electrical or chemical burns

See also

- Decontamination, radiation facts, acute radiation syndrome, mustard, lewisite

Mass sociogenic illness

Overview

- Throughout history large groups of people have presented to professionals (not necessarily doctors) complaining of symptoms of exposure when there is no documented evidence of that exposure. In recent decades many of these 'outbreaks' have involved beliefs about mass poisoning, usually by alleged chemical agents. As anxieties about bioterrorism, 'dirty' bombs and weapons of mass destruction continue to rise, it is likely that more of these incidents will occur
- No satisfactory label exists for these group symptoms. 'Mass hysteria' is a common label, but implies (totally erroneously) that those affected do not have 'real' symptoms but are imagining them or indulging in histrionics. Mass sociogenic illness (MSI) is probably the best label
- One definition of MSI is: 'symptoms which, although suggestive of organic illness, have no plausible environmental cause and produce minimal (or no) clinical or laboratory evidence of disease, and which occur in a cohesive group with shared beliefs about the symptoms'
- It is known that:
  - MSI typically affects groups under physical or emotional stress
  - MSI reflects prevailing social concerns and fears: witchcraft and demonic possession in enclosed religious communities in mediaeval Europe; toxic gases, environmental pollutants, and chemical weapons in communities today
  - MSI affects normal, otherwise healthy, people who do not have major psychological or personality disorders
  - Triggers can include: seeing the index case become ill; smelling an odd odour or peculiar smell, which may be real (eg incense, diesel fumes) or perceived; hearing a rumour
  - The commonest settings for MSI are schools and workplaces (factories, offices, military barracks)
  - Although most MSI incidents are short lived, some can extend over a month or more, or recur on return of the group to the site (schoolroom, office building)
  - Prompt identification is needed to limit and manage cases
  - MSI can be misdiagnosed:
    - In a school in London in 1990, children had symptoms typical of MSI; however, children who had symptoms were more likely to have eaten cucumber for lunch than those who had not; the cucumber was contaminated with pesticide
    - Symptoms in workers in a garment factory in Puerto Rico were assumed, after a short investigation, to be due to MSI. More thorough investigation showed the symptoms to be caused by toxic gases

Diagnosis, investigation and management

- MSI is essentially a diagnosis of exclusion
- Symptoms of MSI are variable and wide ranging (eg headache, dizziness, nausea, abdominal pain, burning throat) but tend to:
  - Be transient and benign
  - Be of rapid onset and recovery
  - Be accompanied by marked anxiety
  - Occur within a segregated group
  - Spread rapidly by sight ('visual' or 'line-of-sight' transmission), sound or oral communication, and through awareness of illness in others
  - Spread from those of a high status to those of a lesser status (eg older schoolchildren followed by younger ones)
  - Predominantly affect females
  - Be exacerbated by prominent emergency and media responses
  - Mimic those of the perceived threat
- **If you suspect MSI, report the incident and cases promptly to the local Health Protection Team, who will investigate**
- Recommended management of MSI includes:
  - Separating those who are ill from those who are not, and from the environment in which the outbreak began
  - Remembering that the cause of illness in the 'index' case may be different from that in the rest of the group, and that the group may contain individuals who have an illness with a physical cause: physical examination and investigation should be thorough enough to exclude serious illness from other causes
  - Providing gentle, honest, truthful and non-patronising reassurance about the likely cause of the outbreak and the likelihood of sequelae

See also

- Detailed guidance for health professionals on the recognition, investigation and management of outbreaks and incidents of unusual illnesses can be found at: www.hpa.org.uk

