Equipment For Immediate Medical Care

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Introduction

The task of compiling and maintaining equipment for immediate medical care can be difficult. Potential clinical challenges vary from acute medical emergencies to the management of multiple victims of major trauma. Whilst some guidance is available on the broader aspects of equipment selection (1-4), there is little clear guidance as to what equipment is most appropriate in the trauma setting and how it should be packed. This article reviews some of the principles of equipment selection and packing and provides practical advice on the development of a trauma bag. This is equally relevant to the provision of medical cover in the barracks setting and to the provision of civilian pre-hospital care by service medical personnel. It should be noted that the Army is currently reviewing equipment for pre-hospital care in the operational setting (Deployable Medical Modules Review) and that this article focuses on generic equipment issues. The equipment required for acute medical emergencies in general practice is described elsewhere(5-7).

Box 1. Factors to be considered

- Who is going to use the equipment ?
  CMT, paramedic, doctor, nurse, medical team
- What types of casualty are likely ?
  Age group, type of injury, numbers
- Where are they likely to occur ?
  Training area, sports field, main road, wilderness
- What conditions can be expected ?
  Terrain, environment, day or night
- How long is medical care expected to be provided for ?
  1/2 hour, 4 hours, 24 hours

General principles

Before starting to select equipment, it is important to consider the circumstances in which it is likely to be used and for whom the equipment is intended (both in terms of the casualty and the immediate care provider) (Box 1). Trauma bags are often assembled with only one seriously injured casualty in mind. What if there are two or more? Certain items of equipment may need to be duplicated and others added if multiple casualty incidents are likely. Similarly, most trauma scenarios focus on adults. Although the emergency management of children follows the same basic principles as that of injured adults, additional equipment will also be needed if paediatric care is required.

With regard to the type of injury, the trauma bag for the sports field will have very different equipment from that used for rifle ranges, road accident work or cave rescue. Thus it is important to consider on whom the equipment is expected to be used and their potential injuries. The probable location of any casualties and the terrain and weather conditions that may be expected to prevail will also influence equipment selection. Equipment designed to be carried across open country will need to be lighter and more compact than that which remains in a vehicle. It may be a long walk to reach the fallen rider or parachutist. Specialist rescue aids may be required for road accident, mountain, confined space and water rescue and each of these environments poses particular equipment problems. In addition to the terrain, environmental hazards such as water and extremes of heat and cold may influence the storage and usefulness of some equipment. Operating in the dark, regardless of the weather, can be extremely difficult without good knowledge of the contents of a carefully packed bag. Even if the most appropriate equipment is chosen, careless initial packing or inadequate maintenance may render the contents of a bag ineffective in any but the most benign environment. It is essential that the packaging is so designed that the practitioner can locate any piece of equipment by feel in the dark.

A further factor to consider is the level of intervention expected of anyone who might need to use the equipment and the likelihood of them obtaining early additional medical support. The rapid availability of a fully equipped paramedic ambulance will obviously influence equipment choices. So too will delayed evacuation or evacuation by other means such as helicopters. In most circumstances, additional support will be available well within 30 minutes but 4 to 12 hours may be more realistic in mountainous or remote areas.

The practitioner also needs to be confident that they will be able to access and use any particular item of equipment when indicated. A key principle is that the equipment should be simple, immediately accessible and, where possible, self-contained. For example, the practitioner should be able to progress step wise (if necessary) through airway management options without having to rummage

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through separate sections of a bag. Cricothyroidotomy kits and military chest drain sets are good examples of pre-packed self-contained equipment packs which contain most items required to perform the procedure. Any omitted items (local anaesthetic, syringe, needle, forceps etc) should be identified and packed with these kits.

Box 2. General principles
- Durability
- Flexibility
- Compatibility
- Safety
- Accountability

Having identified the circumstances in which the equipment is going to be used, some broad general principles should also be considered (Box 2). The equipment needs to be durable and robust. It may need to be packed in crushproof and waterproof containers rather than water resistant soft-packs depending on the circumstances. The equipment needs to be flexible to the extent that it can be readily adapted to the range of incidents that might be expected. Modular packing systems facilitate flexibility and may allow practitioners to choose the modules relevant to the incident (e.g. search and rescue vs. road accident). Compatibility refers to the ease with which the equipment is interchangeable with that used by other providers such as the ambulance service, A&E departments or other receiving medical facilities. Compatibility facilitates use of equipment by other professionals who may arrive to offer assistance and aids re-supply ("one for one" swaps). If the receiving medical facility is not familiar with extrication or immobilization equipment, the casualty may come to further harm during its removal. Measures to ensure that the equipment will be used safely are under emphasised. Safety is ensured by regular training sessions and the inclusion of an aide memoire within the equipment sets. This is especially important if the equipment is being used infrequently, contains drugs or may be used for children. Finally, the responsibility for the maintenance and checking of the equipment needs to be made clear, together with any obligations regarding controlled drugs or accountable items.

