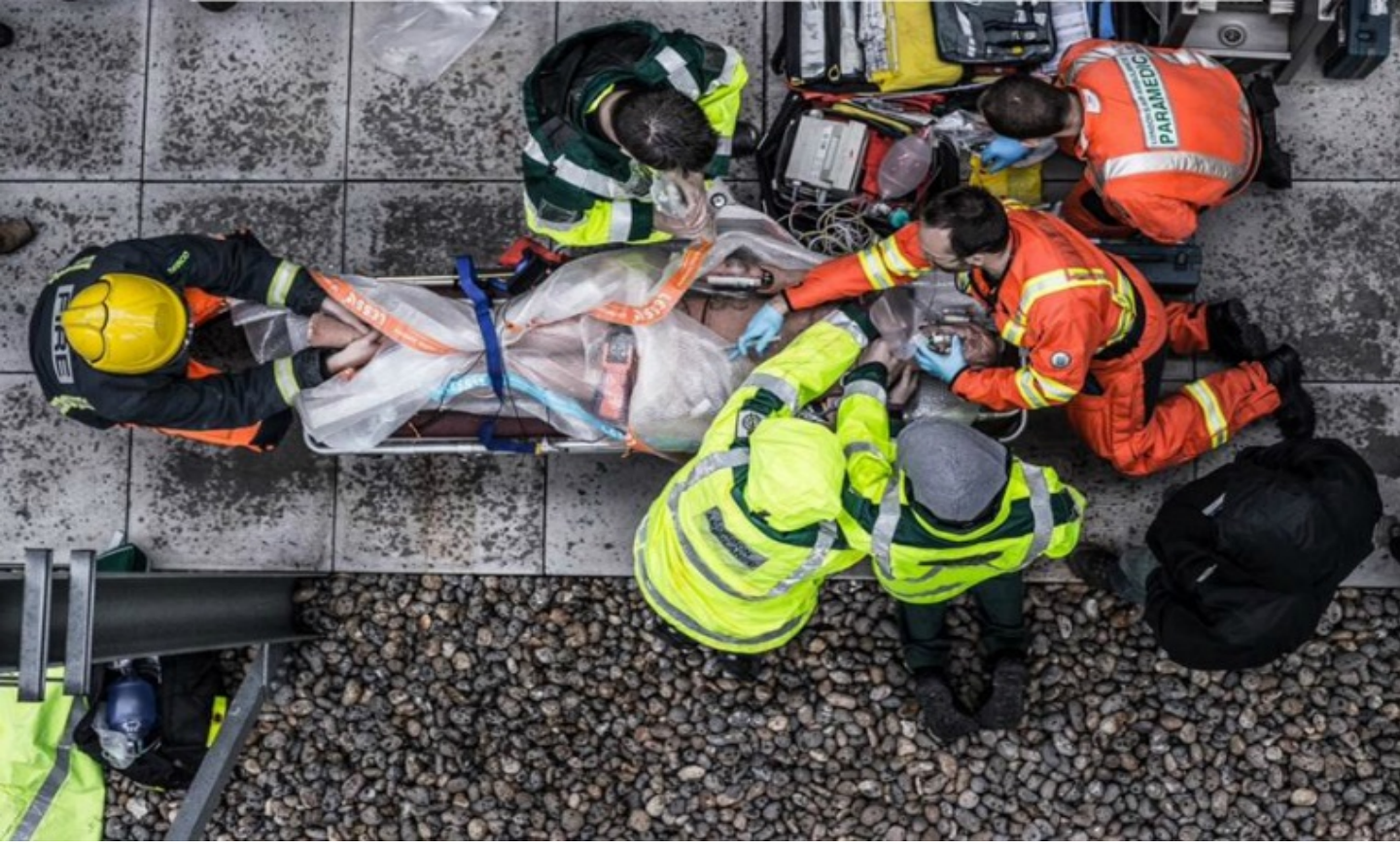

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UNIVERSITY OF ABERDEEN

Undergraduate Pre-Hospital Care Course Student Handbook

Daniel Whitehouse and Ruth Gratton

First edition, August 2015

UNIVERSITY OF ABERDEEN

This handbook was written by Daniel Whitehouse and Ruth Gratton, students at the University of Aberdeen with the kind support & funding from the NHS Highland Medical Education Department.

At the start of writing this handbook the world of pre-hospital care was shocked and saddened to lose one of its leading members, Dr. John Hinds.

Dr. Hinds and Dr. Mark Bloch, who died in 2014, both serve as continued inspirations for both the authors and the editors of this handbook. As such we wish to dedicate this work in their honour.

We would like to thank the following people for their contributions and support to this handbook:

Firstly we would like to thank our supervisors Mr. Michael Gale and Dr. Luke Regan for their continued support, assistance and guidance.

Throughout this handbook we have used quotations from experts in the pre-hospital world, we would like to thank all of them for the insights they shared with us:

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FOREWORD

This manual is intended to shine a light into an area of medical practice that is important, rapidly developing and has the potential to bring life-saving care to patients and locations previously thought outside the scope of regular medical training.

Pre-hospital care for the critically ill and injured in the UK has, in places, undergone dramatic improvements in skill recognition, equipment provision, tasking, governance and research in the past two decades. As a result, students today can reasonably expect to graduate into systems that value the additional diagnostic and therapeutic interventions that an appropriately trained physician can provide at scene. Postgraduate diplomas and fellowships offer academic pathways to interested practitioners and the option of formal sub-specialisation in Pre-hospital Emergency Medicine is now recognised by the GMC.

Whilst operational pre-hospital services continue to emerge and mature, and postgraduate bodies provide clear professional frameworks for the enthusiastic physician, it is at undergraduate level that the specialty lacks parity with its older siblings. As a Medical School we saw the need to fuel the fires of would-be enthusiastic pre-hospital clinicians when they first spark. Access to evidenced-based learning materials coupled with clinical teaching from subject matter experts should help inform the career plans of interested students in similar fashion to the budding plastic surgeons or would be microbiologists catered for elsewhere in the curriculum.

The hope of this manual, and the year long undergraduate course it supports, is to do just that. The co-ordinating authors Dan Whitehouse and Ruth Gratton have achieved the impossible, weaving together the special blend of algorithms, scene awareness and adaptability, reflective learning and expert testimonials that characterise the course. The conviction of senior clinicians that bringing this level of training and exposure to undergraduates is worthwhile should be made manifest in the many Clinical Leads, Directors of Training and experienced pre-hospital clinicians from around the globe who have given their time and expertise to contribute to this manual.

The two doctors most regrettably unable to do so are Dr John Hinds and Dr Mark Bloch. More than any others these two clinicians championed the cause of better pre-hospital care in Northern Ireland and the North of Scotland respectively. This they achieved through the example of their own excellent patient care, their reform and enthusing of the institutions they found themselves in and a firm commitment to educating their colleagues and those in power at every opportunity to the work still left to be done. Both have tragically been taken from the pre-hospital communities they so ably served and we mourn that loss here whilst celebrating the legacy they both achieved in their too-short years. We humbly dedicate this publication to the memory of these two incredible clinicians and exhort those embarking on this endlessly challenging endeavour to follow where they led.

Dr. Luke Regan FRCEM DRTM
Founder of the University of Aberdeen Pre-Hospital course. ***August 2015***

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INTRODUCTION

Hello and welcome to the exciting world of Pre-Hospital Care! This course is designed to give an introduction to pre-hospital care and we hope that through these sessions you will learn a bit, teach a bit and gain enthusiasm for this rapidly evolving field of medicine.

As part of the Inverness Campus teaching for University of Aberdeen undergraduates, a pre-hospital care initiative has been set up and run by experienced and enthusiastic health care workers. This course consists of nine sessions throughout the year focussed on various topics ranging from care in extreme environments to mass casualty situations.

So what is pre-hospital care?

The General Medical Council (GMC) describes pre-hospital care as the provision of '*immediate medical care in what is often a resource limited and physically challenging setting'.* Recently pre-hospital care has been recognised as a sub-specialty, and has its own college faculty. There are also numerous organisations such as BASICS and BASICS Scotland providing pre-hospital care services and training throughout the United Kingdom.

Why is pre-hospital care important to undergraduates?

Pre-hospital care is a fluid career pathway, giving an exciting addition to various specialities including General Practice, Emergency medicine, Surgery and many more. The opportunities in this field are increasing all the time and early exposure at an undergraduate level plays an important role in this.

For undergraduates and associated healthcare workers pre-hospital care training allows development of key non-technical skills essential for future practice including group communication, pressured clinical decision making and the ability to manage some of the more common medical emergencies.

What is this resource and who is it for?

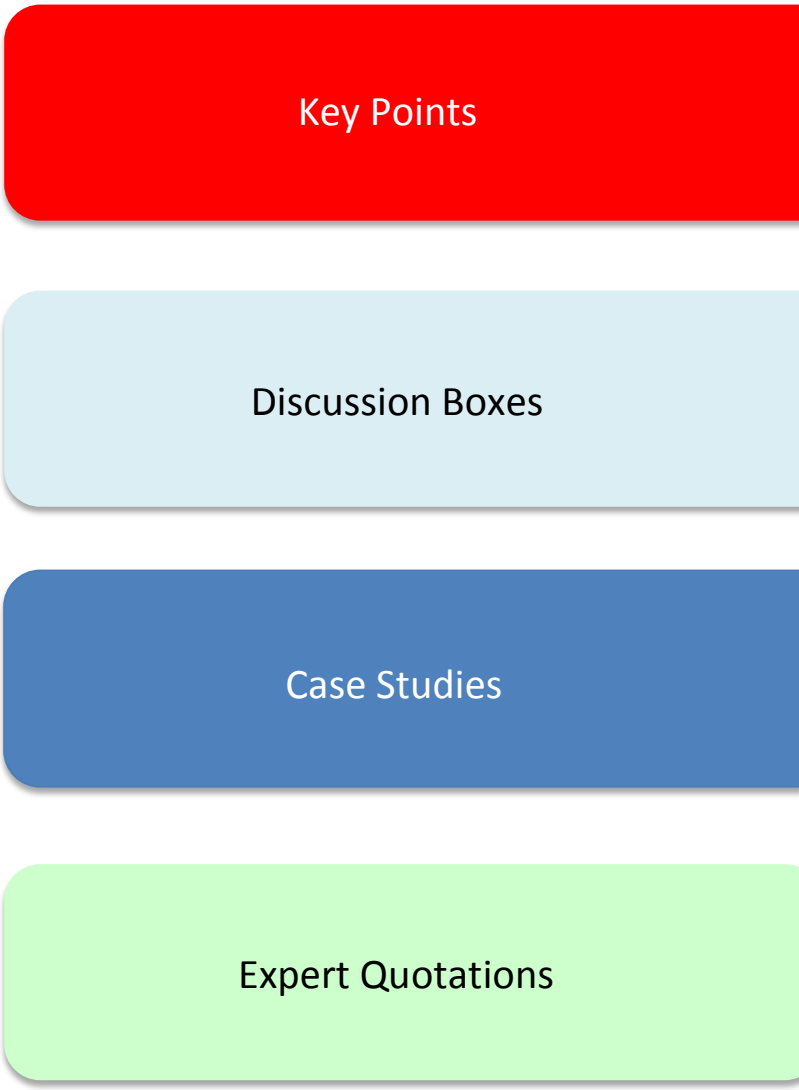
This handbook is designed to accompany the teaching delivered during the pre-hospital sessions. Equally it allows for those not able to make it to the sessions to be able to become more familiar with pre-hospital care and the challenges faced. This contains a more comprehensive look at not only what we do, but why we do it.

