NHS Emergency Planning Guidance 2005

Planning for the Management of Blast Injured Patients
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Planning for the Management of Blast Injured Patients
<table>
<thead>
<tr>
<th>Document Purpose</th>
<th>Best Practice Guidance</th>
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<tbody>
<tr>
<td>ROCR Ref:</td>
<td>Gateway Ref: 9248</td>
</tr>
<tr>
<td>Title</td>
<td>Planning for the Management of Blast Injured Patients Incident</td>
</tr>
<tr>
<td>Author</td>
<td>DH Emergency Preparedness Division</td>
</tr>
<tr>
<td>Publication Date</td>
<td>14 Dec 2007</td>
</tr>
<tr>
<td>Target Audience</td>
<td>PCT CEs, NHS Trust CEs, SHA CEs, Care Trust CEs, Foundation Trust CEs, Medical Directors, Directors of PH, Directors of Nursing, PCT PEC Chairs, NHS Trust Board Chairs, Special HA CEs, Directors of HR, Directors of Finance, Allied Health Professionals, GPs, Communications Leads, Emergency Care Leads, Something else</td>
</tr>
<tr>
<td>Circulation List</td>
<td>Local Authority CEs, Directors of Adult SSs, Voluntary Organisations/NDPBs, Other</td>
</tr>
<tr>
<td>Description</td>
<td>This guidance sets out a set of general principles to guide all NHS organisations in the provision of services to plan and respond for the management of blast injured patients within the context of the NHS Emergency Planning Guidance 2005.</td>
</tr>
<tr>
<td>Cross Ref</td>
<td>NHS Emergency Planning Guidance 2005 and associated underpinning guidance</td>
</tr>
<tr>
<td>Superseded Docs</td>
<td>N/A</td>
</tr>
<tr>
<td>Action Required</td>
<td>N/A</td>
</tr>
<tr>
<td>Timing</td>
<td>N/A</td>
</tr>
</tbody>
</table>
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Foreword

In June 2007, an expert symposium comprising international experts was convened in London to produce best evidence guidance on clinical practice following a blast incident.

This symposium fulfilled the commitment given by the United Kingdom Government’s Department of Health at the Global Health Security Initiative meeting in Rome in 2006 to:

“... hold a workshop to systematically examine the factors that lead to best practices for the clinical management of injuries associated with explosive devices and public health responses to major emergencies.”

The bombings in London on 7 July 2005 resulted in relatively few fatalities other than those who died at the scene. The symposium sought to explore why this was and to agree whether there were wider lessons learned for clinical practice that need to be disseminated both within the UK and internationally. The symposium particularly looked at those areas of clinical practice of the management and treatment of blast-related injuries where there is currently a lack of consensus.

The aim of the symposium was:

1. To establish consensus on various medical issues relating to the care of casualties after terrorist bombings on civilian targets in developed urban population centres
2. To compare this consensus with the activities in the aftermath of the London Underground bombings on 7th July 2005
3. To disseminate these conclusions to the medical community in the UK at large

The conference was split up into six work streams; Prehospital, Emergency Department, Surgery and Critical Care, Haemostasis, and Volume Resuscitation

The key messages to emerge from the symposium were:

- **Keep the needs of the patient at the centre of the response and ongoing care.**

- **In the Prehospital setting**
  There was clear support for the use of prehospital tourniquets to establish haemostasis in trauma of the extremities.

  There is a need to improve communications and the speed at which patients are evacuated from the site of the injury to the place of definitive care.

- **In the Emergency Department setting**
  The critical importance of accurate triage of the casualties both in time and space. This means that those patients categorised as P3s - the “walking wounded” - are moved away from the area in which the P1 and P2 casualties - the more severely injured people - are being treated.

  Severely injured patients need to be rapidly assigned to experienced surgical teams run by an experienced trauma surgeon and anaesthetist with whatever support services
they need.

There should be no delay in moving patients who are bleeding to the operating theatre for surgical haemostasis. Imaging does play a role but imaging such as Computerised Tomography (CT) scans should be reserved for the more stable patients. The key priority is rapid control of haemostasis and, in the cavities of the body, this requires definitive surgical intervention.

**In the surgical setting**

Severely injured patients need to be rapidly assigned to experienced surgical teams run by an experienced trauma surgeon and anaesthetist with whatever support services they need.

- **Use of blood products**
  
  Data from the United States military experience in Iraq and Afghanistan clearly supports the use of blood and blood products early on in the resuscitative procedure (Fresh Frozen Plasma [FFP], cryoprecipitate, and fresh whole blood). It shows that this usage is certainly advantageous in terms of reducing subsequent post operative inflammatory responses, and seems to improve outcome and reduce mortality.

  All fluids administered should ideally pass through a fluid warmer, as hypothermia forms part of the ‘lethal triad’.

- **Resuscitation end points**

  Input from clinical colleagues from Israel and the United States clearly indicates that clinical observations can largely be used to determine resuscitation end points. Particular signs that are of value are the pulse volume, the pulse pressure, the warmth of the extremities, arterial oxygen saturation, and arterial lactate. These should be coupled with other markers of end-organ perfusion (such as urine output). It was very strongly felt that the need for invasive monitoring (with the possible exception of arterial lines) is overstated.

- **Training and Exercising**

  The need for training and exercising of all staff that might be involved in planning and responding to an incident/incidents involving blast injured patients was emphasised. Whilst each individual NHS organisation must evaluate its own training and exercising requirements, there is a clear need to co-ordinate this process across all partners to ensure co-ordinated management of blast injured patients.

The Guidance that follows summarises the discussions at the symposium and is commended to Chief Executives and Medical Directors of all NHS organisations for review and implementation. In addition, a DVD has been produced has been produced and distributed to all NHS Acute and Foundation Trusts for use in grand rounds and other training settings. The DVD shows experts who attended the symposium describing best practice based on evidence and experience.
I would like to express my personal gratitude to all who contributed their knowledge, experience, time and energy to this unique process and its outputs. I would particularly like to thank Dr Hugh Montgomery, Consultant Intensivist, The Whittington Hospital NHS Trust and Mr Eddie Chaloner, Consultant Vascular Surgeon, Lewisham Hospital for having organised the Symposium. I am most grateful to them for the guidance on the content and structure of the event, advice on contributors and their ongoing energy in supporting the development of this Guidance.

Dr Penny Bevan  
Director  
Emergency Preparedness Division
Introduction

1. This section gives best practice guidance to National Health Service (NHS) organisations in planning, preparing and responding to incidents and emergencies that give rise to blast injuries. The principles apply regardless of the number of patients being treated. The guidance covers adults and children.

2. This Guidance has been prepared under the auspices of the Department of Health’s Emergency Preparedness Division and with the expert input of an international symposium of experts that met in London in June 2007.

3. The recommendations made by the symposium included in this Guidance are those considered most likely to improve:

   - the response of NHS organisations to incidents and emergencies that give rise to blast injured patients
   - the care and treatment given to such patients; and,
   - the ability of blast-injured patients to recover.

4. This section must be used in conjunction with the NHS Emergency Planning Guidance 2005 and the relevant underpinning sections including:

   - Strategic Health Authorities (SHAs)
   - Immediate medical care at the scene
   - Primary care organisations
   - Ambulance services
   - Acute and Foundation Trusts
   - Children – to be published Autumn 2007
   - Burn Injured Patients –to be published in Autumn 2007
   - Critical Care - to be published in Autumn 2007
   - Mass casualties

5. The NHS Emergency Planning Guidance 2005 and its underpinning documents provide general guidance, information and context for NHS organisations. This includes an overview of important related legislation including the Civil Contingencies Act 2004 (the CCA) and its categorisation of organisations as Category 1 or Category 2 responders. In brief the responsibilities of each category of responder and the designation of NHS organisations is shown below.

   **Category 1**: those organisations at the core of the response to most emergencies and subject to the full set of civil protection duties.

   For the NHS these include Ambulance services, NHS Acute and Foundation Trusts and Primary Care Trusts.

   **Category 2**: co-operating bodies less likely to be involved in the heart of planning work but will be heavily involved in incidents that affects their sector.
For the NHS, Strategic Health Authorities are Category 2 responders.

6. It is essential that there is good communication between different health care services in order to ensure that responses are structured and cohesive; thus primary care practitioners must be aware of any restrictions/limitations of secondary care that arise as a result of a significant event to allow them to make appropriate decisions about the management and referral of patients.

7. The purpose of the NHS Emergency Planning Guidance 2005 is therefore to describe a set of general principles to guide all NHS organisations in developing their ability within the context of the requirements of the Civil Contingencies Act 2004 (CCA) to:

- respond to a major incident or incidents or emergency
- manage recovery whether the incident(s) or emergency has effects locally, regionally, or nationally.