Once all of these issues have been addressed, a decision on the broad composition of the equipment can be made. For the remainder of this article, a generic trauma bag designed for the resuscitation of one paediatric or adult casualty will be described under several headings (Box 3). It is assumed that further assistance will be available within 30 minutes and that rapid evacuation is possible. Although this may not be representative of the demands faced by some immediate care providers in the military setting, the principles of equipment selection and packing still apply. A good discussion of the interventions that may be usefully performed in the tactical environment is provided by Butler *et al* (8,9) and is a valuable reference for those packing medical equipment for tactical medical support. A discussion of equipment for wilderness medicine can be found at the Wilderness EMS Institute web site (www.wemsi.org) and in standard wilderness and mountain rescue texts. (10,11).

Box 3. Categories of equipment
- Protection
- Communications
- A: Airway management
- B: Chest injuries and ventilatory support
- C: Bleeding and circulatory support
- D: Head and spine injuries
- E: Environment and extremity trauma
- Drugs
- Additional equipment

Protection

Protect yourself, protect the casualty and protect the scene.

These basic principles of immediate care have equipment implications. It is essential that all personnel who may routinely be in contact with potentially infective blood borne agents are immunised against hepatitis B and utilise universal precautions (Box 4).

Box 4. Equipment implications of employing universal precautions
- Protection of existing wounds and the prevention of puncture wounds, cuts and abrasions
  Protective gloves and first aid (self aid) equipment to protect own wounds
- Simple protective measures to avoid contamination with blood or body fluids
  Jackets and/or overalls, latex gloves and eye shields
- Control of work surface and equipment contamination
  Clean up material and disinfectant spray available
- Safe handling and disposal of sharps
  Low risk sharps (eg Safelon®) and sharps containers

The most common contributing factor in injury amongst rescue personnel is lack of personal protective equipment (PPE). Thus when working in a rescue environment, particularly when alongside the civilian emergency services, appropriate boots, gloves, helmets, eye protection and high visibility clothing must be available. The protective clothing worn should adhere to the same standards of visibility and safety as that worn by the emergency services. Jackets for road accident work must meet BS-EN 471 class 3 standards. These are described in detail in the British Association for Immediate Care (BASICS) equipment

directory (4) (updates available at www.basics.org.uk) and advice can be obtained from local Fire and Ambulance Services. Wilderness and tactical environments clearly place different constraints on PPE. Whether the need is for foul weather protection or motorway traffic protection, deliberate decisions need to be taken about PPE and whether it is to be issued on an individual basis or available for whoever is expected to provide the response.

Communications

There are two key aspects to communication equipment. The first concerns the means by which the immediate care responder will communicate with their own control facility and the other emergency services. It does not matter what system is in place but it is essential to ensure that facilities to communicate are appropriate to the circumstances and readily available. The second aspect concerns communicating the details of injuries and interventions to the receiving medical facility. This is particularly important when the providers are not travelling with the casualty and drugs have been administered. This communication is best done using dedicated 'patient report forms' as used by the civilian ambulance services. Polaroid photographs may seem impractical but can communicate an enormous amount of information about the mechanism of injury.

Table 1. Equipment for airway management (see text for details).

Equipment	Notes
Nasopharyngeal airways (3 sizes)	Unwrapped and prepared (tracheal tubes cut to size may be used)
Oropharyngeal airways (4 sizes)	Unwrapped
Suction pump	Prepared for use
Rigid and flexible suction catheters	Sizes appropriate for other airway adjuncts
Wide bore suction tube	
Laryngoscope handle	
Laryngoscope blades (3 sizes)	Blade type according to experience
Batteries and bulbs	
Laryngeal Mask Airway (3 sizes)	
50 ml syringe	For tracheal tube and LMA
Anaesthetic drug pack	With syringes etc.
Tracheal tubes	Sizes 3,5 and 7 (mm internal diameter) as minimum (ready for use but uncut)
Magills forceps	
Bougie	
Intubation accessories	Tie, lubricating jelly, gauze, catheter mount etc.
Cricothyroidotomy kit	Needle and surgical
Size 6.0 tracheostomy tube	Packed with scalpel if not with cricothyroidotomy kit
Jet insufflation apparatus	Prepared for use

Airway management

Airway obstruction and hypoxia is a contributing factor in up to 85% of trauma deaths (12) and may be the sole cause of death in patients with transient loss of consciousness but no other injury(13). The full range of basic (14) and advanced (15) airway management equipment should therefore be available to the immediate care practitioner (within the limitations of their training) (table 1).

Airway management equipment is traditionally packaged as separately wrapped items. Oropharyngeal and nasopharyngeal airways do not need to be sterile. Some argue the same for tracheal tubes: those required for immediate use should be packed in such a way that the cuff is protected from damage but the tube is immediately to hand. Nasopharyngeal airways which require a safety pin through the flange (Portex®) should have this fitted at the packing stage. Ideally nasopharyngeal airways with a bigger flange and which do not require a safety pin (Argyle®) or Linder®) should be used. An appropriate range of sizes of both airway adjuncts is needed.