What is the pre-hospital care course?

The pre-hospital care course runs once every 5 weeks with 9 different sessions throughout the year targeted at undergraduate medical students and other healthcare professionals interested in learning and developing skills in pre-hospital care. The course is taught by expert volunteers with first hand experience of delivering real world pre-hospital care.

Each of the sessions has a theme and begins with general introductions, often followed by small tutorials and skill sessions. Following this, the emphasis is changed away from tutorials, towards scenarios that allow the students to practice and build upon what they have learned earlier.

Throughout the manual there are colour-coded breakout boxes as follows:



PRIMARY SURVEY ALGORITHM

Scene Safety – is it safe to approach?

Catastrophic Haemorrhage → Direct pressure, haemostatic dressing, tourniquet, IV/IO access

Airway (with C-spine)

- AVPU (if talking airway is patent)
- Is there a foreign body in the mouth?
- Signs of airway obstruction?
- Stabilise C-spine

→ Manual positioning, Suction, Magill's forceps, NP airway, LMA

Breathing + oxygen

- **RIPPA**
- Respiratory Rate
- Assess breathing – inspection, percussion, palpation and auscultation
- Is there are tension pneumothorax

→ Oxygen therapy, specific measures

Circulation + IV access + haemorrhage control

- Pulse, Capillary Refill Time, BP by pulse assessment
- Signs of shock e.g. cool peripheries
- Control haemorrhage

→ Direct pressure, Haemostatic dressing, tourniquet, No radial pulse give 250ml crystalloid.

Disability

- Assess – Glasgow Coma Scale, AVPU and pupils
- Hypoglycaemia, Increased intracranial pressure, focal neurology

Exposure/ environment

- Hypothermia
- Manage patient exposure to elements
- Packaging and Extrication

→ Transfer to hospital

Communication and Scene Safety

COMMUNICATION IN PREHOSPITAL CARE

In challenging and adverse environments such as those faced in pre – hospital care, clear and effective communication is essential. The use of specific, unambiguous vocabulary prevents misunderstanding, which could slow provision of care. Communication is complex, involving not just verbal but non-verbal communication skills, such as non-verbal cues and tactile communication.

It is recognised that ineffective communication can compromise patient safety and result in negative outcomes when dealing with a critically ill patient.[1]

Communication Skills

Clear verbal communication is vital during an emergency. It allows you to coordinate with other emergency services as well as gather information about the scene from the patient and bystanders. Keeping language simple and concise will allow information to be passed on quickly, and ensure complete understanding throughout the team.

Documentation during the incident is important; it provides proof that the care provided was appropriate and necessary. This documentation acts as a safety net to the verbal handover; the receiving team is provided with physical records detailing the progression of the patient and the treatment given, aiding the continuity of care.

Physical communication serves as a useful adjunct to simple verbal communication. A good example is by placing your hand on the person's shoulder you wish to talk to. This reinforces the importance of the information you are relaying, and via this simple physical contact the other person knows it is important to listen. Their attention should be directed at you and it allows direct eye contact to emphasise key messages. These skills, and others, are incredibly useful in adverse environments where numerous distractions from the sensory overload at the scene, make it difficult to know what is being said and to whom.

Initial Communication

As the first person on scene you are taught via the ABCDE paradigm to call for help. This first communication with the emergency services is very important as it relays vital information about the incident and the particular services required. It is important this exchange of information is seamless and that appropriate updates are given as the incident progresses e.g. time till arrival to hospital and condition of patient allowing the awaiting emergency department to be prepared to receive the patient.

Communication with the Patient

Alongside gathering information, communication with the patient can have a therapeutic benefit. Speaking calmly and clearly and ensuring the patient is aware of

what is happening, is important, as the patient will be distressed and anxious. Reassurance is a simple but effective means of gaining the cooperation of the patient and relieving anxiety. Creating a dialogue between yourself and the patient allows you to gather important information about the mechanism of injury and symptoms.

If there are multiple responders on scene, it is usually best for one person to communicate with the patient, reducing potential confusion. Often, the person at the head of the patient is designated with responsibility for patient communication; this person should try and gain rapport with the patient by simple introductions before moving onto gathering information. Other verbal ways of therapeutic communication[2] include; direct eye contact and positive facial expression.

Communication to other emergency services

On scene, there are likely more than one of the emergency services, each with their own specific tasks to carry out. It is very easy to become task focused and unaware of the environment in which you're working. It is, therefore, important to ensure there is continual exchange of information between services so that all services are aware of the shared goals.

When initially on scene, you should communicate with the designated leader of the other emergency services. This allows you to identify yourself and coordinate a plan for the patient. Sometimes, when attending a scene you may not have worked with that specific emergency service crew before, so gaining a common understanding with them is important in the initial dialogue.

Patient Handover

The accuracy of the patient handover to the receiving team is vital to save time and allow continuity of care.

A study[3] showed that a common language between pre-hospital care practitioners and the receiving team is necessary. Without this common language, there was difficulty developing a shared cognitive picture from the handover given. In the interviews conducted in the study the term 'Chinese whispers' was used to exemplify how information is easily loss in translation. It was concluded there was a need for a standard handover.

The shared mental model is a way of personnel understanding the clinical picture and implications of the patient's condition. Personnel should be familiar with roles and responsibilities of other team members to promote greater understanding of team dynamics.

How to give an effective handover?

Before a standardised handover, the emergency department must be 'ready' to receive the patient. A few points that increase the speed and fluidity of treatment are commented on below[4]:

1. **Pre-hospital communication and assembly of the team** – this is relaying information to the emergency department before the patient has arrived. This allows adequate and appropriate personnel and equipment to be in place before the patient arrives. This includes things like; putting on personal protective equipment, drawing up drugs and requesting other specialist input.

2. **Identification of the team leader** - this person is the communication link between the pre-hospital practitioners and the emergency department team. They will delegate responsibilities to each team member. All information about the patient is reported back to this person. This person should ask for input from other team members, but the final decision must be made by them.

3. **Handover** – there are a variety of mnemonics used to handover. It must be standardised and unambiguous.

Handover Methods

ISBAR or IMIST-AMBO are commonly used mnemonics for handover[5]. Both provide a structured framework to relay patient information. They facilitate clear, effective and efficient communication by organising patient information in a consistent and concise manner.

I – identification
M – mechanism/medical complaint
I – injuries
S – signs
T – treatment and trends

A - allergies
M - medication
B – background
O – other information

ISBAR, was adapted from the SBAR[6] mneumonic developed by the Unites States Navy Nuclear Submarine Service. It is used more frequently when relaying information from the scene of the incident to ambulance control/ designated hospital. It is also used throughout the health service when communicating information about patients to other healthcare professionals.

I	Identification	Identify yourself and location Identify the patient
S	Situation	What is the current situation? Concerns? Observations?
B	Background	Presenting complaint Relevant history Significant past medical history Medications
A	Assessment	Primary survey What is the problem? Vital signs? Clinical findings? Working Diagnosis
R	Recommendation	What treatment has been given and patient response? What management or treatment is needed?

Encourage questions when the handover is completed. During the handover, there should be no interruption to the person giving the handover. Identification of the team leader is important, so that information can be directed to them.

Group dynamics / teamwork

Mutual respect and trust is a key component of a team's ability to work effectively.[7] Initial dialogue with a team member you don't know is vital to relay your identification and your competency. Other services can be reassured when they see you 'know what you're doing.'

It is important that all team members understand what the aims of management are and the roles of other members within the group. The ability of a team to work under stress can be tested to the limit in a pre-hospital situation.

Team leader

A team leader should be designated at the start, and the rest of the team should be aware of who this person is. This person should be able to coordinate the team and have the communication skills and the necessary expertise to manage the incident. A good team leader will aim to support their team and seek input from them (although the final decision does lie with the team leader). There should be a mutual respect between the team and the team leader and no team member should be afraid of raising concerns to the team leader.

When identifying tasks to be done the team leader should employ a technique called closed loop communication.[7] They should allocate the task to an individual and this individual should acknowledge this allocation and report back to the leader when it is complete. This form of communication aims to reduce misunderstanding by providing unambiguous instructions.

For example:

'Fiona I want you to check the radial pulse'
'You want me to check the radial pulse'
'Yes'

- Effective communication is essential in pre-hospital care
- Identification of a team leader is important
- There should be mutual respect between team members
- Keep language simple, clear and precise

SCENE SAFETY

Pre-hospital care is exactly that, pre-hospital, leading to environments that can be as dangerous as they are varied. Scene safety is a vitally important to protect the full healthcare team, and as such requires careful identification of hazards through a complete risk assessment. It has been estimated that in the United States, over a 5-year period, the fatality rate in emergency medical services was 12.7 per 100,000 workers[8] significantly higher than many other professions.

Your first priority is your own safety; your second is that of your team.

Preparation and Equipment

Preparation begins before arriving at the scene by making sure that you are appropriately dressed for the scenario you will be facing and having the correct equipment. In pre-hospital care you may not be in a situation where this is always possible, but a quick thought towards what you are wearing and what you have with you could be very important later on.

Clothing should be appropriate for long exposures in the environment you are entering, and so it might need to be warm, waterproof, visible and protective.

Personal Protective Equipment (PPE) is used dependent on the dynamic risk assessment of the situation giving information of what is needed. These may include:

- High visibility jacket
- Overalls (fire retardant)
- Knee pads
- Safety helmet and visor
- Safety glasses
- Gloves
- Ear defenders
- Waterproof trousers

Equipment should be checked to see if stocks are up to date, and in date. It is also useful to be familiar with the equipment available and how it is laid out. Transit to the scene can be useful time to re-acquaint with the equipment and think about what may be used and what safety equipment may be needed

Communication between those at the scene and those arriving is vital. Updates of the patients' condition, information on the current environmental conditions and notice of the interventions taken allows those arriving to plan ahead. This allows them to arrange as much as possible, and develop a plan before arrival, minimizing time at the scene. It also can help to plan evacuation and the method for this. Information that the casualty is away from roads and will be hard to evacuate via ambulance could lead to a helicopter being requested instead.

BASICS Scotland provides Sandpiper Bags for clinicians in Scotland to provide 'a standardized portable immediate care medical kit'. There are now over 750 distributed through Scotland. There are over 50 items in each sandpiper bag including:

Vitalograph aspirator, CPR face mask, multiflow oxygen regulator, bag valve mask, nasopharyngeal airways, laryngoscope handle and kit, Portex mini-trach kit and chest drainage kit, laryngeal mask airways, stiff neck collars, paramedic shears, flexible catheter mount, intraosseous needles, 3 way sterile stop cock, Magill's forceps, Guedel airways, laryngoscope blades, reflective jacket and green strobe beacon'

For more information on the sandpiper trust visit: http://www.sandpipertrust.org

At the Scene

Hazard – the potential to cause harm
Risk – the chance of harm occurring

'Don't assume, Look!'