8. Throughout this underpinning document, the term emergency is used as in the CCA, i.e. to describe an event or situation that threatens serious damage to human welfare in a place in the UK or to the environment of a place in the UK, or war or terrorism, which threatens serious damage to the security of the UK. To constitute an emergency this event or situation must require the implementation of special arrangements by one or more Category 1 responders.

9. The responses outlined in this guidance should only be considered appropriate in the event of emergencies that comply with the definition above. Under no circumstances should any NHS organisation seek to initiate or adapt these in order to respond to a problem arising from staff shortages, waiting list pressures, management failures or other local institutional deficiency. The accompanying ethical and medico-legal endorsement that will support NHS organisations and staff in an appropriate escalation response will not be applicable in other circumstances.

10. This Guidance is built on best practice and shared knowledge, while also acknowledging that in certain circumstances restrictions or limitations of normal standards of care will be inevitable. It is intended to provide a platform for all NHS organisations to undertake major incident and emergency planning and to provide information on associated activities that may also be required. In the context of this Guidance, the terms NHS organisation and NHS Acute Trust includes NHS Foundation Trusts.

11. The NHS Emergency Planning Guidance 2005 gives the Chief Executive Officer of each NHS organisation responsibility for ensuring that their organisation has a Major Incident Plan in place that will be built on the principles of risk assessment, co-operation with partners, emergency planning, communicating with the public and information sharing. The plan will link into the organisation's arrangements for ensuring business continuity as required by the CCA. Planning for the needs of blast injured patients forms part of that responsibility for Chief Executives of Acute Trusts.
12. The Guidance that follows is in six sections:
   o The Prehospital Setting
   o The Emergency Department
   o Surgery
   o Critical Care
   o Haemostasis
   o Volume Resuscitation

   Each section commences with the key points that the symposium identified as being most likely to improve outcomes for people who are blast injured. These key points are followed by an examination of the subject, the key learnings are areas of that subject, the best practice, the constraints and dependences and a summary of all recommendations.

13. The majority of the recommendations made in this document relate to the clinical response to incidents giving rise to blast injuries. It is recommended that this document be used in conjunction with the associated DVD Management of Bomb and Blast Injuries; Managing the Incident and Clinical Management distributed to Acute and Foundation Trusts, Ambulance Trusts, All Royal Colleges, Faculty of Accident & Emergency Medicine, Emergency Planning College, BMA and Strategic Health Authorities.
1 The Prehospital Setting

The key points relating to the pre-hospital setting are:

- command and control arrangements need to be clear, well understood and practised and focused on the need to support and facilitate those responding and working in this setting and of the needs of patients;
- expect communications at the scene and between the scene, the control centres and the supporting hospitals to be difficult and for some aspects e.g. the mobile telephone network, to fail. Prepare fallback methods and processes including the use of runners and of paper and pencil notes;
- the focus should be on clearing the scene at the earliest opportunity to take account of the possibility of there being secondary explosive devices and to facilitate the best care of those injured;
- patients should be evacuated to the hospital best suited to their clinical needs as quickly as possible e.g. to trauma centres; to burns centres;
- triage systems need to be a practical and able to respond to large numbers of patients in a short period of time. Current triage methods rely on taking certain clinical measurements and this may not be possible depending on the circumstances of an incident. The Department of Health is sponsoring a review of triage systems nationally. A simplified method made at the symposium proposed that casualties be classified as follows:
  P3 – those able to walk
  P2 – those able to communicate
  P1 – those remaining unconscious or dead
- patient tracking and documentation is an issue and deserves review. Consideration of methods including bar coding need to be considered. The tracking and documentation of casualties who are categorised as P3 is often not done at all with the subsequent loss of the ability to follow up patients and the loss of potential forensic evidence;
- the kit to carry to scene should be kept to a minimum but would include:
  - tourniquets
  - airways
  - compression bandages
  - pain relief
  - needle decompression

The discussion at the symposium considered the following issues in detail.
1.1 Availability and composition of medical resources

**Key Learnings:**
- Demand for medical resources in the Prehospital phase does not match availability. In the early Prehospital phase these tend to be inadequate, whilst the late phase is usually characterised by an excess of resources. Ambulance service personnel are available at immediate notice, whereas doctors responding to prehospital incidents are generally not available to respond immediately. This leads to delays in providing doctors on scene, and generally fewer doctors than are required.

**Best Practice**
- The deployment of resources needs to be actively managed to ensure adequate local and distant geographic cover, together with the ability to provide cover and replace rescuers over a prolonged period of time. Doctors need to be available as part of the immediate response, and clearly defined teams should be available on a 24 hour basis to deploy immediately to an incident in each Strategic Health Authority (SHA) or similar area. Consideration should be given to having other doctors available at 30 minutes and 4 hours notice.

**Constraints and Dependencies**
- Lack of information in the early stages of an incident makes it difficult to accurately estimate the necessary medical response. Medical teams are understandably keen to respond immediately and need actively managing to provide appropriate cover throughout a wide geographic area and over time. Most doctors providing a prehospital response have fulltime NHS posts and provide pre hospital care through charities or other organisations. Work commitments for these individuals generally preclude an immediate response by doctors. This may be partly overcome by the development of an organised system of Prehospital care at a national, regional and level, and by access to better ‘direct communication’. The Department of Health is leading work to review the membership, management and responsibility of Medical Emergency Response Incident Teams (MERIT).

**Summary and Recommendations**
- Availability of medical teams in the immediate and surrounding areas should be established early in the incident to ensure a staged and appropriate dispatch. All ambulance services should ensure 24 hour immediate availability of a medical response compromising appropriately trained and equipped doctors. Local arrangements may need to be made with statutory and voluntary providers of pre hospital response teams including the British Association for Immediate Care (BASICS). Consideration should be given to integrating doctors engaged in the immediate response into the normal day-to-day activities of the ambulance service such as teaching, control room support and clinical support of paramedic crews at more serious incidents in order to make this cost effective.
It is desirable to establish a ‘Pre-hospital system’ that provides appropriately funded, trained and equipped doctors needs to be established at national, regional and local level, whose command and control should be integrated with the existing emergency response tiers. The Department of Health is leading work to review the membership, management and responsibility of Medical Emergency Response Incident Teams (MERIT) that will address this issue.

1.2 Mutual aid

Key Learnings

- Previous major incidents have often resulted in staff and vehicles self-dispatching to scene, to the detriment of the medical cover in their originating area.

Best Practice

- An efficient system of mutual aid should exist across ambulance service boundaries to support neighbouring SHAs, the Devolved Administrations and areas possibly further afield as required by the NHS Emergency Planning Guidance 2005.

Constraints and Dependencies

- Clear command, control and coordination arrangements at scene are often lacking in the initial phase of an incident and do not support the input of first responders.
- Lack of adequate early information of the incident details.

Summary and Recommendations

- All ambulance services should hold a current list of available resources that can be dispatched as part of a mutual aid process. Consideration needs to be given to involving all Acute Trusts and General Practitioners (GPs) who request ambulance vehicles to minimise ambulance demand in affected regions during this period
- A predetermined response for major incident should be encouraged. This should include neighbouring SHAs identifying vehicles capable of providing interhospital transfer of patients including critical care patients as part of the immediate response. Integration with a critical care transport service would allow accurate resource management, as stable Intensive Care Unit/Critical Care Unit patients are cleared centripetally to more peripheral hospitals by dedicated staff
- Mutual aid should also involve the provision of patient transport service vehicles to work with receiving hospitals to facilitate discharge
- Mutual aid between SHAs and the regions of the Devolved Administrations of Scotland, Wales and Northern Ireland to move resources and personnel at short notice should be achieved through a national co-ordination centre for resources, and supra-regional response teams. This facility is available through the Major Incident Coordination Centre at the Department of Health
- Consideration should be given to the integration of military services to supplement those of the civilian arena
• It is desirable that pre-hospital- and transport equipment should be standardised nationally.

1.3 Pre: Training

Key Learnings
• Training is the key to success at major incidents.

Best Practice
• Regular table top and real-time exercise (conventional and Chemical, Biological, Radiological and Nuclear (CBRN)) should be carried out by all those tasked with responding to major incidents. Nationwide accreditation for doctors attending major incidents is recommended.

Constraints and Dependencies
• Requirements for Rapid Sequence Intubation (administration of general anaesthesia to secure the airway - RSI) capability for all doctors will limit any potential rollout of care to all SHAs
• Existing training and courses need to be developed to meet the requirements for the current threat.