Effective suction is essential to airway management. A number of hand, foot and battery operated suction pumps are available. Whichever is used, the device should be packed ready to use. Thus it needs to be packed with a range of sizes of rigid and flexible suction catheters to match the variety of airway adjuncts and tracheal tubes carried. With foot operated pumps, it may be necessary to pack an extra length of suction tubing to ensure that it will reach the casualty (particularly for road accidents). Suction should always be performed in a controlled way and wherever possible under direct vision. A laryngoscope is an invaluable aid to suction and airway toilet even if tracheal intubation equipment is not carried. Whenever laryngoscopes are carried, appropriate spares (batteries and bulbs) should also be available. If the laryngoscope is only required to facilitate suction then simple plastic disposable types usually suffice. Direct laryngoscopy is often better achieved with a metal laryngoscope and an appropriately sized and shaped blade. It is usually possible to use a larger blade on a smaller patient (by limiting insertion) but the converse is not true. Thus large, intermediate and small blades should be carried. Whether to carry straight (Miller), curved (MacIntosh) or other specialist blades depends on the predominant trauma population and the experience of the providers. Straight blades are of value in small children only and the standard curved blades are most commonly used in adults.

Endotracheal intubation is a complex skill that requires training and practice. Although it is of particular benefit to casualties with head or chest injuries (12), there is evidence that inappropriate attempts to intubate may also cause harm.(16) Furthermore, casualties with a Glasgow Coma Score higher than 3 cannot usually be intubated without the use of sedatives and muscle relaxants. Finally, the intubated patient requires close supervision and, when anaesthetic agents have been used, maintenance of anaesthesia. If there is any doubt about the availability of the skills and experience required to intubate casualties at the scene, intubation equipment should not be included in the pack.

The Laryngeal Mask Airway (LMA) is an alternative that is gaining acceptance in pre-hospital use. (12,15,17) Single use devices are available and the training is easier to obtain and assimilate than for tracheal intubation. Less equipment is required and the casualty's level of consciousness does not need to be as low. Although the LMA does not provide the same degree of protection from aspiration as an endotracheal tube, there seems to be little evidence of this problem in clinical practice (12,15,18). LMAs should also be available for when laryngoscopy is impossible (due to the position of the patient) or intubation attempts have failed. They should be packed close to any intubation equipment along with a large syringe to inflate them (40 ml required for size 5). The Combitube is often recommended as an alternative. Unlike the LMA, this device is not routinely used in anaesthetic practice in the UK and it is therefore very difficult to obtain any practical training or experience in its use. Although the Combitube has been used in pre-hospital care (15,18), any advantages it may have over the LMA are probably lost due to lack of training opportunities. The relative advantages and disadvantages of the LMA and Combitube have been well reviewed (12,18).

If intubation and anaesthetic equipment is to be provided, then the full range of equipment should be available, including difficult airway alternatives. The methods and drugs chosen will depend to a large extent on the practitioner's training and expertise. The minimum equipment is a laryngoscope (with appropriate blades and spares), a range of cuffed and uncuffed endotracheal tubes, lubricant, a syringe to inflate the cuff, a method of securing the tube in place (ties are more secure than adhesive tape), a stethoscope and a bag-valve-mask device. A gum elastic bougie, a catheter mount and appropriately sized Magill's forceps may also be of particular value in the pre-hospital environment. Tracheal tubes should be packed ready for use but should remain uncut to allow nasotracheal intubation if necessary.

A later article in this series will focus on the specific issues regarding anaesthesia. There is a wide range of drugs which may be used to facilitate intubation. One of the most commonly used combinations for pre-hospital rapid sequence induction is etomidate and suxamethonium. Maintenance of anaesthesia is then commonly achieved with intravenous bolus doses of midazolam or propofol and a non-depolarising muscle relaxant such as atracurium or pancuronium. For the purpose of the equipment bag, a suitable container will be required to carry sufficient quantities of anaesthetic drugs along with syringes, drawing up needles, saline or water, syringe caps and some form of labeling system. Although pre-printed labels are available, an indelible pen can be used to write on the syringe barrel. The importance of storing all of this equipment in the same place cannot be over emphasized. In many cases, it is safer if all drugs are stored separately and collected prior to departure. It is not advisable to store drugs in a vehicle if there is any risk of the vehicle being broken into. The anaesthetized casualty will need to be accompanied and the right equipment for the transfer should be readily available.

Needle and surgical cricothyroidotomy are the surgical airway techniques which are routinely taught. Pre-packed sets are available for both and the decision about which to carry depends both on the likely clinical circumstances and the availability of insufflation apparatus. In adults, needle cricothyroidotomy should only be seen as a temporizing measure pending further attempts at tracheal intubation, progression to a surgical airway or rapid transfer to hospital. Surgical cricothyroidotomy is contra-indicated in small children. Jet insufflation via a needle cricothyroidotomy requires high flow oxygen and a syringe, three way tap and oxygen tubing assembly or equivalent (Figure 1). It should also be recognised that the minimum tube size that will allow effective ventilation is 6 mm therefore cricothyroidotomy kits should be supplemented with a 6 mm ID cuffed

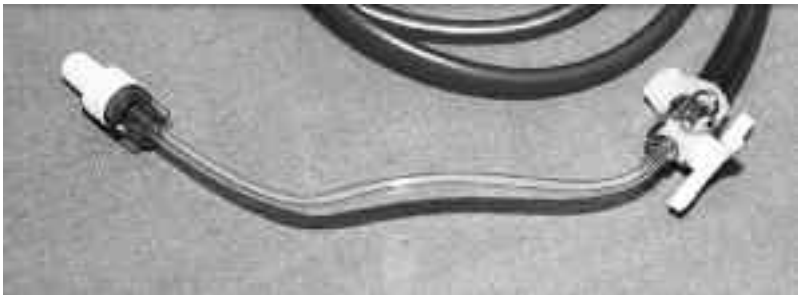

Fig 1. Improvised device for insufflation of oxygen via a needle cricothyroidotomy. Oxygen tubing is secured to one port of a three way tap (with 10 cm extension) by a cable tie. The extension is connected to the hub of the cannula and the spare port is used to control flow.