Scene assessment begins with a full 360° survey and the rescue should not proceed until all the hazards are identified and communicated throughout the team. This can be simple; but at a complex scene, this may be an intensive process with multiple hazards to analyse and a large number of team members in multiple teams to communicate with.

In many situations other emergency service teams will be at the scene, if so the safety assessment and control of safety of the scene is in the hands of the fire rescue service. This does not mean the medical team does not need to be aware of the hazards, but scene control and safety is coordinated by the fire service.

The dynamic risk assessment continues throughout the care provision at the scene. Pre-hospital environments are often highly changeable and the team must be equally adaptable. New hazards identified need to be either avoided or risks reduced, and potentially, if serious enough this may involve withdrawing until the scene is made safe. When in a team there should be clear communication of new hazards to all members of the team and each member should be identifying dangers to both themselves and their team members. In particularly complex situations a safety officer can be appointed.

Hazard examples you may see:

- Moving vehicles – think about protecting the scene with your own car if no help is available
- Fuel spill
- Fire
- Electricity
- Crowds and angry people
- Weather
- Patients – The patient has been listed as a source of injury among emergency medical technicians in up to 37% of cases with a large amount of assaults.[9]
- Numerous more - these are dependent on the situation you are in, again emphasizing the importance of a thorough 360-degree safety assessment.

If you are first at the scene, then early communication of the hazards and environment back to ambulance control can allow appropriate support to be organized. The information that is required can be remembered by the mnemonic ETHANE

E	Exact location
T	Type of incident/injuries
H	Hazards
A	Access
N	Number of casualties
E	Emergency services on scene or required

Another useful mnemonic to remember when approaching a casualty is that a SAFE approach is taken,

S	Shout for help
A	Assess the scene
F	Free from danger
E	Evaluate the patient

Exit strategy

Part of scene assessment is planning an exit strategy, this allows for quick exit of the scene if required, and again this needs communicating through the group. If the situation is deteriorating, then do not forget the basic principle of care for you, care for your team, then care for the patient.

Evacuation

The evacuation route needs to be assessed early, as this will give time for the required transport to be despatched and reduce waiting time. Patient transport can be in a variety of modes; road, air, boat and stretcher are all used in different situations presenting different challenges. A report into trauma care provision in the UK conducted[10] in 2007 showed that the mode of arrival at hospital was an ambulance in 83.3%, 11.7% in a helicopter with other methods making up the rest including mountain rescue, the coastguard and members of the public.

The choice of transport will be made dependent on location of the patient, and where the appropriately provisioned hospital is. Some casualties may require only a basic emergency department, while others may require an intensive care unit with cardiothoracic surgery. This can make the difference between a twenty-minute journey to the local cottage hospital and a two-hour journey by road to a large tertiary center.

Is there road access? Can a helicopter land? These decisions are made between the teams at the scene, the transport teams and crucially the control centers, highlighting the importance of clear communication between all groups.

Setting your scene

A designated equipment drop should be used to place equipment out of danger of contamination and damage, but within reach. This can be as simple as placing a tarpaulin on the ground and putting the equipment on the top. It allows simple organization in a pre-hospital environment and could potentially save time and help quickly locate gear in complex situations.

[1] Greenburg CC, Regenbogen SE, Studdert DM, Lipsitz SR, Rogers SO, Zinner MJ et al. Patterns of Communication Breakdowns Resulting in Injury to Surgical Patients . *Journal of American College of Surgeons* 2007; 204(4): 533-540.of

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[3] Owen C, Hemmings L, Brown T. Lost in translation: Maximizing handover effectiveness between paramedics and receiving staff in the emergency department. *Emergency Medicine Australasia* 2009; 21(2): 102-107.

[4] Orman S. *Pre-Hospital to ED handover. http://aucklandhems.com/2012/11/26/pre-hospital-to-ed-handover/ (accessed 22 July 2015).*

[5] Ambulance Service of New South Wales. *IMIST-AMBO Handover Protocol. http://www.archi.net.au/documents/resources/qs/clinical/clinical-handover/amb-ed/imist-ambo-poster.pdf (accessed 22 July 2015).*

[6] NICE. *SBAR - Situation-Background-Assessment-Recommendation. http://www.institute.nhs.uk/quality_and_service_improvement_tools/quality_and_service_improvement_tools/sbar_-_situation_-_background_-_assessment_-_recommendation.html (accessed 22 July 2015).*

[7] Victorian State Trauma System. *Teamwork and Communicatioin. http://trauma.reach.vic.gov.au/guidelines/teamwork-and-communication/key-messages (accessed 23 July 2015).*

[8] Maguire BJ, Hunting KL, Smith GS, Levick NR. Occupational fatalities in emergency medical services: A hidden crisis. *Annals of Emergency Medicine* 2002; 40(6): 625-632.

[9] Maguire BJ, Smith S. Injuries and fatalities among emergency medical technicians and paramedics in the United States. *Prehospital Disaster medicine* 2013; 28(4): 376-82.

[10] National Confidential Enquiry into Patient Outcome and Death .*Trauma: Who cares?.* : ; 2007. http://www.ncepod.org.uk/2007report2/Downloads/SIP_report.pdf (accessed 22 July 2015).

Catastrophic Haemorrhage

CATASTROPHIC HAEMORRHAGE

A recent revision to the ABCDE paradigm has been the addition of <C>ABCDE whereby catastrophic haemorrhage has been included before the initial assessment of the airway. A catastrophic haemorrhage refers to major bleeding points where pressure can be applied to stem the flow of blood and is the most common preventable cause of death, accounting for 30-40% of deaths, in traumatic injuries, both civilian and military.[1]

This revision has been borne from military experience. The changing face of modern warfare has meant an increase in penetrating injury, accounting for 70-80% of injuries[2] with 10% of preventable deaths due to haemorrhage from extremity wounds. The average time for death in these cases is 5-10 minutes.

This has lead to the current joint military medical doctrine[3] advocating the use of damage control resuscitation that combines <C>ABC with *'a series of clinical techniques from point of wounding to definitive treatment in order to minimize blood loss, maximize oxygenation and optimize outcome'.* This effectively means that Battlefield Advanced Trauma Life Support (BATLS) has moved towards a <C>ABC approach and away from the classic ABC; placing a greater priority on early control of major haemorrhage.

This is an important revision to the paradigm and is vital when faced with a catastrophic haemorrhage, it is, however, important to note that penetrating injury is a rare occurrence in the civilian population.

Compressible versus non compressible

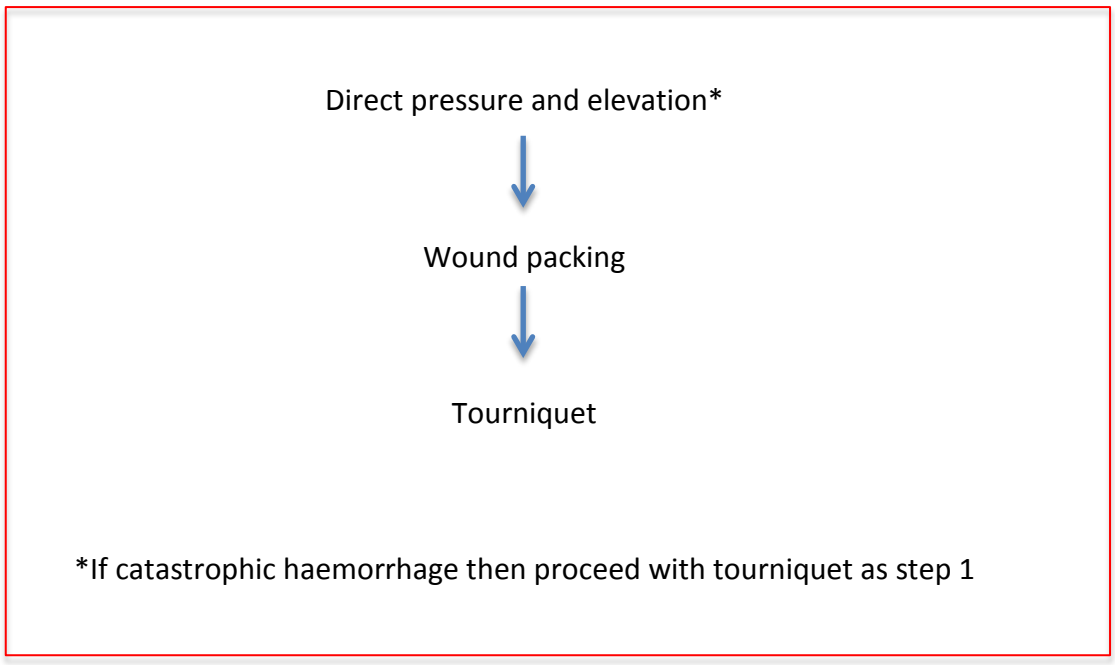
A compressible haemorrhage is one responsive to truncal tourniquets, while a non-compressible is not amenable to them. A non-compressible haemorrhage generally occurs as bleeding into internal body cavities or wounds at truncal junctions to the limbs.[1]

Due to the short time till death due to a catastrophic haemorrhage the <C>ABCDE is now adopted.

Management

With the increasing awareness of the severity, and importance of early management fast assessment and management of catastrophic haemorrhage is an important skill.

- Apply immediate compression bandages and elevation of external wounds.
- Apply prepared bandages, gauzes and swabs containing mucoadhesive agents, including chitosan (Celox), on any open wound where haemorrhage cannot be controlled by direct pressure only. When these come in contact with blood they adhere together clotting the blood, aiding haemostasis. Gauzes should be used to pack the wound at the point of hemorrhaging. Direct pressure should be applied for at least 3 minutes to allow clot formation
- If the haemorrhage remains uncontrolled then an arterial tourniquet can be used. This can be used for bleeding for limb haemorrhage. The tourniquet may also be used as first line therapy depending on clinical triage to prevent deterioration with uncontrolled haemorrhage



If no tourniquet is available the windlass technique may be used. This is where a dressing and bandage are applied to the wound. A second bandage is placed over the top of the wound and a pen is placed under and rotated until tight.[4]

The evidence behind tourniquet use: a study analysis

Large amounts of evidence behind the benefit of tourniquets have come from analysis of use to prevent bleeding in major limb trauma throughout the Iraq war.[5]

They showed significant lifesaving benefits to tourniquet use finding that death rates from exsanguination has dropped to 2% in the Iraq war compared to 9% in the Vietnam War where tourniquet usage was lower. The report also showed that in wars, such as Somalia, where there was increasing but not universal use of tourniquets, had a rate of 7% indicating a correlation between increasing tourniquet use and death rates. A more striking result of the study showed 0% patients died from exsanguination among Israeli soldiers who are the most prolific users of tourniquets.