Summary and Recommendations
• Training for those responding to major incidents must be distinct from ‘more general’ major incident exercises. Annual participation in both a conventional and a CBRN exercise must occur- as both table-top and real-time
• One such event should occur at SHA or appropriate regional level per year
• It is recommended that Rapid Sequence Intubation capable clinicians (as a minimum standard) be available as immediate responders
• It is desirable that a national set of standards, and national accreditation, be created for doctors
• NHS job plans should reflect major incident training/exercises. Individuals should be specifically tasked with preparing and delivering training, as well as desktop and ‘live time’ practices on an (at least) annual basis. Attendance at such training should be mandatory for appropriate staff
• Prehospital sub-specialty training programmes should include major incident management skills (including CBRN) and critical care skills for all those who might have to engage in a major incident in any capacity. A ‘core module’ of knowledge should be available to all (threat nature, mechanisms of injury, patterns of injury, principles of care, triage, structure of organisation), to be supplemented by specialist modules appropriate to the individual’s field (for example, critical care, general surgery, plastic surgery, accident and emergency, pre-hospital).
1.4 Pre: Transport to scene

**Key Learnings**
- Vehicular transport is difficult in heavily congested areas around a major incident. The London Ambulance Service, for example, has successfully used bicycles to dispatch paramedics, and such facilities should be made more widely available.
- Responders, in particular doctors, are often required to travel in their own unmarked vehicles. Facility for transport to the scene should be made available through conventional emergency service structures wherever possible. The means of identifying any other unmarked transport used, and the individual, should be agreed regionally and nationally such that access can be granted to the scene of an incident with the minimum of delay.

**Best Practice**
- Vehicles other than cars and ambulances maybe used as an alternative means of paramedic transport in urban areas. Doctors responding in their own vehicles should be appropriately trained and equipped to carry this out safely by the NHS organisation that sponsors their involvement.

**Constraints and Dependencies**
- Resources will need to be identified

**Summary and Recommendations**
- Vehicles other than cars and ambulances should be considered as alternative means of paramedic transport in urban areas
- Doctors responding in their own vehicles need appropriate training and equipment to carry this out safely
- Doctors and their vehicles should have the means to identify themselves as having access rights to a scene.

1.5 Event: Command and Control

**Key Learnings**
- Considerable benefit would derive from additional interservice training
- Support should be provided to those on scene to encourage the early and appropriate declaration of a major incident
- Multiple health strategic (Gold) controls (based variously at ambulance, SHA, hospital, police, etc) confuse the response.

**Summary and Recommendations**
- Consider streamlining the command and control processes to create a single centralised Strategic (Gold) command supported by a single tactical (Silver) command at scene. The Department of Health published revised Command, Control and
Coordination arrangements to simplify arrangements. It is published as new guidance on the provision of public health advice during a major incident and is available at: http://www.dh.gov.uk/en/Policyandguidance/Emergencyplanning/DH_073846

- Providing support to those on scene to call/designate a major incident
- Regular tabletop and practical exercises involving representatives from all emergency services.

1.6 Event: Safety

Key Learnings

- Delaying rescuers entering the inner cordon until it has been declared safe is likely to risk loss of casualty lives
- Confined space (including tunnel) rescue is often associated with particulate contamination of air (e.g. smoke, asbestos, blood etc)
- It is important in the event of a blast to consider if there might be secondary contamination from Chemical, Biological, Radiological and Nuclear (CBRN) contaminants. Or if the force of the blast has released chemical or other fibres from surrounding structures. The use of experienced senior doctors to assess casualties in the potential hot zone is likely to result in early identification of toxodromes and rapid effective management e.g. administration of antidote. A zero time major incident activation for doctors will make this possible - even with current arrangements doctors are often on scene within the first few minutes of a major incident without the need for an extra financial expenditure
- It may take some time to declare an incident free from chemical or radiological risk.

Best Practice

- Risk assessment at scene needs to take account of the requirement to ensure the safety and welfare of rescuers. Enhanced safety and specialist technical advice should be available e.g. counter terrorist bomb disposal expert (either on scene or remote), and through tactical awareness training and operational support
- All rescuers should be equipped with simple respiratory filtration
- Where possible, doctors should assist paramedics in patient triage in the hot zone
- Those responding to any major incident have been issued with and should carry functioning radiological monitoring.

Constraints and Dependencies

- Costs and time necessary for complex training
- Costs for monitoring
- Risk of injury and death to rescuers
- Cost of respiratory protection.
Summary and Recommendations

- Consideration needs to be given to reviewing the acceptable level of risk that is taken by medical personnel, particularly in the initial stages of an incident.
- Consideration should be given to the routine carriage of respiratory protection by those likely to enter these environments. Clarification is needed over which agency decides if an incident is ‘CBRN’ in the initial stages.
- The real risk of secondary devices needs to be taken into account for scene management. As part of response, immediate advice should be available either on scene or remotely regarding secondary devices. Enhanced safety and specialist technical advice should be available e.g. counter terrorist bomb disposal expert (either on scene or remote), and through tactical awareness training and operational support.
- The Hazardous Area Response Team (HART) Project, sponsored by the Department of Health, will see teams of highly trained emergency medical technicians and paramedics located across England to provide a better response to major incidents. The crews will be trained and equipped to work in highly hazardous areas, providing advanced life support, triage and treatment to those affected by a major incident, including those with chemical, biological, radioactive or nuclear risks. However, typical incidents to which HART crews are dispatched are building collapses, serious road-traffic collisions, fires, and tube trains stuck between stations underground in which there can potentially be thousands of dehydrated patients.
- With evidence that doctors improve the efficiency of triage at major incidents, the use of doctors in the hot zone is recommended to prevent over triage of what is likely to be large numbers of casualties.
- Medical teams should be given enhanced chemical monitoring (carbon monoxide, explosive petroleum products, hydrogen sulphide and high/low oxygen environments) in additional to the radiological monitoring already issued.
- Training of a dedicated pool of medical personnel as part of a formal structure assuring availability should take place. This should be part of the implementation of a national structure.

1.7 Event: Communications

Key Learnings

- Activation - Current arrangements to activate medical teams vary widely across the country and in some cases rely on telephone systems that may be disrupted at a major incident.
- Communications on scene - communications using telephones and existing VHF networks are unreliable. In particular communications underground in their current format are ineffective.

Best Practice

- Activation - Paging systems, particularly satellite based systems, provide a more reliable means of activation.
• Communications on scene - Reliable communications are vital for the successful management of a major incident. Communication between a lead Major Incident Commander direct to a receiving centre should be allowed. Integration with existing emergency service communication systems is vital.

Constraints and Dependencies
- Activation - Financial constraints
- Communications on scene - Technological capability. Financial constraints.

Summary and Recommendations
- Activation - Current activation systems need to be reviewed with the aim of rapidly introducing a more reliable method of communication
- Multi-modality activation i.e. the use of copper wire land line, mobile, paging and satellite communications - Consideration should be given to making use of all current available technologies
- Communications on scene - communications at a major incident need to allow communication with all rescuers (particularly those underground), Strategic and Tactical Controls and receiving hospitals. Availability of Airwave system to MIC structure is advocated. Subsurface-ground communication systems should be developed. Backup plans should be developed which have minimal reliance on technologies, to be used in the event of communications failure
- The facility for direct communication from Prehospitalmedical teams to one another and to receiving sites should be established.

1.8 Event: Assessment

Summary and Recommendations
- Effective deployment of resources can only be undertaken with effective communications. When medical resources are limited, they should be targeted to sites requiring triage and sites where seriously injured patients require treatment on scene, such as those that remain trapped in wreckage. Early medical reconnaissance will enable estimation of the on scene requirements for critical care support.

1.9 Event: Triage

Key Learnings
- ‘Scoop and run’ works very well in Israel, where training, regular experience, and the existence of a ‘trauma structure’ allow smooth operation. In the absence of these in the UK, this approach is may not be optimal here, although the need for the quickest possible evacuation to appropriate definitive care cannot be overemphasised.

Best Practice
- Critically injured patients should be moved to hospital as soon as possible.
Summary and Recommendations

- Effective triage is key to efficient dispatch and subsequent treatment of casualties by receiving hospitals, and robust mechanisms for delivering it effectively must be put in place.
- Triage should be performed by an appropriately trained and, ideally, experienced practitioner to help minimise the possibility of “over” triage, which is otherwise common. When practitioner resources are limited, the involvement of a doctor in this process is a priority.
- Current triage methods may be ineffective, particularly in a CBRN environment. Urgent research is necessary to improve triage in these environments.
- The Maritime & Coastguard Agency’s (MCA) use a different terminology (Tango 1 - Tango 4) that NHS organisations need to be aware of to try to avoid potential confusion in incidents in which they are involved.
- Establishing a survivor reception centre on-scene is considered vital. Failure to establish this early in the event results in many survivors leaving the scene unrecorded, possibly injured, contaminated and without counselling, and also hinders post-event forensic analysis.
- Uninjured people need to be triaged into a separate category and labelled/tracked.
- Patient disposal to receiving hospitals should be co-ordinated by the Tactical (silver) commander and communicated to the Strategic (Gold) Command. In the absence of communications, a predetermined response should be adopted.
- All hospitals should declare a minimum capacity that can be integrated into survivor distribution in the absence of specific communications.
- Where possible P1 and P2 patients should be transported to the nearest appropriate centre.
- Patient tracking must be addressed. Use of new technologies (bar code, GPS systems) offers clear, quick and easy methodologies that will enhance data gathering, scene management by Gold, and the maintenance of the forensic evidence chain.