Fig 2. Airway management equipment as packed in a trauma bag. Oropharyngeal and nasopharyngeal airways are arranged by size and are immediately accessible. LMAs and intubation equipment is protected within an additional bag. Not on the picture are the cricothyroidotomy set, improvised connector and 6.0mm tracheostomy tube. Note that none of the airway devices remain in their original packaging.

Table 2. Equipment for chest trauma and ventilatory support (see text for details).

Equipment	***Notes***
Lightweight oxygen cylinder	With regulator and key if necessary
Non-rebreathing masks	Adult and paediatric sizes
Bag-valve-mask apparatus with reservoir bag	Adult and paediatric sizes -with disposable bacterial filter if re-usable
Oxygen tubing	
Chest drain kit	Including scalpel, introducer, chest drain, suture and drainage bag.
Pneumothorax kit	Including long cannula, syringe, tape and flutter valve
Asherman chest seal	Only has 1 gauze swab included
Gauze swabs	
Forceps	Unless included in chest drain kit
Hand held sutures	To secure drains
Adhesive tape role	
Pulse oximeter / Capnometer	Pocket size (with spare batteries and probes)

tracheostomy tube.

Effective management of the airway may have the greatest impact on mortality and morbidity of all pre-hospital interventions. The airway management equipment therefore needs to be comprehensive and accessible. It is surprising how little space this may take (Figure 2). The clinical management of the traumatized airway has been reviewed elsewhere (19).

Chest injuries and ventilatory support

The equipment required for managing chest injuries and providing ventilatory support includes all the airway management equipment and the specific equipment shown in table 2. All casualties should have high inspired oxygen concentrations delivered by a system which best meets their ventilatory pattern and needs. In the spontaneously breathing patient, a non-rebreathing mask with a reservoir bag and oxygen flow rate sufficient to meet peak inspiratory demands will provide maximal oxygenation. These masks usually come in adult and paediatric sizes and are packed with short lengths of oxygen tubing. It may be necessary to pack an additional length of spare tubing to increase the reach. Oxygen cylinders have been until relatively recently made of steel and restricted in volume by pressure limitations on the cylinders. It is traditionally taught that a D size oxygen cylinder will contain 340 litres of oxygen. Newer carbon-fibre / aluminium composite cylinders are stronger and lighter. The same cylinder size can be pressurized to a higher degree and will contain more oxygen. These lightweight cylinders are ideal for pre-hospital trauma bags.

Casualties who require assisted ventilation may obtain this via mouth to mask or bag-valve-mask (BVM) apparatus. Single use BVMs in a variety of sizes are now available but are much more expensive than simply adding a disposable bacterial filter to a reusable BVM. If oxygen is available, a reservoir bag and length of oxygen tubing will also be required. Otherwise, the BVM can be used without a reservoir.

The most important pre-hospital interventions in casualties with thoracic trauma are ventilation and decompression of a tension pneumothorax (12,20). Open chest wounds should be sealed and flail segments stabilised. Although decompression of a tension pneumothorax can be achieved by insertion of an intravenous cannula in the second intercostal space, mid-clavicular line, there are few cannulae which are of sufficient length to ensure that the pleural cavity is reached. The minimum length should be 4.5cm on the basis of studies of chest wall thickness (21). Pre-packed emergency pneumothorax kits (which are essentially mini-chest drains) are available which contain long, wide bore cannulae with skin fixing devices and one-way flutter valves. Either tube (22) or open (23) thoracostomy may be indicated for delayed evacuation or prolonged entrapment. Both techniques have been shown to be safe in the pre-hospital environment and are associated with significant improvements in oxygen

saturation, blood pressure and pulse rate (20). Tube thoracostomy kits are available which contain a scalpel, chest drain, flexible introducer, hand held suture and drainage bag. Additional local anaesthetic, needles, syringes, alcohol swabs, gauze, tape and, perhaps most importantly, forceps may be regarded as luxuries but will make the procedure easier and more comfortable for the patient. Open thoracostomy can only be performed on ventilated patients. Only a scalpel and gauze dressing are required. Open chest wounds can be closed with traditional three sided dressings using, for example, the wrapper of a first field dressing and some tape. More recently however, the Asherman chest seal has been introduced. This pack contains a self adhesive disc with a one way flutter valve and a gauze swab and is designed simply to be placed over an open pneumothorax once the skin has been dried. Little further equipment is required to manage chest trauma (Figure 3).