It was further found that the survival rate was significantly higher when the tourniquet was applied before the onset of shock compared to after onset of shock with survival rates being 96% before and 4% after. This indicates that early use is of vital importance, supporting the idea of including catastrophic haemorrhage at the beginning of the ABCDE paradigm

Side effect of tourniquets

The major morbidity effects associated with tourniquet use include localised complications such as pain, nerve palsy, arterial insufficiency, vascular spasm, fracture of plaque and limb shortening.[6] These have, however, been shown to occur in low levels and are outweighed by the lifesaving benefit. [5]

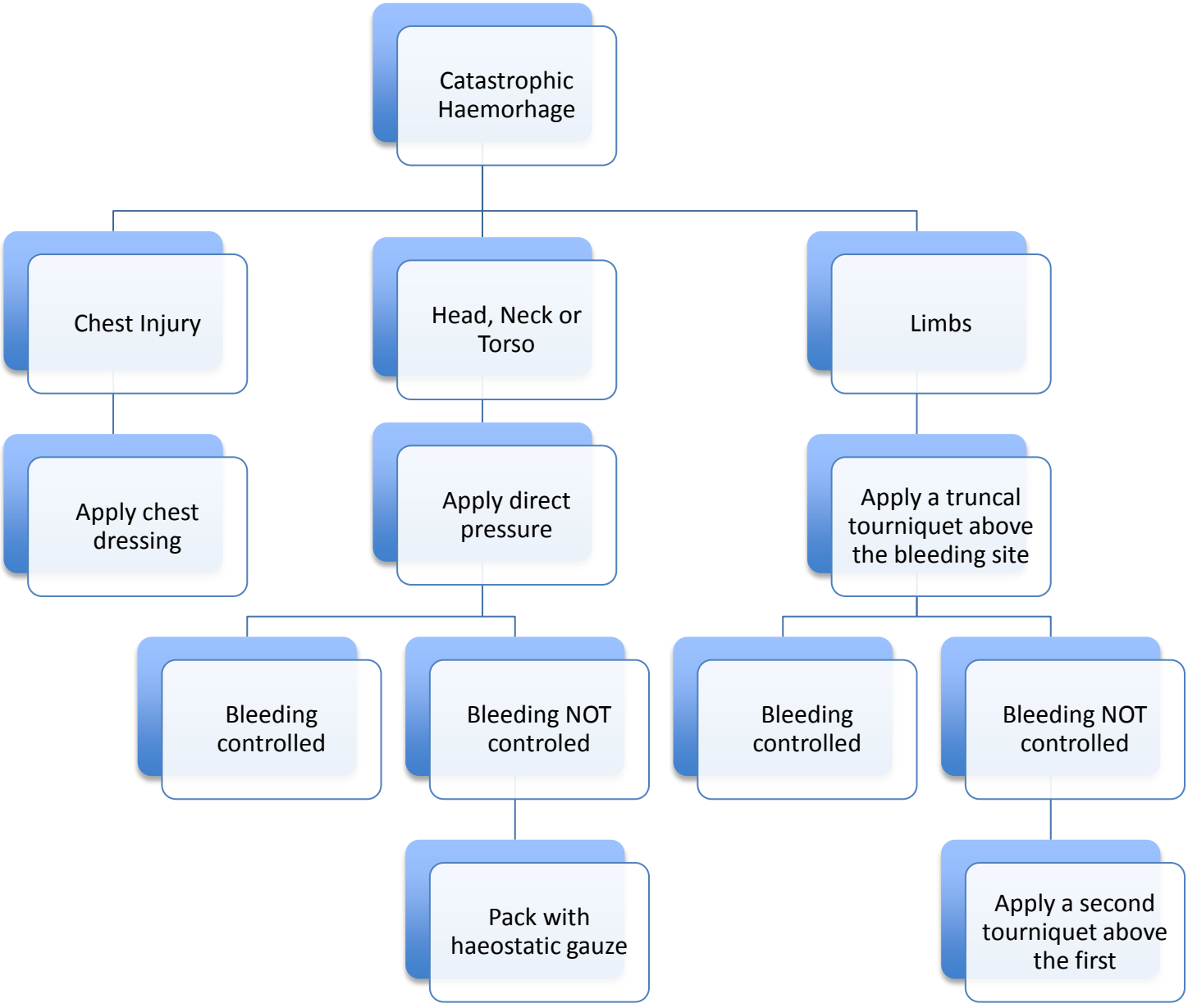
Application for more then 2 hours can result in permanent nerve injury, muscle injury (contractures, rhabdomyolysis and compartment syndrome) leading to a general consensus of a 2-hour limit on tourniquet application. [4]

Where you can go wrong?

Tourniquet failure was most commonly found as the result of insufficient pressure.[5,6] Clothing can obstruct the tourniquet, preventing application of sufficient pressure, or rescuers can be unwilling to apply the correct amount of force needed. Not enough pressure in the tourniquet not only prevents the tourniquet being effective, but also can increase blood loss due to venous pooling of blood. The venous system is occluded at a lower pressure compared to the arterial system, therefore insufficient force in the tourniquet will affect the venous system, but not the arterial, leading to pooling of the blood and an increase in the bleeding.

In one case it was noted the tourniquet failed as it was applied to the wrong arm, this did not have any impact on the haemorrhage.

Catastrophic Haemorrhage algorithm



How to pack a wound

Apply direct pressure to the wound

Unravel and insert a haemostatic gauze, packing the wound

Apply pressure through a fresh dressing for three minutes

How to apply a tourniquet

If, after initial triage, catastrophic haemorrhage is suspected then a truncal tourniquet is applied.

1. Place the tourniquet proximal to the site of haemorrhage, but as close as possible to the haemorrhage. Apply onto direct skin if possible

2. Pull through the buckle till tight

3. Rotate the handle to apply sufficient pressure to cease bleeding and record the time of application

1 Mandel et al . Vasoconstriction by Electrical Stimulation: New Approach to Control of Non-Compressible Hemorrhage. http://www.nature.com/articles/srep02111 (accessed 13 Jul 2015).
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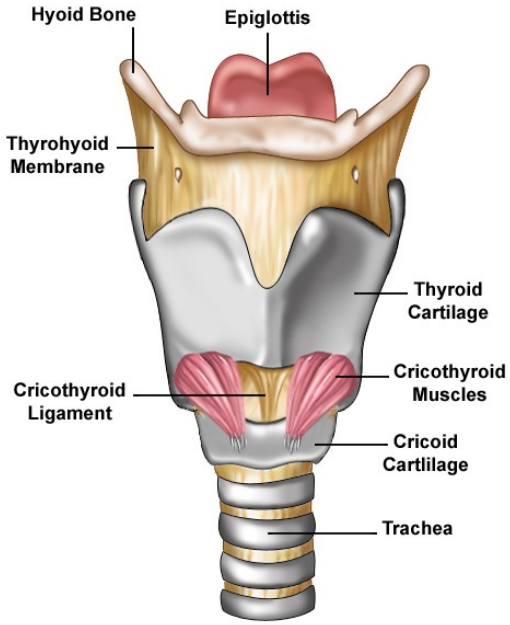
Airway

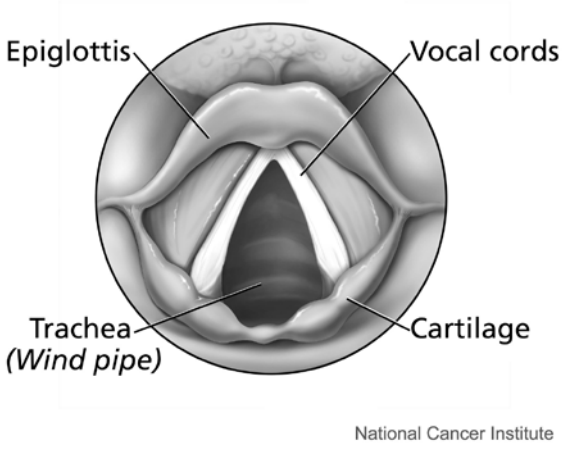
A

ESSENTIAL ANATOMY

The airway is a broad term used to describe the respiratory tract, and can be separated into the upper and lower airway.

The upper airway consists of the oral cavity, nasal cavity and pharynx (oropharynx, nasopharynx and laryngopharynx), while the lower airway consists of the trachea, bronchi and alveoli. The larynx separates the upper and lower airway and is a structure consisting of cartilage (including the cricoid and thyroid) the epiglottis, ligaments and muscles.





National Cancer Institute

What is the Epiglottis?
A flap of mucosa covered elastic cartilage superior to the vocal cords; two mucosal folding's that generate sound. This gives protection to the lower airway preventing objects entering the lungs. It may become swollen, and can cause an obstruction itself

Oral Cavity
The oral cavity is the main entrance to the airway, consisting of the teeth, gums, tongue, soft and hard palate.

Clinical Relevance
These structures all have a role in the obstruction of the airway, with the tongue of particular importance as the most likely to obstruct the airway due to loss of neural innervation at lower conscious levels.

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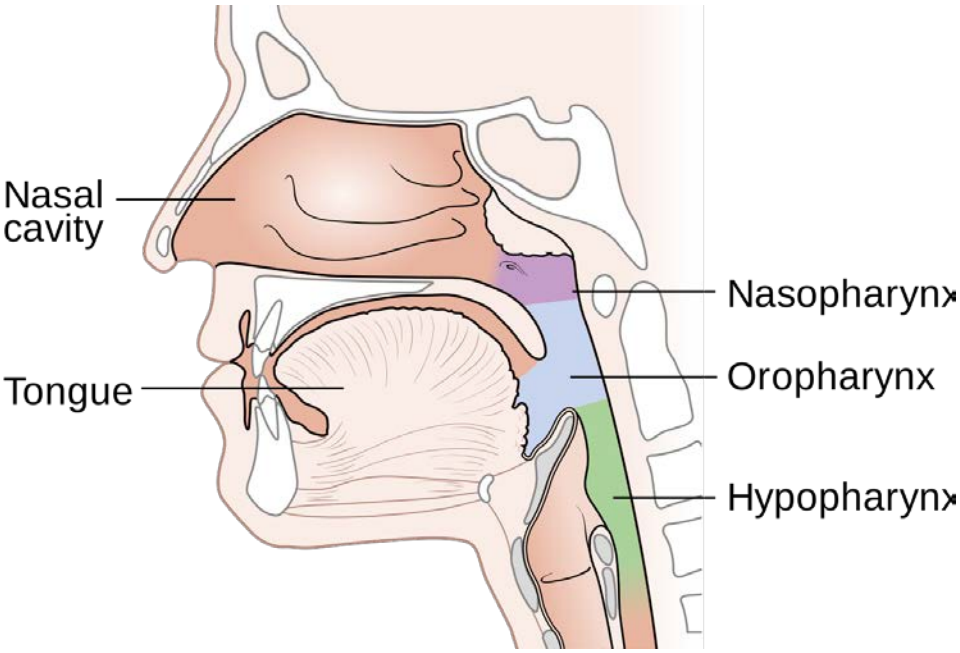


Nasal Cavity
The nasal cavity consists of bone and cartilage and lined by mucosa. It is a highly vascular site and, as such, may cause extreme haemorrhage. The nasal cavity is also prone to obstruction.

Why is the unconscious patient at risk of airway obstruction?
In an unconscious patient it was previously thought that posterior displacement of the tongue was the source of airway obstruction.[1] It was suggested that when the patient is unconscious, the jaw is relaxed, allowing the tongue to move to the back of the throat, obscuring the airway.

It has now been suggested[2] that it is a more complex mechanism then just posterior displacement of the tongue. Bodin suggested a complex mechanism involving the tongue and epiglottis as the source of airway obstruction, during the paper it was shown that even when the tongue is bypassed the airway can still close. Direct Endoscopic visualization of the airway[3] also indicated the epiglottis was being sucked over the laryngeal inlet causing obstruction.