1.10 Event: Treatment

Key Learnings

- Past experience shows that ambulances are not always adequately equipped to deal with the medical needs of many casualties.
- First aid equipment provision at transport hubs has been improved as part of an ongoing programme.
- Appropriately trained and experienced medical command and control arrangements should be available at scene.

Best Practice

- Staff responding to incidents involving blast injuries should be supplied with appropriate kit and equipment to deal with those injured.
- Bandages and dressings for first aid use are being supplied to major transport hubs.
Constraints and Dependencies
- Cost and practicalities of maintaining in-date equipment.

Summary and Recommendations
- To deal with blast injured patients, it is recommended that ambulance vehicles should carry 5 rolls of cling film, multiple tourniquets, and appropriate dressings.
- It is important to carry adequate analgesics that can be administered by ambulance paramedics and doctors to deal with blood loss.
- Possibilities are being explored for paramedics to be able to administer more effective analgesia at scene.
- First aid equipment is being provided for major transport hubs to support the response of ambulance services. The packs contain enough dressings and gloves to allow station staff and members of the public to carry out emergency first aid until ambulance services arrive on the scene. They will be essential in the crucial first minutes after an incident, whether it is the result of an accident or deliberate attack. These packs are a result of lessons learned from the London bombings.
- The creation of national standard operating procedures for the management of patients by doctors at major incidents should be encouraged.
- Joint Royal Colleges Ambulance Liaison Committee (JRCALC) guidelines should be adopted in full by all ambulance trusts to prevent problems with cross boundary working.

1.11 Event: Transport

Key Learnings
- Casualties may exceed available ambulance capacity, and conventional ‘one patient per ambulance’ rules significantly delay scene evacuation.

Best Practice
- Where possible and necessary, two or three patients should be placed in each available ambulance.

Constraints and Dependencies
- Little individual care can be given to multiple casualties in one ambulance.

Summary and Recommendations
- When the number of casualties exceeds the number of available ambulances, all ambulances should consider transporting as many P1 and P2 patients per vehicle as possible. Ambulance Incident Commanders (AICs) will determine the best use of vehicles available for the transport of casualties. The use of buses or coaches must be notified to Strategic (Gold) Command and the destination for these vehicles agreed before they leave the scene if possible. These vehicles must have medical or ambulance service escorts on board.
- A more efficient system is needed on scene to label and track patients. Consideration should be given to methods such as bar coding and tracking devices. Unique identifiers should be issued by the ambulance service to each patient at the scene of the incident.
• Emphasis is needed to remind those responding to a major incident that they should placed so that they should allow clear entry and egress from an incident.

1.12 Post: Team debriefing

Summary and Recommendations
• Ensuring there is a means to capture details of all those involved in the incident including those casualties who have been well enough to be asked to leave the scene is a major task. These casualties may have undetected injuries including deafness and a means of enabling them to report symptoms need to be developed to allow appropriate follow up e.g. the use of pre paid and addressed post cards to return
• Note and record keeping is difficult at most major incidents. This can significantly impair the post-event analysis of events
• The issue of personal speech recording equipment such as dictaphones to those in Operational (bronze), Tactical (silver) and Strategic (gold) positions may make it easier for responders to make notes and records of the incident
• A documented, fact-finding hot debrief should be conducted as soon as possible after the incident
• NHS organisations may wish to producing an interim report of their response within 72 hours of the end of the incident and the means for producing such a report, for example, designating and agency to collate data from all sources. The final report could be cascaded to all NHS organisations involved in the incident
• Issues relating to patient confidentiality hinder post event analysis and this is true for day-to-day medical audit. There is a need to review current legislation with regard to improving the availability of patient data.

1.13 Post: Maintenance of capability

Summary and Recommendations
• Control rooms should match the deployment of medical resources with need to ensure that the ability to respond is maintained throughout the incident. Once it is know that an incident is likely to be protracted, early planning is necessary to ensure regular replacement of exhausted rescuer
• Clear pathways need to exist to ensure rapid replenishment of supplies and drugs
• Provisions should be made for an enhanced response following a major incident in preparation for further incidents as per DH guidance on Mass Casualties.
2 The Emergency Department

The key points relevant in the Emergency Department setting are as follows:

- Experience indicates that the seniority of the person undertaking triage is not as important as the need to have appropriate training and experience. Therefore triage does not necessarily require a member of consultant medical staff.
- Hospital emergency plans should have pre-identified the minimum number and skill mix of staff required to treat each casualty designated as P1. Hospitals should not accept more P1s than they can care for optimally unless there are no other facilities available.
- A clear pathway and means for managing those who arrive and are triaged needs to be defined. Hospital emergency planning should ensure that all staff are aware of the patient management pathways for each group of casualties.
- The emphasis should be on maintaining the movement of patients through the department by means appropriate treatment.
- Patient tracking should be given priority in order to maintain the chain of patient management. Compatibility with Prehospital systems is highly desirable.
- Monitoring of patients should focus on clinical assessments, especially of end-organ perfusion.
- Small penetrating, seemingly unimportant, intra abdominal injuries can cause early patient collapse, delayed morbidity and death.

2.1 Triage

Best Practice

- Triage status changes with therapy, and as occult injuries become manifest. Seemingly innocuous wounds may conceal severe underlying injuries. Patients should be evaluated on arrival in the Emergency Department and re-assessed frequently, usually half hourly, throughout their Emergency Department stay.

Constraints and Dependencies

- All hospital Major Incident Plans should include a procedure for lock down in line with the current guidance including HBN 00-07.
- If there is considered risk of casualties having been contaminated, facilities and procedures must be put in place to decontaminate casualties before their entry to hospital. Hospital planning must consider this possibility.
Summary and Recommendations

- The clinical conditions of patients may change and therefore continuous patient assessment should be undertaken at all points including prior to entry to healthcare areas and at hospital entry.
- Hospital emergency planning should include provision for single routes of access to be created, with security in place to prevent alternate uncontrolled access. Health Building Note (HBN) 00-07 Resilience planning for the healthcare estate published in 2007 gives guidance regarding access control in health care facilities.
- Triage must be performed by a person trained in trauma triage (this requires definition and will be determined by the triage system adopted). The Emergency Department control team should decide who performs this task.
- The Department of Health is sponsoring a review of triage systems nationally.
- CBRN awareness must be in place during triage.

2.2 Expectant Care

Current guidance issued by the Department of Health to support emergency preparedness states:

“In the event of demand for healthcare exceeding or overwhelming supply, the underlying principle is to achieve the best health outcomes based on the ability to achieve health benefits. Regard must be given to appropriate professional guidance including the General Medical Council’s “Good Medical Practice”.

Best Practice

- Few civilian major incidents in the UK have been uncompensated. Treatment standards during a major incident should thus be expected to be the same as those applied to the single patient with the same injuries. However, in mass casualty events this may not be achievable.

Summary and Recommendations

- Where demand exceeds supply, care should be focused on those most likely to benefit from the care available. In all cases, patients should be made as pain free and comfortable as possible.

2.3 Imaging

Constraints and Dependencies

- A range of general radiological and specialist imaging skills will be needed to support the assessment and treatment of blast injured patients.
- Access to imaging can be a rate limiting point in the patient care pathway. If this is identified as being an issue during training and exercising, hospital incident planning should address this issue.
- A mix of general and specialist radiological skills is needed for trauma care.
Summary and Recommendation

- Imaging must not be a rate limiting factor except in the rare decompensated major incident. Technological solutions are available to increase imaging capacity.
- In new build hospitals, the ability to provide appropriate imaging in the Emergency Department to optimise throughput and diagnostics should be considered. In existing buildings, consideration should be given to optimisation of patient throughput.
- Normal imaging protocols are to be followed whenever possible.
- It is desirable that radiologists supporting trauma management attain competence in imaging of all body areas even if usually practising in a specialist area.

2.4 Training

Constraints and Dependencies

- Additional training should be made available for the wide range of clinicians who may be put in clinical leadership roles in the event of an incident.