Fig 3. Contents of chest trauma pack within main trauma bag. Pre-packed emergency pneumothorax set (containing needle, cannula, syringe, connector, extension, Heimlich flutter valve and skin cleaning and fixing equipment), chest drain kit (containing scalpel, chest drain, flexible introducer and drainage bag) and Asherman chest seal. Additional sutures, forceps, gauze and tape are also packed.

Table 3. Equipment for bleeding and circulatory support (see text for details).

Equipment	Notes
First field dressings	At least three
Wide crepe roller bandage	To use as pressure dressing
Hand held suture	Scalp wounds, securing lines
Sphygmomanometer	Anaeroid
Blood pressure cuff	Arm and thigh
Venous tourniquet	
Intravenous cannulae	Preferably with self retracting needles and side ports
Adhesive tape and dressings	
Gauze swabs	To clean blood and allow tape and adhesive to stick
Cross match sample kit	Including identity bracelet, syringe and sample bottle
Butterfly cannulae	
Cut down kit	Including curved and straight forceps, scalpel, suture material and gauze / adhesive tape
Intraosseous needle	With three way tap and syringe
Emergency infusion device	One peripheral and one central/femoral
Blood giving set (drip set)	With integral filter
Heavy duty shears	
Crystalloid	Hartmann's or Saline

Capnometry (the analysis of carbon dioxide in exhaled air) and pulse oximetry are now used routinely in hospital practice and have become a basic standard of monitoring for inter-hospital transfers. Many advocate this level of monitoring in pre-hospital care, particularly in the context of entrapment and pre-hospital anaesthesia (24). Pocked sized pulse oximeter, capnometry or combined units are now available and should certainly be considered in the trauma bag if anaesthesia is contemplated. In the initial assessment of a casualty, use of the pulse oximeter whilst assessing the airway and chest will provide a rapid and accurate assessment of pulse rate and saturation. Capnometry will provide confirmation of endotracheal tube placement and assessment of the adequacy of ventilation. There are however significant training and maintenance implications if these monitoring devices are included in a trauma bag.

Bleeding and circulatory support

Table 3 provides a list of equipment required to control bleeding and support the circulation. Although there continues to be extensive debate about the pre-hospital management of haemorrhage, some aspects are clear (Box 5). Firstly, compressible haemorrhage must be controlled by whatever means possible. This usually applies to limb injuries and direct pressure, elevation, use of arterial pressure points and use of an arterial tourniquet may be required. First field dressings remain ideal for direct compression. A wide crepe roller bandage may be used to provide additional pressure. In bleeding scalp wounds, it is often effective to place a large hand held suture through the skin flap. A sphygmomanometer with thigh and arm cuffs can be used safely as a tourniquet. Traction splintage of a femoral shaft fracture is possible using compact traction

Box 5. Principles of haemorrhage control and circulatory support
- Control compressible haemorrhage
- Identify non-compressible haemorrhage and shock and evacuate urgently
- Do not allow cannulation attempts to prolong scene time
- Cannulate trapped patients or while on route to medical facility
- Titrate fluid replacement to maintenance of the radial pulse
- Use crystalloid as fluid replacement

splints and will reduce bleeding into the thigh. Secondly, non-compressible haemorrhage (intra-abdominal, intra-thoracic or pelvic injuries) must be identified as soon as possible and evacuation to a surgical facility expedited. No time should be wasted at the scene in securing intra-venous access or administering fluids. Clearly if the patient is trapped or requires intravenous analgesia (26) then intravenous (IV) access is required. Finally, profoundly hypotensive casualties will require volume replacement regardless of the injury and the current recommendation is to allow some hypotension to persist (controlled hypotension) and provide fluid replacement sufficient only to maintain the radial pulse (12,25,27). It may be very difficult to obtain intravenous access in casualties and a range of IV access equipment should be available. Conventional intravenous cannulae with a side access port for administration of drugs are normally used. There is however some evidence that self-retracting cannulae (e.g. Safelons®) are safer to use in the pre-hospital environment because of a lower incidence of needlestick injuries (28,29). The Faculty of Pre-hospital Care issued guidelines on the pre-hospital management of shock based on a recent expert consensus meeting.

Fig 4. Intravenous access equipment as packed in a trauma bag. Two each of the five standard sizes of Safelon® are immediately accessible along with (from left to right) a identification wrist band, 10ml syringe, cross match sample bottle, crepe bandage, packet of gauze, adhesive IV dressings, venous tourniquet and adult and paediatric elbow splints. Underneath is a pack containing specialist intravenous access equipment (see text).

Fig 5. Intravenous access equipment for specialist or difficult access. An intra-osseous needle is packed along with a 20 ml syringe and a 3 way tap with extension. A venous cut down set comprises a scalpel, one pair curved forceps, two pairs of straight forceps, and a hand held suture. Butterfly cannulae, a peripheral emergency infusion device and a long (12cm) cannula are also included. Gauze and tape complete the kit.