The key message is that the patency of the airway is controlled by soft structures which, when innervated, provide good tone. The absence of muscular stimulation allows a change in structure leading to obstruction of airway. This explains how positioning is so important to management of airway problems.

A

ASSESSMENT

The easiest way to assess whether a person's airway is patent is to just **talk to them**. If the patient is talking without any difficulty it indicates there is not a major obstruction at that time.

'If the child (or adult) is screaming their airway/breathing is fine regardless what they say'

Key terms

- Open Airway – you can see it is open
- Patent Airway – clinical signs of air is passing in and out the airway
- Maintaining airway – the upper airway reflexes are intact including the cough and gag reflex
- Threatened airway – clinical suspicion is that there may be imminent deterioration.

- Assess consciousness – can they speak in full sentences, just phrases, single words, or not at all?
- Look in the airway – is there any visible obstruction?
- Asses ability to take a deep breath
- Look for signs of airway obstructions

'If the airway looks difficult. Think/Expect it is difficult'

SIGNS OF AIRWAY OBSTRUCTION	
Absent breath sounds	
Added sounds of laboured breathing	• Stridor – a harsh, high-pitched sound heard in upper airway obstruction caused by turbulent airflow at the supraglottis, glottis, subglottis or trachea[4]. This is a sign of significant airway obstruction and is important to recognize. • Expiratory wheeze – lower airway obstruction • Gurgling due to fluids such as blood and vomit in the airway • Stertor - described as low pitched heavy snoring/ gasping noise. Caused by partial airway obstruction above the larynx.
Paradoxical chest movements	Commonly described as see-saw respiration, this indicates complete airway obstruction. This is a very late sign and is rarely seen in the pre-hospital environment. *Why does this occur?* During inspiration the diaphragm moves downwards and the abdominal walls moves outwards to create a negative inter-thoracic pressure. With airway obstruction, air is unable to enter the thoracic cavity, meaning the negative pressures cause the chest to be drawn inwards. This appears to an observer as abdominal expansion and chest collapse hence the name 'see-saw' respiration.
Use of accessory muscles	Gives an indication of the increased effort required due to obstruction
Reduced consciousness	Can be a sign of airway obstruction occurring secondary to cerebral hypoxia and hypercapnia[5]

Is there partial or complete airway obstruction?

In complete airway obstruction there is no respiration; this will kill the patient and requires emergency measures to be taken.

PARTIAL OBSTRUCTION	COMPLETE OBSTRUCTION
Use of accessory muscles to aid breathing	Absent breath sounds
Tracheal tug	Unable to talk
Paradoxical chest movements (almost complete)	Silent chest
Intercostal recession	Paradoxical chest movements
Tripoding (seen in children and adults)	

Tripod Stance (tripoding)

Common Causes of Airway Obstruction in Pre-hospital Care

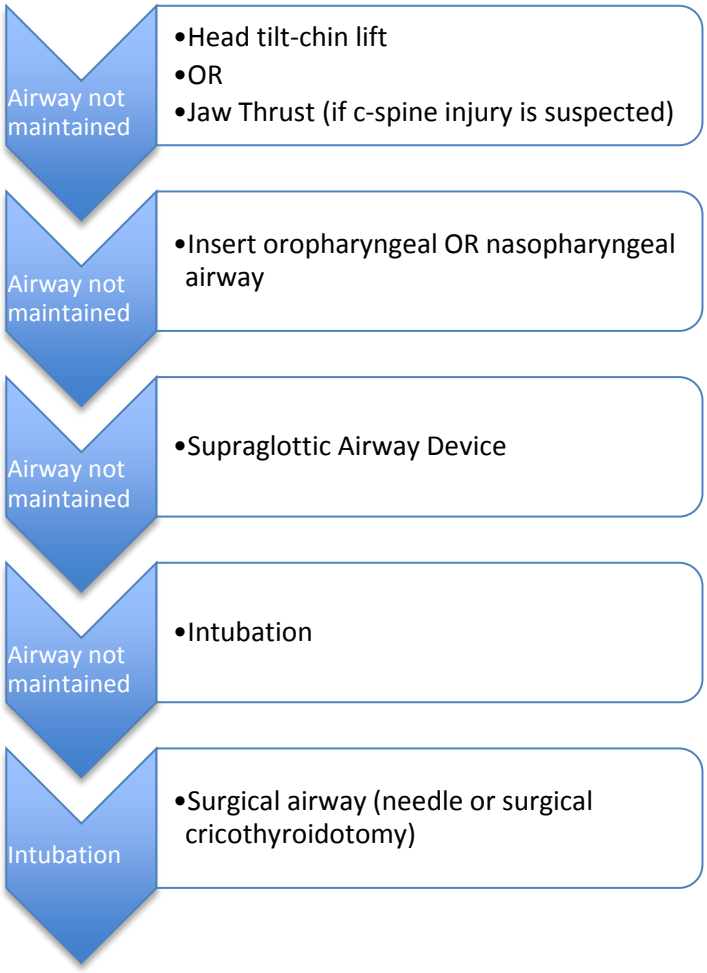
- Loss of consciousness
- Foreign Body
- Trauma
- Blood
- Airway interventions
- Saliva
- Vomit
- Inhalational injury (Burns)
- Anaphylaxis

MANAGEMENT

'The greatest airway is the one between your eyes'

The Airway Ladder

After an initial assessment is completed there are a number of steps that can be undertaken to try and return patency to the airway.



Is Cervical spine control is impacting on airway management? Collars will impact on airway management and control of airway is allways more important than cervical-spine (c-spine).

A

POSITIONING

The first step is to consider simple positioning of the patient.

The ‘Sniffing position’

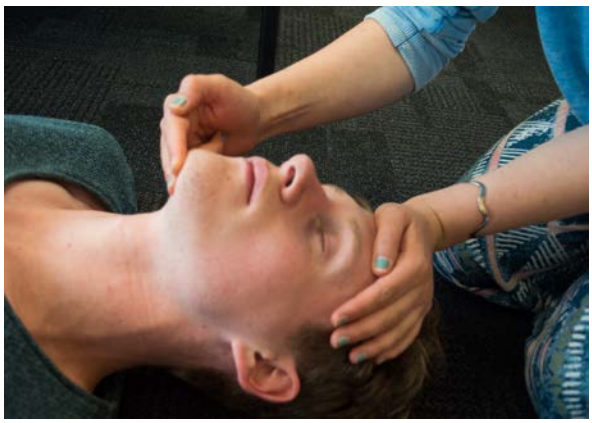
The patient is placed on their back with flexion of the neck on the body and extension of the head on the neck to position the ear in line with the sternal notch. This can be achieved by placing a pillow or rolled clothes under the patients head.

We have talked about the patients positioning, but positioning of the responder is important too. Airway control should be conducted from behind the patient, unless the situation makes this impossible or unsafe, and should be in a position that is comfortable for you as in most cases you will be there for a prolonged amount of time.

POSITIONING

These are the first steps on the airway ladder, and are undertaken if the patient cannot **maintain, and subsequently protect their airway.**

HEAD TILT CHIN LIFT OR **JAW THRUST (C-spine injury is suspected)**



Patient Positioning is important, but so is your positioning
How long do you think you could maintain a jaw thrust?
Pre-hospital care is about resource management, where yourself and your team are the most important resource available.
How can you maintain an airway manoeuvre for as long as possible?

'Most pre-hospital airways are NOT difficult'

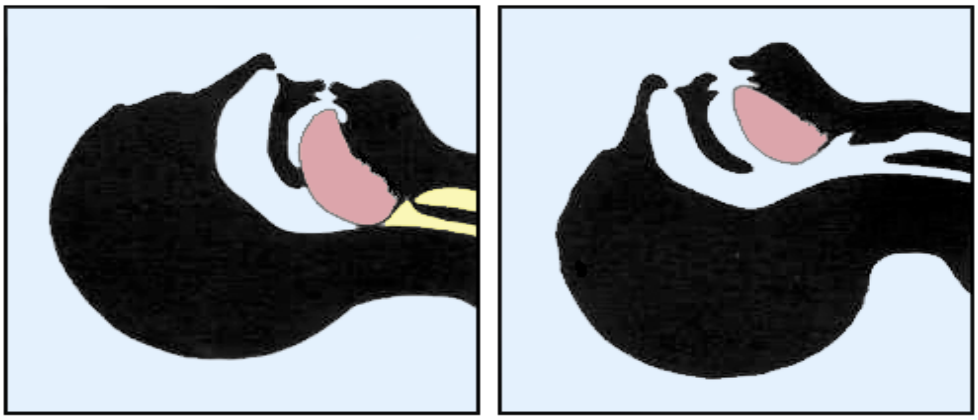
A

HEAD TILT-CHIN LIFT

The head tilt-chin lift is the first manoeuvre to attempt if the patient is not able to maintain or protect their airway. This is a simple manoeuvre yet it has been shown to be highly effective. Guildner[1], in a study published 1976, showed 28 out of 30 patients were adequately ventilated through a chin lift alone with 2 patients requiring an oropharyngeal airway insertion.

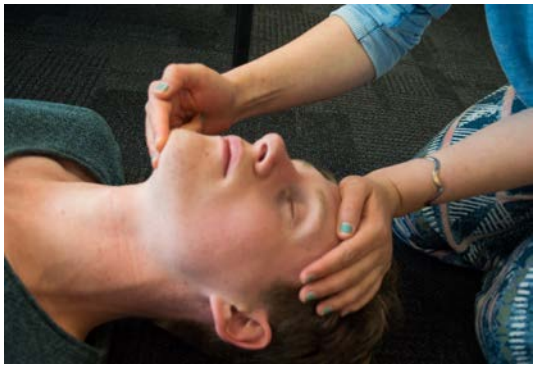
How does it work?

It is suggested[2] that the anterior displacement of the hyoid bone is key in restoring airway patency, and that this is achieved by a head tilt-chin lift.
The image below shows how the airway obstruction formed by the epiglottis and tongue base, can be relieved by the simple head tilt-chin lift.



How to conduct a head tilt and chin lift?[6]

1. The hand is placed on the forehead with the head gently tilted backwards
2. Two fingers are placed under the patients chin which is lifted to stretch the neck structures



JAW THRUST

The Jaw thrust manoeuvre (JTM), or the Essmarch-Heiberg manoeuvre, was first described over a century ago and is still used as a primary method for airway intervention.
This is an alternative to the head tilt-chin lift manoeuvre. This moves the mandible forward relieving the obstruction of the soft palate and epiglottis. Endoscopic studies[3] have been used to show the effectiveness of a JTM showing that the JTM used in isolation can significantly improve obstructed airways in anaesthetised patients.

When do we use it?

The JTM is used instead of the head tilt-chin lift in situations where you suspect a cervical spine (c-spine) injury.

Cadaveric studies[7] showed a significant decrease, roughly half, in the amount of angular motion in unstable C1-C2 injury performing a jaw thrust as opposed to a head tilt-chin lift. This was statistically significant for both axial and anteroposterior translation of the cervical spine therefore suggesting decreased risk to c-spine stability.