Summary and Recommendations

- Training for major incident management especially needs to be team-based, workplace-based and kept constantly under review to be most effective. The core competencies need to be nationally defined.
- The NHS Emergency Planning Guidance 2005 requires that major incident plans should be exercised and tested at least annually and a report of this made to a meeting of the Board of that NHS organisation.
- It is desirable that there be a clinical lead within each NHS Trust with responsibility to make input to the major incident planning process. The NHS Emergency Planning Guidance 2005 included recommendations for the management of the planning process in NHS organisations.

2.5 Communications

Constraints and Dependencies

- Major incident plans should include provision for communications difficulties and failures during the course of an incident. The Cabinet Office is currently reviewing telecoms resilience and is due to report in 2008.

Summary and Recommendations

- Plan for communication difficulties and failure.
- The Department of Health should investigate and recommend a multi-faceted system for alerting medical staff. HBN 00-07 Resilience Planning for Healthcare Estate addresses issues around communications in an emergency.
- Hospitals should ensure that communications systems are resilient. This should include consideration of the use of satellite telephone communication. The AIRWAVE system being introduced should also bring improvements in communications resilience.
2.6 Patient Identification and Tracking

Constraints and Dependencies

- Information about those treated and discharged from the incident scene cannot presently be collated. This may be an important group for psychological follow-up.

Summary and Recommendations

- The NHS should have a standard system for the tracking of unidentified patients. The identification of unknown patients is the responsibility of the police. NHS Trusts will wish to consider the arrangements for identification, tracking and recording patients. This system should be capable of being integrated with triage systems/documentation, comprise Acute Trust having, for example, pre-designated computer generated numbers (identity) allocated to each patient that are ready to assign immediately without further computer data entry. 1000 packs per Emergency Department are recommended.
- The patient identification system could include photography
- Clear documentation is needed about the geography at which injury occurred (i.e. which incident, if these are multiple)
- Hospital information systems should consider including systems for patient identification and tracking during a major incident, especially if a patient needs to be transferred for specialist treatment.

2.7 Clinical

Key Learnings

- Blunt and penetrating trauma predominate in patients involved in explosion should be managed aggressively
- Blast lung injury is uncommon
- Degree of blast exposure should be clinically assessed
- Patients may require large volume resuscitation
- Innocuous wounds may be a marker of significant injury
- Actively exclude injuries to tympanic membranes, eyes and face (specialist eye, ear, face screening team may be useful)
- Consider biological/organic shrapnel, and all patients with wounds require tetanus and Hep B prophylaxis and HIV tests (though not immediately for the latter).

Summary and Recommendations

- Hospital incident plans should include arrangements for a pre-existing trauma system extant/functioning prior to any major incident i.e. not arising de novo at time of crisis
- Each Trust should consider having a designated clinician responsible for the overall trauma system including liaison with other Trusts in the area
- Each hospital must have a designated clinician responsible for the overall trauma response system
• Each multiply injured patient must have a designated clinician co-ordinating care (case manager)
• Each Trust should have a major trauma treatment plan detailing how differing types of injury will be managed, enabling each patient to get to the right specialist at the right time (including transfer).
3 Surgery

The **key points** to relating to the surgical setting are as follows:

- Severely injured patients need to be rapidly assigned to experienced surgical teams run by an experienced trauma surgeon and anaesthetist with whatever support services they need.
- There should be no delay in moving patients who have suffered or are suffering significant blood loss to the operating theatre for surgical haemostasis.
- Imaging does play a role but imaging such as CT scans should be reserved for the more stable patients.
- The key priority is rapid control of haemostasis and, in the cavities of the body, this requires definitive surgical intervention.

3.1 Patient flow

- The major preventable cause of death from blast injury is incompressible haemorrhage. After tourniquet, control of major limb haemorrhage and management of compressible bleeding, patients should be immediately evacuated to hospital. If incompressible haemorrhage has been identified, the patient should transit with little or no delay to the operating theatre.

3.2 Pre-existent surgical /trauma capability

**Best Practice Recommendations**

- Patients injured by explosives should, whenever possible, be taken directly to hospitals with the appropriate facilities to manage multisystem trauma. This will require prior knowledge of institutional capability and capacity by the Prehospital care providers.
- Where possible, paediatric casualties should be taken to the designated centre for paediatric trauma.
- The optimal management of victims of explosions will take place within an established regionalised system of trauma care. Designated hospitals should have a defined capacity for each triage category of injured patient. Each hospital should designate a lead surgeon with responsibility for planning and coordinating the hospital response to major incidents involving explosions.

**Constraints and Dependencies**

- Contingency planning must recognise that surge capacity is affected by time of year, and time of day.
3.3 Providers of surgical care and training

**Best Practice Recommendations**
- Surgical care should be delivered by consultant surgeons who treat emergency patients as part of their existing job plan. These surgeons should have received specific training in the surgery of trauma. The definitive care of patients injured by explosions is predominantly surgical. Surgeons must be involved as early as possible in the care of such patients.

**Constraints and Dependencies**
- The lack of direct experience in the management of explosion casualties for the majority of surgeons in the UK is a limit to best practice. To address this, the specific problems associated with blast injury and its management should be included in the curriculum for higher surgical training in orthopaedics and general surgery. Existing training courses should be strengthened, and a specific team-based cross-speciality course evolved to highlight the management principles. The Royal College of Surgeons of England is best placed to create this course and the Emergency and Trauma Surgery Steering Committee of the College should be tasked accordingly.

3.4 Utilisation of surgeons

**Best Practice Recommendations**
- The major incident plan should recognise the requirement for there to be a nominated experienced surgeon to make surgical triage decisions in the Emergency Department. Their remit should include formulation of the surgical plan (deciding exactly what operation should be done, which speciality needs to be involved) and liaising with OR managers to optimise OR flow and utilisation. Surgeons should remain in hospital and Prehospital deployment should be discouraged. Management of the entrapped patient requiring Prehospital amputation should be carried out by appropriately trained and experienced Prehospital care providers. In the rare circumstances where such an individual is not available, a surgeon could be dispatched, ideally from a hospital other than the main receiving hospital.
- Whilst the lead roles in immediate surgical care will lie with general and orthopaedic surgeons, specialist disciplines, particularly plastic surgeons (with expertise in burns) and neurosurgeons for head injuries should be involved from the outset. Explosive injuries also frequently require expertise from Ear Nose and Throat (ENT) and ophthalmology.

**Constraints and Dependencies**
- Geographical constraints mean that neurosurgical/ thoracic/ plastic surgery / burns care centres may not be co-located with receiving hospitals/ designated trauma centres. In these circumstances, a clear plan and a robust communications structure should be put in place well ahead of any major incident to allow expertise in these disciplines to be contacted as required.
3.5 Management of Non-Major Incident patients

**Best Practice Recommendations**
- Elective surgery must be stopped as soon as possible after the declaration of the major incident. Emergency patients already in the hospital should have their care re-prioritised along with the major trauma patients. The Emergency Department must be closed for at least 24 hours after onset of an event, if mass-casualties are admitted, and only reopened when the operative burden of those inpatients over coming days and weeks has been defined. Inpatients able to go home should be encouraged to do so.

3.6 Emergency Department surgical decision making, investigations, surgical triage

**Best Practice Recommendations**
- A careful physical examination remains the fundamental basis of assessment. Treatment principles should follow established (ATLS) guidelines. Adjuncts to decision making include 'trauma series x-ray' (chest and pelvis), resuscitation room blood gas analysis, USS, DPL, CT. Chest XR is not necessary in a conscious patient without evidence of dyspnoea or chest injury.
- Haemostatic surgery should not be delayed by the need for imaging.
- Patients with haemodynamic compromise and clear evidence of abdominal injury should have a prompt laparotomy. Unstable patients should have an investigation for torso injury in the operating theatre. In the patient suspected to have suffered intra-abdominal injury but in whom no haemodynamic instability is immediately apparent, a normal ultrasound scan is of limited diagnostic use. In such circumstances, rapid CT with intravenous contrast is the investigation of preference.
- Active warming of the patient, and all supplied intravenous fluids, is suggested to avoid hypothermia in the Emergency Department, and is also important to minimise the risk of subsequent coagulopathy and acidosis.
- Routine trauma blood tests, arterial blood gases, base deficit, serum lactate and INR should be available at the point of care in the Emergency Department. Blood banks should have a pre-planned ‘massive transfusion protocol’ to allow rapid provision of blood and blood products in the event of an explosive event.