The debate concerning whether or not to give IV fluids does not diminish the importance of having the relevant equipment immediately to hand if it is required. Figure 4 shows the IV access equipment packed in a trauma bag. It should be noted that there is no requirement to open additional pouches or packs. In some cases, innovative techniques may be required to achieve IV access. Placing a venous tourniquet around the upper arm, inserting a fine cannula or butterfly in a distal vein, and injecting a small volume of fluid to distend the proximal veins is often described. Thus butterfly needles and fine gauge cannulae are required. Intraosseous infusion may be necessary in children and an additional three way tap and 20 ml syringe (20 ml/kg fluid boluses) should be packed with the needle. Less commonly, a venous cutdown at the brachial or long saphenous vein may be necessary. A scalpel, forceps, suture material and gauze will be required (Figure 5). Similarly, external jugular, femoral or central venous access may be the only option and appropriate equipment should be available. Emergency infusion devices are pre-packed kits containing a needle-catheter-wire-dilator assembly that are designed to allow a small 'search' needle to be used to identify the appropriate vein and a wire to be passed into the vein. The tract is then dilated and a much larger cannula (catheter) passed. These infusion devices are available in a variety of sizes and include a scalpel. These can also be used for enlarging existing peripheral venous access or creating large bore femoral or subclavian access.

With regard to type of fluid, there is currently no clear evidence from controlled trials that resuscitation with colloids reduces the risk of death compared to crystalloids or that any one colloid solution

is more effective than any other (30,31). Crystalloids are therefore considered the most appropriate first line fluid until such time as clear evidence of benefit from alternatives emerges. Perhaps the most appropriate fluid replacement for casualties who are trapped at the scene and shocked is blood. Blood transfusion is indicated when the estimated blood loss is > 20% blood volume and the expected duration of entrapment and transfer is likely to exceed the time required to organise blood (24). It may take a long time to organise blood at the scene if arrangements have not been made in advance with receiving medical facilities. In practice, blood is only very rarely available in the pre-hospital environment. If blood transfusion is an option, an identification bracelet and the appropriate transfusion sample bottle should be packed (generally 10ml without anticoagulant). Giving sets suitable for blood transfusion must have an integral filter. To minimize the risk of inadvertent transfusion through a giving set without a filter, it is recommended that all giving sets packed in the trauma bag are blood giving sets. Butcher's hooks make ideal drip stands and add little extra weight to the bag.

In practical terms, it is often difficult to gain access to the casualty to assess a limb injury or place the cannula. Heavy duty shears are often required to remove clothing and these should be packed with the IV access equipment. Splints which hold the elbow extended (Arm-loc®) are available in adult and paediatric sizes and are ideal for the casualty who is confused, agitated or is going to be moved. They provide a fixed platform for cannulae in the antecubital fossae if properly applied. Other means of protecting IV access once it has been obtained include adhesive dressings, adhesive tape, sutures and bandaging. All of these options should be available.

Head and spine injuries

Primary traumatic brain and spinal cord injury results from mechanical disruption of neural tissues either by direct forces (penetrating injuries) or following deformity of the skull or spinal canal. While nothing can be done to reduce the effect of this primary injury, secondary insults in the minutes to hours following injury can have a major effect on mortality and morbidity. The common causes of this secondary injury are hypoxia, hypoperfusion and, particularly for spinal injuries, further mechanical disruption (32,33). Thus the principles of immediate care for patients with head and spine injury, are simply to maintain the airway, ensure adequate ventilation and prevent hypotension. The only additional equipment required which can be packed into a trauma bag is a semi rigid cervical collar to assist with immobilisation of the cervical spine. A cervical collar does not adequately immobilise the cervical spine on its own and all patients with suspected spinal injuries should have the entire vertebral column immobilised. The practical implications of this require that a deliberate assessment of the likelihood of spinal injury is performed and unnecessary immobilisation avoided (34,35). If spinal injury is considered likely, the casualty cannot be moved until additional resources and equipment are available. Clearly, where there is immediate risk to life from other injuries or environmental hazards, the casualty must be rescued as rapidly as possible and some risks to the vertebral column and spinal cord must be accepted.

There are two patterns of semi-rigid cervical collar, both of which come in a range of sizes. The two piece collars have a wider range of sizes if all are carried but can take up more space. The single piece collars come in six sizes and are only slightly less bulky. A recent innovation is the adjustable single piece cervical collar. This collar can be adjusted to fit most adults. There is no difference in the degree of cervical spine immobilization provided by the different types of semi-rigid cervical collar. The type chosen should be compatible with other emergency services and receiving medical facilities. One piece collars are recommended.

Environment and extremity trauma

Hypothermia associated with trauma may increase mortality. Where possible, the casualty should be protected from the environment with his or her own clothing. Additional protection may be obtained by covering the casualty with plastic sheeting. Foil blankets do not provide any additional protection over plastic sheeting. Chemical warming packs are widely available and may be of help when placed in the groin and axillae. Perhaps of greater importance is administration of warm intravenous fluids. Warm fluids can usually only be provided if they have been carried within the clothing of the immediate care provider or a vehicle warm box is available. The ambient temperature of the area where the trauma bag is stored may be important in this regard. The back of a Land Rover or an unheated room is usually inappropriate. Once fluids have been put up, insulating devices (some with integral chemical warm packs) are available to cover both the blood administration set and the fluid container. These bulky items will be of particular value in cold environments, winter months or prolonged rescue.