Psychological effects of traumatic events

Overview

- Any traumatic incident or disaster, whether natural or man-made, has a psychological impact on those involved – survivors, the bereaved, witnesses, rescuers, responders and health professionals, and their families, relatives, friends and workmates
- Traumatic events provoke strong reactions. These can include pride and professional satisfaction in responding well to a difficult task, a sense of purpose and solidarity, but also profound sadness, anger, rage and grief
- Most of those affected will adjust gradually, over time – some will need more support than others
- Any incident that causes fear and uncertainty may be accompanied by an increase in health concerns, anxiety and somatic symptoms in the public. Somatic symptoms are caused by the physiological response to anxiety – they are not 'imaginary' or 'all in the mind' – and can be easily confused, by the persons themselves and by health professionals, with symptoms of exposure. Estimates suggest that the numbers of persons presenting with health concerns and anxiety may outnumber the directly exposed by 5-20 to 1. Providing reassurance and allaying anxiety are important both in preventing long term symptoms in this group, and in preventing collective behavioural disturbance and mass panic
- Risk factors for more sustained responses and for the development of post-traumatic stress disorder, depression, anxiety disorder, or substance abuse include: proximity to the event, multiple stressors, a history of trauma, unresolved anxieties, and pre-existing chronic illness

Common responses to a traumatic event

Emotions	Cognition	Physical	Other effects
Numbness, feeling nothing	Difficulty in concentrating	Tiredness, exhaustion	Emotional outbursts
Sadness, grief	Shortened attention span	Headache, other aches and pains	Increased argumentativeness
Fearfulness for self	Poor memory	Dizziness	Withdrawal, silence
Fearfulness for others	Disorientation	Nausea, gastrointestinal upset	Temporary loss/increase in appetite
Feeling overwhelmed	Intrusive/unwanted memories	Rapid heart rate	Changed interest in sex
Blaming others/self	Heightened alertness	Profuse sweating	Increased smoking/restarting smoking
Feeling depressed	Difficulty in making decisions	Tremor, shaking	Overuse of alcohol, substance abuse
Volatile emotions, anger	Difficulty in sleeping, poor sleep	Jaw clenching, teeth grinding	Inability to rest
Irritability, jumpiness	Bad dreams, nightmares	**Breathing difficulty, chest pain***	Unnecessary risk-taking

*Require immediate medical attention

Caring for health care professionals

- Few of us perform better – either physically or mentally – after prolonged sleep deprivation: ensure that professionals have adequate rest
- Whatever the emergency, try to limit time on duty to no more than 12 hours a day; rotate staff from highly taxing to less taxing functions, and, if practicable, from tasks requiring direct involvement to more routine tasks
- Encourage staff to take brief, frequent breaks from the scene; provide somewhere quiet, safe and private 'off scene' for staff to eat, drink and rest without interruption, and try to ensure that staff are able to stay in touch with friends and family
- Support staff in taking steps that will help to maintain their well-being – there is nothing unprofessional about being responsibly self-caring
- Make sure that staff are aware of the availability of other sources of support (eg their own GP; chaplains and other religious or spiritual advisors) and provide telephone numbers for access to confidential listening or counselling services

Helping patients to cope with trauma

- Listen – and be ready to help patients and relatives to talk about their responses when they feel ready to do this
- Try to communicate clearly, openly, and with compassion: use ordinary language free from medical jargon, check to see that anything you have explained has been understood, paraphrase what the patient has said to make sure that you have understood them
- Validate emotions – intense reactions and painful emotions are a common, understandable and expected response to a traumatic event: things may never be the same, and recovery may be an uneven process, but life will feel better with time
- Keep your own experiences to yourself: remember, you do not know 'just how' someone feels, though you may sometimes think that you do
- Help patients to identify concrete needs, and then try to see that these are met – foster communication with or about family, friends and colleagues – it is quite usual for traumatised patients to be more worried about others than themselves
- Keep families together and provide assistance in locating loved ones
- Encourage those affected to rest, keep to their usual routines, and help them to identify ways to relax
- Encourage those affected to identify and use other sources of support to talk through their experiences and responses – family and friends, spiritual, religious, community or cultural networks

Indications for referral to a mental health professional

- The initial management (4-8 weeks) should be supportive social care from family and friends. Early counselling or mental health intervention has been shown to have a negative effect
- Persistent non-resolving symptoms that interfere with daily living
- Symptoms severe enough to prevent self-care: not eating, not washing/bathing, not changing clothes
- Problematic use of alcohol or drugs
- Those with suicidal or homicidal thoughts, feelings or plans
- Domestic violence, child abuse or elder abuse
- Those with symptoms of mental illness – either pre-existing, or newly developed