**Constraints and Dependencies**
- Haemostatic surgery should not be delayed by the need for imaging.

3.7 Damage control surgery

**Best Practice Recommendations**
- Individuals injured by explosions should be considered as 'war surgery' patients and treated accordingly.
- Damage control surgery can be defined as the minimum surgery required to stop haemorrhage and control contamination. It involves 'minimal essential care' and 'tactical abbreviated surgical control', and is used to prevent exhaustion of an individual patient's physiological reserve or exhaustion of surgical capability and resources. All patients injured by explosions should have their treatment planned in accordance with the principles of damage control surgery.
Constraints and Dependencies

- Surgeons who will care for victims should be trained in the techniques of damage control surgery. There is currently a shortage of such individuals in the UK. A pre-planned system of directing patients to centres where such surgeons are based is essential to ensure the best possible care [see 1.1 and 1.2].

3.8 Definitive surgical care

Best Practice Recommendations

- All bleeding should be stopped at the first operation. Wounds should be debrided; dead and non-viable tissue should be excised, contamination should be removed by a combination of sharp excision and low pressure, high volume irrigation. Sterile solutions are not mandatory for this process.
- Extremity injury is likely to form the bulk of the burden of injuries. A decision to amputate a limb should be taken by more than one consultant. Amputation should be considered as an extensive debridement. There is no role for guillotine amputation (amputation of all tissue at one level).
- Consider the use of a proximal pneumatic tourniquet to a limb that is being amputated to minimise intraoperative blood loss. Tourniquets applied in the Prehospital phase should be replaced in the OR with wider, pneumatic tourniquets by personnel experienced in their use.
- Flaps need not be constructed at the first operation but at re-look surgery, recognising that the wound will evolve in the first 48 hours.
- Expect multiple fragment injuries that cross borders and junctions- CT imaging is helpful to find fragments in patients who are stable enough to allow pre-operative imaging.
- Fasciotomy should be performed without delay if there is any suspicion of compartment injury. Adequate fasciotomy must decompress all compartments, in the lower extremity, a two incision technique should be used. 'Closed fasciotomy' techniques are not suitable under any circumstances. Consider compartment syndrome in the thigh as it may be occult.
- Fasciotomy of the upper extremity should include decompression of the carpal tunnel. Fasciotomy of an injured extremity may need to be further extended into the hand or foot as required.
- Regional techniques for postoperative analgesia should be used liberally. Caution should be exercised with epidural analgesia as this can mask compartment syndrome in the contralateral limb.
- Deep Vein Thrombosis (DVT) is a major risk in patients injured by explosions and individual risk should be assessed. Mechanical prophylaxis is highly recommended for all patients with the addition of pharmacological prophylaxis as soon as this is deemed safe after any operative intervention.

3.9 Wound dressing / temporary cover of wounds:

Best Practice Recommendations

- Early microbiological investigation of wounds is recommended. There is no requirement for antiseptic (Betadine) dressings. For most patients one dose of antibiotics at the time of surgery will be sufficient, assuming surgical debridement is adequately performed.
- First re-look surgery should be planned to take place in the OR at between 48 hours and 72 hours. Wounds should not be exposed routinely on the ward.
• Topical negative pressure dressings are valuable adjuncts in caring for complex wounds [i.e. Vac dressings]
• Patients injured in explosions are at high risk of compartment syndromes. A high index of suspicion must be maintained when assessing patients with limb or abdominal injury.
• Recognise that major wounds will probably not be ready for closure at the first re-look and that this does not indicate failure of management
• Not all small wounds need formal surgical debridement, but all small wounds should be thoroughly cleaned and inspected to rule out deeper injuries beneath a superficial skin breach
• Wound photography is a valuable adjunct to on-going management. Specific consent is not required if the photograph is to remain exclusively part of the clinical record.
• There is no role for donor/cadaveric skin as a wound dressing
• Consider the possibility that biological material from third parties may be implanted into patients close to an explosion. Deliberate use of individuals infected with viral diseases such as Hepatitis or HIV is a risk in suicide bombings. Tissue and blood sampling for blood borne disease from patients may be required and advice from epidemiologists or public health specialists with respect to prophylaxis for viral disease may be needed.

3.10 Forensics

Best Practice Recommendations
• All embedded fragments from wounds should be retained for possible forensic investigation. Clothing should be air-dried and retained.

3.11 Data collection/Record keeping/Communication in hospital/Documentation & registry

Best Practice Recommendations
• Collection of data from explosive events can only reliably be assured within the framework of a pre-existing established trauma registry.

Constraints and Dependencies
• Lack of an established trauma registry has led to loss of valuable data from the 7th July 2005 London bombings due to fragmentation of data and lack of co-operation and communication between hospitals.

3.12 Ongoing care

Summary and Recommendations
• Patients should be admitted under a multidisciplinary team but be under the care of one clinician to permit co-ordination and continuity of care
• Multidisciplinary team (MDT) meetings should be held twice a day in the early days after the event to facilitate planning for further surgery
• A trauma ward may need to be established as a temporary measure to facilitate organisation of ongoing care
• A detailed and complete secondary and tertiary survey including a comprehensive review of imaging should be undertaken in the Critical Care Unit to pick up potentially missed injuries (especially ear drums and eyes)
• Provision of ongoing care should be part of major incident plan that should also include arrangements for managing the normal workload of the hospital, possibly by diverting new admissions to other nearby hospitals for several days after the event
• All patients (in all triage categories) should be seen by specialist psychiatric teams at a suitable point after the event.

3.13 Expectant patients

Summary and Recommendations
• Where demand exceeds supply, care should be focused on those most likely to benefit. In all cases patients should be made as pain free and as comfortable as possible. The underlying principle is to achieve the best health outcomes based on the ability to achieve health benefits. Senior clinicians should contribute to decisions about patients no longer able to benefit from care.
The key points relevant to the provision of Critical Care are as follows:

- Planning to be able to manage surge capacity is necessary to ensure that critical care capacity can meet the needs of those patients who are blast injured;
- Close liaison is needed with emergency department (ED): international experience suggests that the presence of critical care specialists in the Emergency Department improves the response, ensuring appropriate and thorough assessment and treatment. Critical care staff should be regarded as an integral component of the trauma response team, ensuring ‘best practise critical care’ starts at the outset.
- Particular attention should be paid to the regular assessment of soft tissue injuries so as to identify compartment syndrome. This may involve regular measurements of serum creatine phosphokinase levels and of compartment pressures
- The need for further wound debridement should be kept under constant and regular joint review with surgeons

4.1 Capacity

Best Practice Recommendations

- All hospitals must have a critical care surge capacity plan as recommended in the NHS Emergency Planning Guidance for managing incidents where normal critical care capacity may be exceeded. This should be is implemented as part of the major incident response under the clinical control of the lead critical care consultant. This plan should relate to in-hospital issues, and each hospital should aim, as a minimum, to be able to double its critical care capacity in event of a major incident. Surge planning should also address and plan for inter-hospital communication and patient flows. It should be recognised that such flows may, in exceptional circumstances, include movements abroad
- Existing stable patients requiring ventilation can be transferred to a satellite area, such as HDU or theatre recovery
- Mass casualty patients should be admitted to ICU, or to satellite areas adjacent to theatres such as theatre recovery
- A critical care bed requires appropriate equipment and qualified staff; this defines the limit of surge capacity
- Where necessary, critical care capacity can be expanded through the transfer of existing patients (recognising there are arguments both for and against the transfer of
existing patients to make way for another). Major incident plans should include mechanisms for transfer of existing Critical Care Unit patients to hospitals remote from major incident area. It is recommended that a specialist critical care transfer service be established which could be used at such times (as well as in a ‘routine’ role). In the absence of availability of such a service, then ‘retrieval’ may prove advantageous to ‘delivery’ through conserving local staff

- Major incident plans should include mechanisms for the transfer of injured patients to hospitals equipped with necessary resources and surgical specialties.
- If local systems allow the dispatch of mobile teams to smaller hospitals, these teams need to be familiar with the local environments and setup
- Each Critical Care Unit should make efforts to ensure that their own unit is not overloaded. Plans should be laid for supplies of (for instance) equipment and staff for days subsequent to the incident. This may involve the staggered deployment of Critical Care Unit staff, rather than all additional staff being utilised on the day
- As much information as possible should be gathered from the scene, where effective triage is essential. Lesser injured patients may saturate capacity early and late extractions (likely to be the most injured) may arrive when a facility is full.

Constraints and Dependencies

- Adequate generation of capacity requires an integrated command chain to ensure appropriate access to resources both within and outside the hospital
- Clinical decisions should be tailored to maximise the efficient use of resources for existing and new patients. These resources should not be overwhelmed.