The clinical management of limb injuries in the pre-hospital environment has been

recently reviewed (36). Fractures and major soft tissue injuries should be immobilized before movement if possible. Triangular bandages take up little space and can be used to splint upper limb injuries, hold dressings in place and provide additional support to improvised lower limb splints. Flexible Velcro 'Frac-straps®' have a similar use but are more bulky. Webbing utility straps from the trauma bag or personal load carrying equipment and rifle slings can all be used to help immobilize fractures and package the casualty. The Sam® splint is a malleable splint which can be applied to upper or lower limbs and, together with crepe bandages, slings or straps, makes a very good pre-hospital splint. One traction splint should be carried separately. The Sager® splint is recommended for ease of packing, compactness, ease of use and its facility for splinting both legs.

Drugs

In the context of trauma care, the drugs required at the scene are predominantly analgesic, sedative and anaesthetic agents. Pre-hospital analgesia and sedation has recently been reviewed (26). In essence, the choice of agents depends entirely on the likely circumstances (oral vs. intra-muscular vs. intravenous) and the expertise of the provider. A simple drug pack should contain opiate analgesia (morphine or diamorphine with water), anti-emetic (e.g. cyclizine) and sedative (midazolam) agents. Flumazenil and naloxone are mandatory whenever benzodiazepines and opiates may be used.

Table 4. Drugs included in the drug pack (excluding anaesthetic agents).

Adrenaline 1:1000, 1mg/ml, 1 ml prefilled disposable syringe with 25 g needle
Adrenaline 1:10000, 100 mcg/ml, 10 ml prefilled disposable syringe
Adrenaline 1:1000, 1 mg/ml, 5 ml prefilled disposable syringe
Aspirin dispersible 300 mg tablets
Atropine 600 mcg/ml, 1 ml amp
Atropine 300 mcg/ml, 10 ml prefilled disposable syringe
Chlorpheniramine 10 mg amp
Cyclizine 50 mg/ml, 1 ml amp
Diamorphine 10 mg amp
Diazemuls 5 mg/ml, 2 ml amp
Diazepam rectal tubes 2mg/ml, 2.5 ml, (5 mg) tube
Flumazenil 100 mcg/ml, 5 ml amp
Frusemide 10mg/ml, 5 ml amp
GTN aerosol spray 400 mcg / metered dose
Glucagon 1 mg vial with water
Glucose 50% solution in 50 ml prefilled disposable syringe
Hydrocortisone 100 mg vial with 2 ml water
Ketamine 10 mg/ml, 20 ml vial and 50 mg/ml, 10 ml vial
Lignocaine 20 mg/ml, 5 ml prefilled disposable syringe
Midazolam 2mg/ml, 5 ml amp
Naloxone 400 mcg/ml, 1 ml amp
Procyclidine 5 mg/ml, 2 ml amp
Salbutamol aerosol 100 mcg/metered dose (and spacer device)
Sodium bicarbonate 8.4% in 50 ml prefilled disposable syringe
Terbutaline 500 mcg/ml, 1 ml amp
Water for injections 5 ml amp

In the context of road traffic accidents in civilian practice, four medical conditions are commonly seen either as a cause or consequence of the accident (37). The commonest is ischaemic heart disease which ranges from an episode of angina (treated with glyceryl trinitrate spray) to myocardial infarction leading to primary cardiac arrest (treated with aspirin and thrombolytics or adrenaline and defibrillation). The treatment of primary cardiac arrest is very different from that of cardiac arrest in relation to trauma. A decision should be taken about whether or not to provide for the management of cardiac arrest within a trauma bag. The authors carry a separate bag, which is packed with the defibrillator in their civilian pre-hospital work. Other common medical conditions are hypoglycaemia and seizures in the context of epilepsy, febrile convulsions or following head injury. These conditions are easily treated with simple and safe drugs. The only other medical condition commonly seen in the context of road accident work in the authors experience is asthma and allergy. The motorcyclist who slides through a field of oil-seed rape and presents with severe anaphylaxis is perhaps the most dramatic example. The asthmatic child whose asthma is brought on by the shock of a minor accident is perhaps more common. In all of these cases, simple drugs can be carried to effectively initiate management outside hospital. An example of a pre-hospital drug pack is given in table 4. There are clearly legal and administrative difficulties associated with the maintenance and security of drug packs and these should be taken into account.

When packing the drugs, the same principles apply with regard to the anaesthetic agents described above. All necessary syringes, needles, syringe caps, diluents and labels should be available in the same pack. An aide memoire with drug dosage and administration instructions for each drug carried should also be available within the pack. This is particularly important for the care of children. A tape or chart which relates length to body weight and drug doses should be provided if children are to be treated.

Additional equipment

There is clearly a broad range of additional equipment that could be put to good use in the pre-hospital environment. Some of this is shown in Figure 6. However, the practicalities of maintenance, storage and carrying this equipment should be taken into account at the planning stage. Once again, the need to tailor the trauma bag to the likely circumstances in which it will be used is essential. In most cases, the

Fig 6. Additional items carried by the authors. The trauma bag is in the background. Additional items shown here are a multi-modality monitor (pulse oximetry, non-invasive blood pressure recording, capnography and ECG), a Sager® traction splint, a Kendrick® Extrication Device, a portable ventilator, a Samalite® emergency lighting unit and a fluid warming bag.

equipment described above will more than adequately cater for the needs of the casualty and additional resources will often be available within a relatively short time. Less glamorous additional items of equipment which should however be considered are sweets or chocolate bars for the provider, hand wipes, clinical waste bags and a sharps container.