How do conduct a Jaw thrust[6]

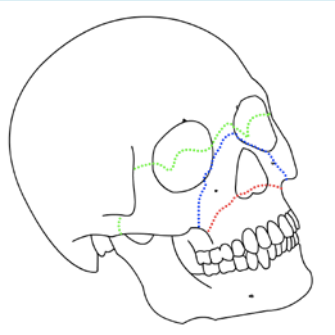
1. Fingers placed behind the angle of the mandible
2. Pressure upwards and forwards
3. Mouth opened by downward displacement of the chin

After these have been performed it is important to return and reassess. If there remain still any concerns over the patient's airway, then more definitive management may be called for.

Handing over the airway

When in a pre-hospital environment it could be a long time before support arrives, therefore there could well be a need to handover control of the airway to allow rotation of roles.

We have already looked at patient positioning, with the sniffing position being preferred, but what if the patient has received a blow to the face resulting in a Le Fort fracture?



This would cause the airway to collapse if the patient is lying on their back.
How would this impact on positioning?
How could you adapt your practice?

AIRWAY DEVICES AND PROCEEDURES

'Practice the sequence, practice with the kit. The key to excelling in the pre-hospital environment is to be the master of your equipment and have thought through exactly how to use it in the moment. Have an algorithm and don't deviate unless you have to.'

SUCTION

Oropharyngeal and nasopharyngeal suction is performed by the introduction of a catheter into the airway to remove obstructions from a variety sources including vomiting, bleeding, secretions or water and to ensure a patent airway.
This will rely on the provision of a suction unit, which can be handheld and battery operated, or in an ambulance and fixed.

This should be conducted with direct visualisation of the obstruction. Patient positioning is important as gravity can either help with drainage, or conversely encourage blockage. If possible position the patient on their side, as gravity will help the drainage. The size of catheter used will depend on the obstruction, vomit or blood will require a larger bore compared to saliva
Suctioning should not occur for over 15 seconds continuously due to the associated risk of hypoxia.[8]

Indications

- Audible secretion such as gurgling
- Noisy crackles suggestive of secretions
- Ineffective cough with a physiological deterioration in the patient

MAGILL FORCEPS

These are hand held twin-bladed forceps with an oblique angle between the handles and blades to prevent obstruction of the operators view. They are used to remove foreign bodies from the airway and aid delivery of endotracheal or gastric tubes. They are best used with a laryngoscope to give the best view of the larynx and surrounding soft tissues.

Following simple airway measures you may still be required to insert a simple airway adjunct. They are indicated if manual methods fail to maintain airway patency.

OROPHARNGEAL AIRWAYS

An oropharyngeal airway is inserted to prevent the tongue from covering the epiglottis maintaining the patency of the airway. They are indicated only in unconscious patients, due to the gag reflex leading to vomiting or laryngospasm, possibly compromising the airway further.
Contraindications include mandibular fractures, major oral trauma and trismus (due to the fact you cannot physically insert the airway).[9]

Sizing of a Guedel

To select the correct size of Guedel you measure with the flange at the front teeth and the tip should reach the angle of the mandible. Sizing is important; as if the adjunct is too large there is a risk of closing the glottis or damage to local structures.

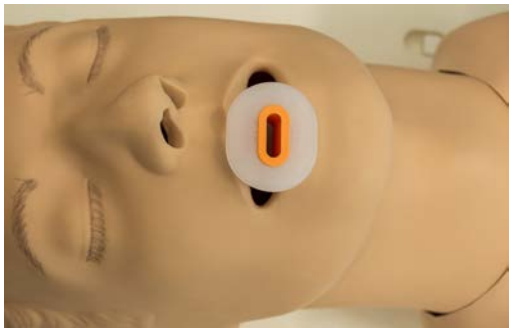
Insertion of a Guedel

Adult

1. This is firstly inserted with the concave pointing upwards

2. The airway is then rotated through 180° on insertion

3. The airway is then fully inserted until the flange is flush with the mouth



Children

This is inserted directly, with no rotation. Gentle displacement of the tongue, either with the blade of a laryngoscope or with a tongue depressor can help with positioning.

NASOPHARYNGEAL AIRWAY (NPA)

This is an airway adjunct used in patients with an intact gag reflex, therefore indicated in those who are not deeply unconscious. They are also used when an oropharyngeal is not suitable, such as mandibular fractures, major oral trauma and trismus.[9]

A NPA creates a conduit between the nose and the nasopharynx, bypassing any obstruction at the level of the nose or base of the tongue. It lies just above the epiglottis and prevents the tongue from falling back onto the posterior pharyngeal wall.

Bleeding is fairly common, occurring in 30% of cases.[10]

Sizing

The ideal length[9] lies within 1cm of the epiglottis, the same study also showed that the traditional method of sizing against the patients little finger is unreliable and has poor correlation with the size needed being reliant on the patients height. Average height females require a size 6 Portex, and average height males require a Portex size 7.[9]

Sizing is important. If too long it may stimulate the laryngeal or glossopharyngeal reflexes producing a spasm or vomiting. It can also enter the space between the epiglottis and the tongue causing obstruction. If too short the airway would not be able to separate the soft palate from the posterior pharyngeal wall.

'If the patient needs an NPA, they need two NPA's'

Use with a basal skull fracture

There have been two published single case reports[11, 12] of intracerebral NPA placement leading to it being taught that a basal skull fracture is a contraindication to insertion of an NPA. This, however, was challenged by Roberts et al[9] in the Emergency Medical Journal who encouraged a case by case approach to NPA insertion in basal skull fractures and stated:

'This contraindication needs to be interpreted in the appropriate setting: faced with airway obstruction and the possibility of a basal skull fracture a rescuer must secure the airway prior to any further management'
In reply to this Ellis et al[13] published a further case study on intracerebral placement and questioned the idea that the placement is 'very infrequent', saying: '*but how many instances of intracerebral NPA placement occur but are not published?'*

An International Liaison committee on Resuscitation[10] therefore recommends that if there is the confirmed or suspected basal skull fracture then an oral airway is preferred, however if this is not possible the potential benefits of a gentle insertion of a nasopharyngeal tube outweigh the risks.

It does, however, remain important to note the risks involved with NPA in a basal skull fracture, and to attempt other airways if possible.

How to insert a NPA

1. Select the correct size of NPA, the association with height allows rapid selection:
- Male – small 6, average 7, tall 8
- Female – small 6 with a safety pin 1 cm from the flange, average 6, tall 7.[9]
2. Lubricate the NPA
3. Insert with the bevel towards the septum, advancing straight forward following the floor of the nose

SUPRAGLOTTIC AIRWAY DEVICES

Supraglottic airway (SGA) devices are commonly used during surgery and in the pre-hospital environment. There are numerous different types of supraglottic device. The following are the most commonly used and evaluated supraglottic devices, but there are many more.

I-gel

The i-gel is the most commonly used SGA device consisting of a soft non-inflatable cuff made out of a gel-like substance to give a tight seal around the laryngeal inlet. The gel design means that no inflation is necessary potentially speeding up the process of insertion and causing decreased compression and trauma in the airway.

Laryngeal Mask Airway (LMA)

The LMA consists of a wide bore tube with an inflated cuff. It is designed to form a seal around the laryngeal opening. This is much easier to insert compared to endotracheal intubation, with failure rates in intubations shown to be around 14% in a meta-analysis of pre-hospital airway control.[14] LMA applied successfully in 100% of cases by paramedics used predominantly for CPR, multiple trauma and neurological disorders.[15]

It is used as an alternative to endotracheal intubation due to the failure rates associated with intubation, and studies have shown it to be both safe and effective.

ProSeal Laryngeal Mask

This is a laryngeal mask device with an inflated cuff to improve the seal as compared to the standard LMA. There is a drainage tube to allow passage for regurgitated fluid or to allow placement of a gastric tube. Randomised control trials have shown insertion success rates were lower then the LMA, however, the seal gained was more effective.

Laryngeal Tube (with or without integrated suction tube)

There are multiple variations of the laryngeal tube, some with a suction tube and some without. The standard tube consists of an airway tube with a distal and a proximal cuff that is located in the middle of the tube. The device is inserted until the teeth are in line with the black line on the device and the cuffs are inflated.

Studies have found the ease of insertion to be similar between the LMA and the laryngeal tube with a possible, but potentially not clinically relevant, improvement in seal as compared to the classic laryngeal mask airway.[16]

Oesophageal Tracheal Combitube

This is a supraglottic device that several guidelines including the European Resuscitation Council and the American Heart Association have listed as a primary device for use in 'cannot intubate' situations. It is a two-barrelled device that can be placed in the trachea or oesophagus. It isolates the oesophagus from the trachea, minimalizing aspiration risk and has minimal c-spine movement on insertion. The combitube can be placed blindly, meaning direct laryngoscopy is not needed and has been shown to be as effective during resuscitation as an endotracheal airway.[17] It has however been shown to have higher incidence of complications including sore throat, hoarseness and haematoma, as compared to the LMA.[18]

DEFINITIVE AIRWAYS

'No/Few patients suffer from lack of intubation - but a lack of ventilation/oxygenation'

There are two main varieties of definitive airway:

- Intubation via orotracheal or nasotracheal tube
- Surgical airway, including cricothyrotomy or tracheostomy.

If LMA, oropharyngeal or pharyngeal airway device has not maintained the airway then move onto provision of a definitive airway

The provision of a definitive airway requires the equipment, training and competence, beyond that expected from an undergraduate. What follows is a brief look at indications for a definitive airway and the different types you may encounter.

Indications for definitive airway[19]

1. Presence of apnea
2. Need for airway protection from aspiration: vomitus, bleeding.
3. Unconsciousness: Glasgow Coma Scale (GCS) <8*
4. Severe faciomaxillary fractures
5. Risk for obstruction: neck haematoma, laryngeal/tracheal injury
6. Impending or potential airway compromise: upper airway burn

Do we need a definitive airway with a GCS <8?

It has been long taught in various settings that patients should be intubated with a GCS of less than 8. This is due to the idea that at this level, patients are at increased risk of aspiration and due to absent cough and gag reflexes, are not able to maintain their own airway, leading to respiratory compromise. There is no doubt that the patient with a very low GCS score needs airway support when they are unable to protect their own airway, however evidence is not as clear about the relationship between GCS and the ability to protect the airway.

A study conducted in 1991[20] showed the gag reflex was increasing likely to be depressed with a GCS of less then 8. They did however show that the reflex was sometimes not suppressed in some patients below 8, and sometimes absent in levels above 8. It was also found that cough reflexes were present in patients with a GCS of less than 8.

A later study[21] found that the percentage of patients with intact gag reflexes was significantly lower below a GCS of 8. However there were patients, 34% of those with a GCS less than or equal to 8, in which the gag reflex was present and normal. They found that 50% of patients with a GCS of between 9-14 had absent or attenuated reflexes, and would require intubation. This study confirmed the presence of gag reflexes in certain patients with a GCS of below 8 and suggested that these would be 'safely managed without intubation' and, due to the risks of intubation, that it 'may therefore be inappropriate to perform intubation based solely on the basis of 'GCS ≤ 8'.