4.2 Critical Care Pathway

Best Practice Recommendations

- Close liaison is needed with Emergency Department (ED): Israeli experience suggests the presence of critical care specialists in the Emergency Department helps improve the response, ensuring appropriate and thorough assessment and treatment. Critical care should be regarded as an integral member of the trauma response team, at least in major incidents. This means that senior critical care physicians should attend the emergency department as soon as possible and assist/ advise in supervisory/liaison role during ongoing care prior to admission to critical care. This should be intended to provide continuity and expertise, ensuring ‘best practise critical care’ starts at the outset rather than for hands-on care
- Another senior critical care physician (in parallel) should triage existing Critical Care Unit patients and set up satellite areas.
- Screening for spinal injury should ideally be done in the ED, and before transfer to critical Care
- Communication needs to be reviewed and ‘failure’ planned for (in terms of computers, mobile telephones, and pagers). Runners, paper and pencils are reliable, and should be available
- Patients in confined-space explosions with major injury who require immediate surgery should be returned to recover in the critical care area intubated
• Evidence from Israel suggests up to 12% of patients in critical care following blast events have injuries that were initially missed. Thus, all patients should be regularly reassessed and have a comprehensive secondary survey and early appropriate directed investigations. There should be a LOW threshold for performing a CT head scan in patients who remain intubated in critical care. In addition, one should ‘beware the lucid interval’ in non-intubated patients

• Non-critical care personnel may be required further down the critical care pathway to assist with patients’ secondary/tertiary surveys, and their ongoing review/assessment.

• Critical care consultants should co-ordinate the spectrum of clinical input into patients receiving critical care

• Best practice protocols should be followed for all critical care patients including protective lung ventilation, and care bundles where appropriate. These should start at the beginning of the critical care pathway i.e. in Emergency Departments. While multiple specialist inputs may be needed, it is more important than ever that critical care staff continue to ‘do the basics well’

• Particular attention should be paid to the regular assessment of soft tissue injuries so as to identify compartment syndrome. This may involve regular measurements of serum creatine phosphokinase levels and of compartment pressures

• The need for further wound debridement should be kept under constant and regular joint review with surgeons

• It should be recognised that critical care does not finish on discharge from ICU

• After the incident, an ‘intensivist of the week’ model should be used, with that intensivist co-ordinating patient care and flows.

4.3 Training

Best Practice Recommendations

• Critical care management of mass casualty incidents would be enhanced by the provision of appropriate training and by including of critical care staff in major incident training and exercising

• The establishment of a cross-discipline board to generate a common-stem training is recommended. A critical care module of training should be developed for all those pursuing a career in this field. However structured, critical care physicians should be aware of blast physics, mechanisms and patterns of injury (primary - quaternary), command and control, MAJAX planning, matters of administration (including patient movement and staffing), ethical matters and issues relating to ‘complex’ explosions (such as those with a CBRN element)

• Training of hospital teams is also required with regular ‘cross-site’ training and practice; it is essential that critical care departments know how all other departments operate and vice versa. Tabletop exercises alone may be inadequate: ‘real time run-throughs’ using weighted mannequins or moulage volunteers may prove advantageous.
4.4 Paediatrics

Best Practice Recommendations

- It should be assumed that mass-casualty incidents may overwhelm paediatric units such that adult units will need to admit children of all ages.
- Reaching a place of safety and appropriate clinical care is the priority. However, agreement should be sought with local paediatric intensive care units (PICUs) as to ‘what defines a child’ during a mass casualty incident (in terms of age or size), so as to help prioritise those who require early transfer to a paediatric facility.
- Given that children may be treated by adult physicians, a ‘basic information card’ should be developed giving guidance on paediatric-specific care (e.g. drugs to avoid, preferred agents/ doses).
- Critical care units should plan for accessing specialist paediatric resources within this country and, if necessary, abroad.
5 Haemostasis

The key points relevant to establishing effective haemostasis are as follows:

- There was clear support for the use of prehospital tourniquets to establish haemostasis particularly from extremity trauma;
- All fluids administered should ideally pass through a fluid warmer, as hypothermia forms part of the ‘lethal triad’
- Data from the United States military experience in Iraq and Afghanistan clearly supports the use of blood and blood products early on in the resuscitative procedure particularly early use of Fresh Frozen Plasma (FFP), cryoprecipitate, and fresh whole blood. It shows that this usage is advantageous in terms of reducing subsequent post operative inflammatory responses and improving outcomes including mortality.

5.1 Pre-existing requirements-Massive Transfusion products

Summary and Recommendations

- The need for a standard national massive transfusion protocol that could be easily implemented in the Emergency Department (ED) should be considered. National use will prevent need for retraining, and allow cross-site work
- Higher Ratio of Plasma: Packed Red Blood Cells (PRBC) (1:1) should be used from the outset in those anticipated to need massive transfusion
- Higher ratio of platelets:PRBC improves outcomes and should be instigated.
- Systems should be in place to allow rapid thawing of large volumes of Fresh Frozen Plasma (FFP).

5.2 Diagnostic tests of coagulation

Summary and Recommendations

- It is important that laboratory based testing is rapid enough to contribute to decision making
- Point of care testing should be available and easily accessible in the Emergency Department. Temp<35 degrees Celsius, acidosis (base deficit, Base Deficit (BD)>-4), Prothrombin Time (PT)> 16, Haemoglobin (HgB)<11 grams/dl, lactate, pulse>105 bpm, and systolic blood pressure (SBP) <100 mmHg are all are easily measured, and help recognise the patient who requires massive transfusion and/or needs urgent surgical intervention
- The BD as part of blood gas (arterial or venous blood) is the most important test
- Point of care testing of PT should be developed to improve specificity.
- Management should keep up to date with and plan for the latest developments in functional clotting measurement, for example, thrombelastography – TEG.
5.3 Monitoring of coagulopathy

Summary and Recommendations

• Point of care testing is required is required.

5.4 Integration of regional & national blood service

Summary and Recommendations

• There is a need to ensure that a dedicated telephone line is available between hospitals and regional blood transfusion centres. A review of blood transfusion centres should consider the time it will take for blood, blood products and skin to be transported.

5.5 Availability of emergency blood

Summary and Recommendations

• Systems need to be in place to ensure the rapid delivery of blood, blood products and skin to Emergency Departments.
• Deployment of blood to the scene should be discouraged
• All fluids administered should ideally pass through a fluid warmer, as hypothermia forms part of the ‘lethal triad’. All ED’s should ensure that they have adequate provision of multiple warmers (>3 per casualty) for a massive casualty scenario. Operating theatres should likewise expand such availability.

5.6 Optimum use of blood and products

Summary and Recommendations

• Patients must proceed rapidly to definitive haemorrhage control. If rapid control is not possible in minutes in the ED, they should transit to an appropriate facility (angiographic or, more likely, operating room)
• Hypotensive resuscitation should be practiced until definitive haemorrhage control is established
• Current massive transfusion (MT) guidelines may be inadequate, and a national MT protocol should be revisited taking into account the availability of platelets
• The FFP:PRBC ratio should be increased to 1:1 (450mls:250mls: US military data due to be published, long term survival improved)
• Current US military guidelines recommend an increased platelet:PRBC ratio (1:6), as further research suggests an improved outcome. Prospective investigation is required before this becomes the UK standard of care taking on board current military experience
• Blood use may in fact not actually exceed normal day usage, especially if elective surgery is cancelled
• Current multi centre international trials, Crash-2, are investigating the effects of antifibrinolytic treatment on death and transfusion requirements among trauma patients with, or at risk of, significant haemorrhage.

5.7 Haemostatic adjuncts
Summary and Recommendations

• The role of adjunctive therapy such as recombinant Factor VIIa (rFVIIa) and aprotinin in trauma is as yet unclear and we cannot currently recommend such use.

5.8 Rationing and resource limitations

Summary and Recommendations

• Ongoing oversight of the use of blood products should occur so as to ensure appropriate usage of products and anticipate potential shortage
• Consideration should be given to rationing blood products in potentially expectant cases.

5.9 Documentation

Summary and Recommendations

• Use of blood products and other haemostatic agents, including tourniquets and tourniquet time, should be documented
• This documentation should be part of an agreed system. Such data are crucial to performance improvement and research.

5.10 Role of donors & wastage

Summary and Recommendations

• Media calls for mass donors are unhelpful. Any call should be coordinated through the National Blood Service. Independent calls offering donation should be discouraged.