Training and administration

Once equipment has been selected, a cycle of packing, experimentation and re-packing should be commenced with simulated casualties. The simulation need not be sophisticated but should involve removing the relevant equipment from the bag whilst under pressure (rather than going through a mental or written checklist). This remarkably simple exercise will reveal problems associated with illogical arrangement of equipment or over-packing (the bag has to be emptied on to the roadside to find one item). One of the authors struggled with a trauma rucksack designed by a leading teaching hospital which failed because access to equipment packed first was only possible by removing everything else it contained. Simulations should include step wise progression through airway management options, rapid application of oxygen and ventilatory support, haemorrhage control and intravenous access and management of fractures, pain, agitation and medical emergencies associated with trauma.

Once the packing has been completed, an equipment checking policy and checklist must be developed. The responsibility for checking the equipment should lie with those who use it. This ensures that the immediate care practitioners remain familiar with the equipment. Similarly, the responsibility for cleaning and maintaining equipment should also rest with those who are expected to use it.

There are considerable difficulties in maintaining sterility of equipment packed for immediate use and, where possible, disposable (single use) items should be selected. There are cost implications associated with single use items and in some cases, it may be cheaper to consider re-usable items such as laryngoscopes, pulse oximeter probes, splints and bag-valve-mask devices. A reusable bag-valve-mask can be combined with cheap disposable bacterial filters and a simple disinfection routine. Before attempting any disinfection, all equipment should be thoroughly cleaned with warm soapy water (while wearing household gloves). The most practical way to rapidly disinfect equipment is to use a fresh aqueous solution of sodium hypochlorite (bleach) in a concentration of 1:10000 parts per million available chlorine. This corresponds to a 1:10 dilution of household bleach but it should be emphasised that the strengths of individual proprietary brands of bleach may differ. Where possible, advice should be sought from local hospitals or other medical facilities which disinfect and sterilise equipment.

Summary

The equipment lists provided in this article are not intended to be proscriptive or definitive. They are simply an illustration of the logical application of equipment selection and packing principles according to the likely needs of the casualty. Although trained personnel with relatively little equipment can perform simple interventions, optimal care requires some advanced techniques and good quality comprehensive equipment. Such equipment is available for pre-hospital use. Regardless of what equipment is packed, the immediate care practitioner must understand the circumstances in which the equipment is likely to be used and tailor it to the likely needs of the casualty.

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Equipment For Immediate Medical Care

Commentary

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The first ports of call for many Immediate Medical Care providers at conferences, meetings and exhibitions are the equipment trade stands. There is a need to know what new and exciting devices are available to help us achieve our aim in caring for our patients. Given the environment that we use our equipment and skills in, this enthusiasm coupled with attention to detail may well be considered essential. The article on equipment for immediate medical care provides an excellent logical and comprehensive account of the process of choosing and even packing the appropriate equipment needed by any level of Immediate Care practitioner. Individual items of equipment have changed slightly since it was published and some new items (such as the Bone Injection gun (1) and the Intubating Laryngeal Mask Airway (2)) are now available, but the method of identifying the equipment remains as described. When selecting equipment for use in our various environments, we are urged to match our equipment to our clinical competencies, our patients' needs and the conditions within which care must be delivered. Helpful insights are given by those who have obviously spent many hours going through this process themselves.

So have we moved on, or should we have moved on? With the increasing skill set of NHS Paramedics, the role of the civilian Immediate Care practitioner is becoming more specialised and increasingly delivered in different ways - through specialist land or helicopter based teams. This presents new challenges in terms of the amount and type of equipment that may be carried. As our practice evolves, so the equipment that is needed to support us and the framework within which the equipment is governed must also evolve. There has been a re-emphasis in healthcare practice recently on the safety of equipment both to the operators and our patients (3). For example, with the ready availability of intravenous cannulae specifically designed to reduce the risk of needlestick injuries, can we justify using anything else in the pre-hospital environment? Similarly, recent guidance for the Department of Heath on disposable equipment to reduce the risk of transmission of bloodborne viruses and prions, has let to the introduction of single use equipment such as laryngoscopes, laryngeal mask airways and surgical instruments (4). For the individual practitioner, this may decrease the need for cleaning of equipment, but may increase the need for compatibility with other providers to allow more efficient re-supply. Other issues of safety have also to be considered - how often are our pieces of electrical equipment independently checked? (5). For the safety of our patients, are we confident that we are safely and appropriately introducing new items of equipment?

Within a volunteer organisation such as an Immediate Care Scheme, equipment governance must be a priority, and procedures must be developed to ensure that equipment approved is suitable for the requirements of the task and matched by the skills of the operator. This all comes at a cost and close liaison with NHS Ambulance Trusts may help. A clear and professional approach to our equipment in its selection, organisation and governance, can only improve our clinical care and professional standing.

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