Due to the current presence of criteria for intubation with a GCS of less then 8 in trauma, it makes conducting a study in this population difficult. Therefore, looking at the poisoned patient population, where no such criteria are present but who often have low GCS scores, allows investigation into the incidence of aspiration and requirement of intubation in patients with low GCS scores. A study looking at exactly this[22] found that it was safe to observe and not intubate patients even with a GCS of less then 8. There were no cases, during the study, of aspiration or need to intubate in the twelve patients who presented with a GCS of less then 8.

In conclusion, the old mantra of 'less then 8 intubate' does not seem to ring true. The incidence of absent gag reflexes did increase with a lower GCS, yet significant percentages of patients were shown to have intact gag and cough reflexes, retaining the ability to maintain their own airway. In these patients it would therefore be inappropriate to intubate. The current evidence suggests intubation should be considered in patients with a low GCS, yet only used with significant airway compromise. This should not, however, be an automatic procedure in patients with a GCS of less than 8.

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'GCS 8 is NOT the determining factor for intubation, [there are] MANY other factors'

INTUBATION

Endotracheal intubation is the insertion of a cuffed tube into the trachea to maintain airway patency. The tube can then be connected to a form of artificial ventilation allowing maintenance and protection of the patients' airway and freeing the rescuers hands to continue with further tasks.

There are two main forms of intubation used during trauma life support, the orotracheal and nasotracheal. Nasotracheal intubation however is not a regular UK practice and not performed on scene, being conducted in hospitals and retrieval cases. Intubation is the insertion of a definitive airway, however, it does carry a failure rate when conducted in both the pre-hospital environment and hospital environment[23] meaning a supraglottic device may be preferred.

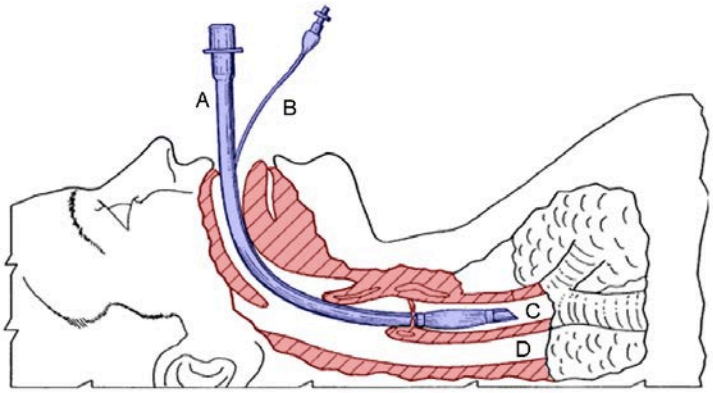
OROTRACHEAL INTUBATION

This is insertion of a tube through the mouth to the trachea; and is performed only by trained individuals in the pre-hospital environment.

Contraindications and Complications

Instability in the c-spine is not an absolute contraindication to the procedure though strict in-line stabilisation is necessary. This is due to increased motion, specifically extension[24] of the c-spine during the procedure, which has been shown in cadaveric studies.

The major complication associated is misplacement leading to oesophageal intubation and therefore not forming an airway, leading to hypoxia. Intubation can also provoke vomiting and aspiration, lead to laryngospasm, bronchospasm and trauma to local structures.[25]



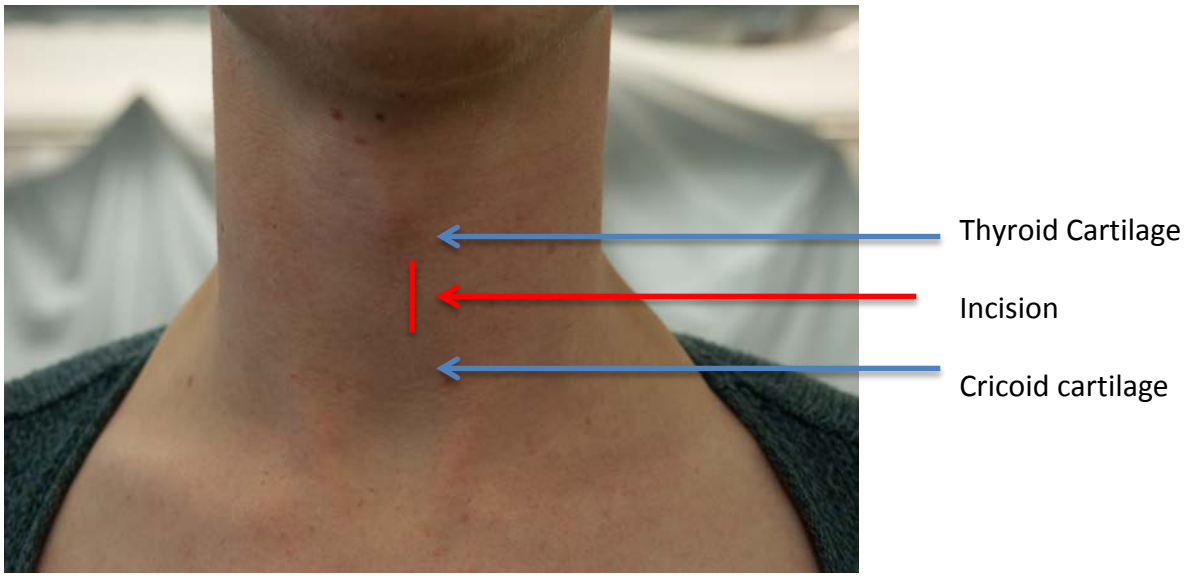
SURGICAL AIRWAYS - CRICOTHYROTOMY

This is performed by a qualified clinician in the pre-hospital or hospital environment. It is undertaken when intubation is not viable or the airway is not maintained via intubation and is considered quicker and easier then tracheostomy.

An incision is made through the cricothyroid membrane and a tube is then inserted to establish a patent airway.

Contraindications and complications

Acute complications, including haemorrhage, misplacement and damage to local structures are noted in 15% of cases.[26] Cricothyrotomy is not appropriate in children under 12 years old.



A needle cricothyrotomy can be used in a pre-hospital scenario using an 18-guage needle inserted through the cricothyroid membrane. This, however, only serves as a temporary airway and allows for 15-20 minutes of oxygenation before conversion to a cricothyrotomy or tracheotomy.[26]

For more information there are some excellent web resources available on this subject:

- https://vimeo.com/123573243 The Emergency Surgical Airway by Scott Weingart.
- https://vimeo.com/19132289 Open Cricothyrotomy by Scott Weingart
- http://www.acepnow.com/article/tips-tricks-performing-cricothyrotomy/ Tips and Tricks on performin cricothyrotomy by Richard Levitan
- http://emcrit.org/podcasts/levitan-surgical-airway/ Richard Levitan on the Surgical Airway

A

CHOKING

Choking is a scenario where all students should be aware of the signs, symptoms and management. This guidance is taken from the British Resuscitation Councils Advanced Life Support guidelines.[27]

General signs of choking	
• Occurs when eating • Patient clutching at neck	
SEVERE	MILD
'Are you choking?' • Unable to speak • Respond by nodding	*'Are you choking?'* • Speaks and answers yes
• Unable to breathe • Wheeze • Silent cough • unconscious	• able to speak, cough and breathe

Management

Adult

<u>Mild</u>

- Encourage coughing but no other action necessary

<u>Severe</u>

Give 5 back blows

Stand to the side and behind the patient. Lean the patient forward and give 5 sharp blows, with the heel of the hand, at the midpoint between the scapulae.
Check after each blow to see if the obstruction has passed.

Give 5 abdominal thrusts - If the back blows have failed to resolve the obstruction

When standing behind the patient place both arms around the upper part of the abdomen, place clenched fist under the xiphisternum and grasp with the other hand, pulling inward and upwards.

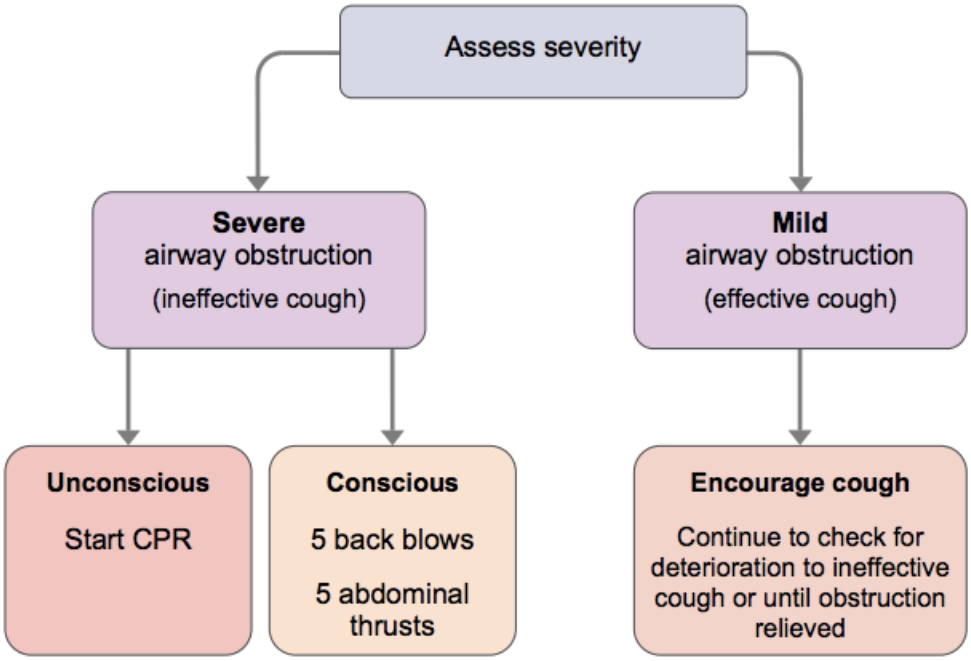
If the obstruction is not relieved continue with alternate 5 back blows and 5 abdominal thrusts for three cycles then phone an ambulance

If at any point the patient becomes unconscious begin CPR. If a team member with the appropriate skills and equipment is available, undertake laryngoscopy and removal of the foreign body.

2010 Resuscitation Guidelines

Resuscitation Council (UK)

Adult Choking Treatment Algorithm



Children and infants

Choking is common in infants and children, the overall management is similar to that in an adult, however abdominal thrusts are not advised in infants, due to the relative increased size and decreased protection of the liver and spleen.

Infant (under 1 year)[28]

1. Give up to five back blows firmly on the back while holding the baby face down along your thigh with the babies' head lower then the bottom.