5.11 Prehospital haemostasis

Summary and Recommendations

• In catastrophic haemorrhage, there should be emphasis on rapid extrication and transfer to definitive surgery. Prehospital fluid management should aim to maintain SBP of 90mmHg (or a palpable radial pulse). Those patients likely to have established vascular disease should be resuscitated to nearer normal SBP levels
• Training in these concepts, and in device use, is critically important: this is especially true of the basic concept of sustained manual compression: in practice maintaining effective and sustained manual compression is difficult and should be directly addressed in dedicated training. Junctional areas (neck, axilla and groin) are particularly difficult and require additional emphasis
• Bystander first aid training must take into account possible requirements for haemorrhage control in mass casualty events (manual pressure only) balanced with the absolute requirement to rapidly clear the scene
• Attention must be paid to the prevention of hypothermia, which will exacerbate coagulopathy. Simple ‘suit packs’ are available, and should be available for use.
• After ambulance arrival the principle haemostatic interventions are: pressure on the wound with the new elastic dressings and / or on pressure points, haemostatic dressings, elevation, tourniquets
• Commercial tourniquets should be available
• Use of these interventions are modified by number of casualties vs. providers, hypotensive resuscitation as described above, hypothermia prevention and most
importantly rapid evacuation. When physicians are on scene a Foley catheter may be used as an advanced manoeuvre inflated in wound depths to treat catastrophic haemorrhage control

- The evidence is suggestive but not definitive for Haemostatic adjuncts. There will be a large training element associated with their use, and used after other methods have failed. Gauze dressings are considered inadequate, and should be replaced with elasticated dressings, and possibly haemostatic dressings.

5.12 Emergency Department haemostasis

**Summary and Recommendations**

- Training is important in all interventions and concepts. The haemostatic interventions in the Emergency Department are similar to those in the prehospital environment: hypothermia prevention, rewarming, control of compressible haemorrhage with pressure dressings (gauze), haemostatic dressings tourniquets, minimal fluids (where haemorrhage is uncontrolled)
- These interventions and sequence are modified by number of casualties vs. providers.

5.13 Non compressible haemorrhage control

**Summary and Recommendations**

- Patients must proceed rapidly to theatre for definitive control as the primary haemostatic manoeuvre for non-compressible haemorrhage
- Hypotensive resuscitation is practiced only until definitive haemorrhage control is obtained, then full resuscitation to a normal endpoint is obtained.

5.14 Damage control surgery

**Summary and Recommendations**

- The senior surgeon must be present early in the Emergency Department to facilitate rapid decision making
- There is less role for conservative management (non-operative) in mass casualties. The definitive control of haemorrhage largely requires surgery in the damage control mode of haemostasis
- In the multiply injured casualty, tourniquet use should be considered while performing damage control surgery in chest, abdomen or cranial cases
- These is a role (limited) for interventional radiology in selected cases, which must be balanced with the time and resources required for this intervention
- Cell savers are useful in most cases when institutions have in place the expertise and equipment to routinely use them.

5.15 Tourniquets

**Summary and Recommendations**

- Evidence from US military in Iraq and Afghanistan has found improved outcomes with liberal use of tourniquets after explosion injury. In mass casualty events where sustained manual compression of wounds is difficult an effective commercial tourniquet has a role. The time of application and removal should be documented. Proper, timely, adequate, safe application and expedient removal are critical to a favourable risk to
benefit ratio. It should be removed on arrival in Emergency Department with surgical supervision and reapplied if bleeding resumes

- Tourniquet use needs to be properly documented with a large red “T” written with an indelible marker on the forehead, crossed through when the tourniquet is definitively removed
- Clinicians need to be aware of the potential disadvantages of their use (amputation rates and nerve injury), but this should not limit their use. Once again there is a large training element associated with effective and safe tourniquet use.
6 Volume resuscitation

The **key points** relating to effective volume resuscitation are as follows:

- Control of bleeding should, wherever possible, precede volume resuscitation
- There should be no delay at scene to secure vascular access for volume resuscitation
- Rapid transfer to surgical facility where surgical haemostasis can be obtained is the primary goal. The majority of casualties do not require Prehospital intravenous fluids where transfer to hospital can be achieved quickly
- All fluids administered should ideally pass through a fluid warmer, as hypothermia forms part of the ‘lethal triad’

6.1 Control of bleeding

**Summary and recommendations**

- Control of bleeding should, wherever possible, precede volume resuscitation
- Control of external bleeding prior to fluid resuscitation may utilise a number of methods (see haemostasis, section 5)
- Control of internal bleeding:
  - Early recognition of, and need for, splinting of obvious fractures, including pelvis
  - Rapid transport to hospital for definitive haemostasis (see haemostasis, section 5).

6.2 Vascular access

**Summary and recommendations**

- There should be no delay in securing vascular access for volume resuscitation at scene
- If immediate transfer is possible, cannulation should take place *en route* if time permits
- If there is a delay at scene, the preferential order of access for adults and children is peripheral, then intersosseous (IO) access is recommended
- In CBRN incidents, IO use has a higher priority
- In-hospital vascular access may also include use of central venous cannulation and (*in extremis*) cutdown.

6.3 Pre-hospital/Emergency Department resuscitation

**Summary and recommendations**

- Defined resuscitation terminology includes:
  - Permissive hypotension (cannulation and minimal fluid administration to maintain cannula patency)
Hypotensive resuscitation (fluid administration to a hypotensive patient to elevate arterial pressure to a target SBP of 80-90mmHg, or palpable radial pulse)

- Normotensive resuscitation (fluid administered to a hypotensive patient to elevate SBP to a target of 110 mmHg).

- Attempts to establish intravenous access should not delay transfer to hospital
- If a radial pulse is not palpable, resuscitate to radial pulse or SBP 80-90mmHg, using aliquots of 250 ml crystalloid. Consider 1st line 250 ml HSD (Hypertonic Saline Dextran).
- For short transfer to hospital, continue hypotensive resuscitation
- If transfer to hospital is delayed (>1hr from time of injury), change strategy to reset systolic blood pressure target to 110mmHg at 1 hr post-injury (normotensive resuscitation achieved without rapid infusion)
- Those patients likely to have established vascular disease or patients with suspected head injury (deteriorating Glasgow Coma Score (GCS) or GCS<13) should have normotensive resuscitation from the outset
- The physiological response to haemorrhage with blast injury can be different to haemorrhage alone, e.g. compensatory response to haemorrhage alone is attenuated with blast injuries.

6.4 Hypothermia

- Avoid hypothermia
  - Warm intravenous fluids
  - Preserve body heat. The use of ‘suit packs’ is advocated at scene, where transfer is likely to be delayed.
- Avoid hypotensive resuscitation for prolonged periods: this necessitates rapid establishment of definitive haemorrhage control (see section 5, haemostasis)
- There is some evidence that early administration of hypertonic fluid may reduce the inflammatory response to hypoperfusion
- Large volumes of crystalloids alone increase the incidence of acute lung injury/abdominal compartment syndrome.

6.5 Inpatient resuscitation endpoints

- Corrective coagulopathy strategies include early use of FFP (for clotting factors) and Packed Red Blood Cells together with addressing acidosis and hypothermia (see section 5, haemostasis), aim for the following coagulation endpoints:
  - PT and activated partial thromboplastin time (APTT) less than 1.5 times normal
  - fibrinogen >1
  - platelet >80x10^9 L-1
- Initial cardiovascular resuscitation should be based on direct measures of circulatory function e.g. stroke volume
- The aim is to restore effective tissue oxygen delivery to reduce the metabolic acidosis
- Once circulatory stability has been achieved, cardiovascular resuscitation is considered to be complete when there is evidence of adequate tissue perfusion, e.g. no metabolic acidosis.
- Normalise core temperature
- Target Haemoglobin 8-10 g/dL
• Monitoring does not require technologies other than point of care testing: feeling peripheral perfusion and pulse volume, and assessing physiological parameters (conscious level, urine output, acidosis resolution) is adequate in the Emergency Department.

6.6 Children

• It has been established that children do not tolerate hypotensive resuscitation
• Quick access to definitive care (a specialist centre if possible) is advocated. Specialist advice should be sought if transfer is not possible
• Capillary refill gives better indication of volume status than radial pulse
• Fluid administration should follow European Paediatric Life Support (EPLS) guidelines.

6.7 What fluids, how much, when?

• Rapid transfer to surgical facility where surgical haemostasis can be obtained is the primary goal
  o Majority of casualties do not require Prehospital intravenous fluids where transfer to hospital can be achieved rapidly.
• For hypotensive adults without head injury, initial low volume fluid resuscitation
  o Goal-directed to target systolic blood pressure 80-90mmHg (palpable radial pulse) in non-compressible, non-controllable haemorrhage (hypotensive resuscitation)
  o Consider using 250 ml Hypertonic Saline Dextran as initial slow fluid bolus for its immunomodulatory role and initial resuscitation
  o If transfer to hospital is delayed (>1hr from time of injury), change strategy to reset systolic blood pressure target to 110mmHg at 1 hr post-injury (normotensive resuscitation achieved without rapid infusion).
• For patients likely to have established vascular disease and casualties with significant head injury resuscitate to SBP 110mmHg
• Once admitted to hospital use red cells and FFP early to prevent and correct coagulopathy and continue restoration of cardiovascular parameters.