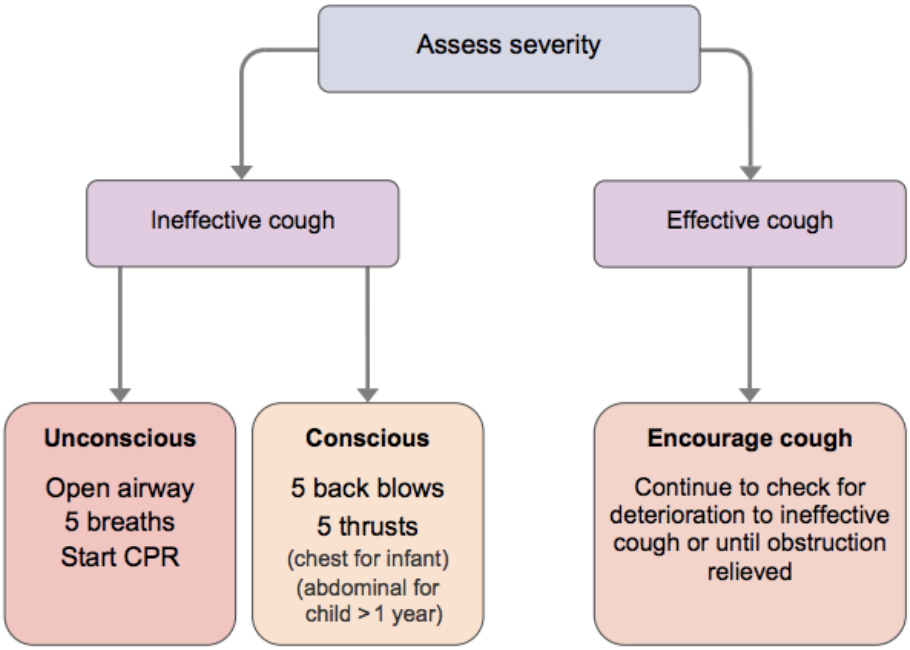
2. Give up to five chest thrusts, turning the baby over and placing two fingers on the sternum pushing inwards and upwards

3. If this does not dislodge the object repeat steps one and two, phoning for an ambulance after three cycles.

2010 Resuscitation Guidelines

Resuscitation Council (UK)

Paediatric Choking Treatment Algorithm



CERVICAL SPINE

Assessment

The cervical-spine (c-spine) consists of the first seven vertebrae of the vertebral column. It is at increased risk of injury during trauma due to high mobility in flexion, extension and rotation. The overall prevalence of c-spine injuries in all trauma patients, not classified by severity, is rare at an overall prevalence of 3.7%, this percentage rising to 7.7% in those patients unable to be adequately assessed at scene due to issues such as reduced consciousness and distracting injuries.[29]

Although c-spine injuries may not occur in the majority of patients, it is still important to have a high index of suspicion when dealing with suspected c-spine injuries. When they do occur they can have devastating implications for both quality of life and survival. It is currently best practice to immobilise the c-spine if there is a strong mechanism of injury and/or abnormal clinical findings until definitive radiological imaging can be undertaken. The severe consequences of a mismanaged c-spine injury also emphasise the necessity of health care workers having an awareness and understanding of c-spine injuries in trauma patients.[30]

There is a risk of secondary injury to the c-spine during the primary survey, packaging and transportation. Immobilisation of the c-spine is thought to prevent such an injury.

Although the necessity of this is debated, Hauswald's biomechanics states that the initial injury to the c-spine is caused by greater forces than could be applied doing any proceeding movements. They also suggest that if the patient is alert they will find a position of comfort, and that muscle spasms will prevent any damaging movements of the spine and that these are superior to that provided by intervention.[31] A review later made the conclusion that alert and cooperating patients did not require c-spine control even with a high index of suspicion.[32]

When should c-spine be immobilised?[33]

In a pre-hospital care setting it is common practice for blanket immobilisation. For this there are two main sets of rules that are used to guide c-spine injury suspicion and immobilisation, these are the NEXUS criteria and the Canadian C-Spine Rule (CCSR). They are both highly sensitive but use a different combination of risk factors to assess the c-spine. NEXUS criteria focus more on low risk criteria to exclude injury, whereas CCSR[34] looks at both high and low risk factors.

NEXUS Criteria:

- No midline tenderness
- No focal neurological deficit
- No loss of consciousness IHIH
- No intoxication
- No painful distracting injury

CCSR:

- High risk factors (>65 years old, paraesthesia, mechanism of injury)
- Low risk factors (absence spinal tenderness)

  Neck rotation through 45

Management Considerations

Cervical spine (C-spine) assessment is encompassed with airway management although emphasis must be placed on effective airway management. If it is impossible to maintain c-spine and airway control, airway should take priority.[35]

Current clinical practice is to assume c-spine injury in any trauma patient with a mechanism of injury or clinical findings associated with such an injury. However, it is expected that practice may change to selective immobilisation in order to prevent unnecessary immobilisation, as it is estimated that around 50 -100 patients have their neck immobilised for every actual c-spine injury.[33]

The standard initial management of the cervical spine is by manual inline stabilisation of the head and neck in a neutral alignment, which aims to prevent the patient from moving their head. This is achieved by holding the both sides of the patient's head with the neck in the midline.[36]

Although manual inline immobilisation is common practice, there is debate about the necessity of the practice as most of the guidance is mainly from expert opinion rather than scientific evidence. A recent review stated there was little high-level evidence on immobilisation versus none immobilising of the c-spine, and a need for larger prospective studies is required.[37, 38]

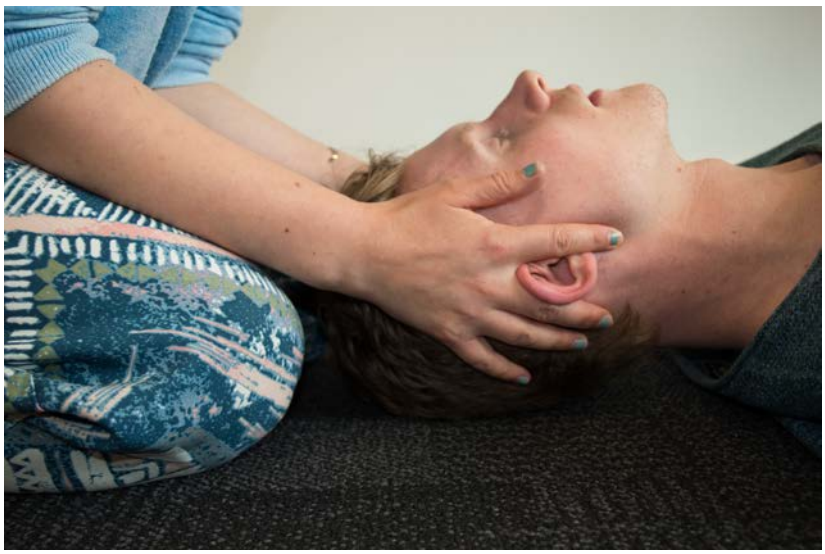
MANUAL INLINE STABILISATION

For pre-hospital scenarios manual inline stabilisation is usually the best method of c-spine stabilisation, a collar does not replace the need for stabilisation and may have a significant impact on the airway.

Manual Inline stabilisation (MIS) is the initial step in c-spine control and provides a degree of stability before triple immobilisation can be carried out. It allows continued c-spine protection during packaging, extrication and transport of the patient and can be carried out from various positions: sitting, lying down or standing up depending on the position of the patient. The key is to stabilise your elbows on either the ground if lying down or knees if sitting up. This prevents arm movement by the responder when fatigue sets in.

The patients head should be supported by two hands or both knees (using your knees is sometimes a handy method when there are limited responders as it frees your hands to auscultate the chest for example). While placing your hands against the side of the patient's head it is useful to note to splay your fingers to prevent you from covering the patients' ears. This means that if the patient is alert they can hear instructions and information the responders may be telling them.

A large advantage for manual inline stabilisation is that the person at the head is not just maintaining c-spin control. They can maintain the airway, monitor consciousness and maintain rapport with the patient. This allows the patient to be kept informed of what is happening helping relax them. The responder can also instantly notice if there is any change to the patient, such as increased pain, helping guide the clinical management.



A

It is expected that after a while tiredness will set in and someone else may take over control of the c-spine. For this handover clear and effective communication using specific, unambiguous vocabulary is essential. For example:
Challenge: “You have control”
Response: “I have control”

CERVICAL COLLARS

The neck collar is designed to aid MIS and prevent excessive movement of the head. It is important to remember that the collar is not a replacement for MIS and the neck collar alone does not fully immobilise or protect the c-spine. It is used as an adjunct to other immobilisation techniques.

How to size:

- Neutral alignment
- Imaginary horizontal line from the base of the mandible to the angle of the trapezius
- Measure the number of fingers distance between
- Size **your** fingers against the collar (different people have different hand sizes therefore three fingers on one person is most likely different to three fingers on another person). Place the number of fingers you previously measured from the bottom of the plastic to the red sizing dot. Then push to lock.

Issues around cervical collars

Even though cervical collars have been a part of prehospital care for a long time alongside their frequent inclusion in Advanced Trauma Life Support (ATLS) and prehospital care guidelines, there has been growing opposition to their use, mainly due to limited evidence supporting their benefit.

The collars main function was to immobilise the c-spine and therefore prevent secondary injury to the spinal cord. But the ability of the cervical collar to prevent c-spine movement in trauma patients has not actually been assessed. Regarding the practicalities of using a cervical collar, it has to be noted that an incorrectly sized and fitted collar can do the same if not more damage than lack of immobilisation.[39]

Health care workers fear of the c-spine injury and the label that accompanies the cervical collar may actually deter them from carrying out essential assessment and management of a patient. If a collar is used for a long enough period of time the issue of pressure ulcers is also raised.[40]

TRIPLE IMMOBILISATION

The c-spine is not described as secure until either MIS or triple immobilisation has been carried out. MIS can be removed when the patient is fully immobilised by triple immobilization: hard collar, head blocks and tape. Some services, however, do not use all three and may only apply a collar or head blocks and tape.

How about if the patient is lying on their front? For effective inline stabilisation and full assessment a log roll may need to be performed. For this there are two methods that could be used.

It's late at night; you are driving back from Aberdeen to Inverness for your placement. You see some tire marks on the road and pull the car into the side. In the trees beside the road you can see a car which is upside down and twisted out of shape.

- *What scene safety issues could you encounter?*

After a complete safety assessment and phoning for help, you approach the scene. A fellow road user has stopped and is offering to help; he has basic first aid training but has not applied this for many years. You get to the car and can see a middle-aged female, trapped inside. She is unresponsive, loudly snoring and smelling of alcohol, there is no sign of catastrophic haemorrhage.

- *What would your initial approach be?*
- *What is the significance of snoring?*
- *How could you best utilize your help?*
- *How would you wish to manage the airway?*
- *What problems could be faced with managing the airway in this trapped patient?*
- *Is there anything else you may be considering at the scene?*

You manage to secure the c-spine and administer an adequate jaw thrust, but to do so you are in an incredibly uncomfortable position and are quickly tiring.

- *How could you best use your help?*

The ambulance has still not arrived; you get a strong smell of petrol that you then see leaking out of the car. You cannot free the patient.

- *What are your thoughts at this time?*
- *At what point would you be considering a withdrawal from the scene?*

A

Managing an airway in a patient lying supine is one thing; when they are upside down and trapped it's an entirely different scenario. Being able to get an adequate jaw thrust may be nigh on impossible in this situation.

In initial presentation the patient is snoring, this could be a sign of severe airway compromise, or is the patient inebriated? Is it the patient who smells of alcohol, or has a wine bottle exploded in the car? These are questions you have got ask yourself at the scene.

Then the situation changes; the sight and smell of petrol may not be enough to prompt a withdrawal from the scene, but if you suspect that there is a serious risk to you or your assistance then this might be what you have to do.

A dynamic risk assessment will be constantly changing and adapting, you must be aware of the changes and act appropriately. This will throw up some difficult decisions but these are what can be faced in pre-hospital care.

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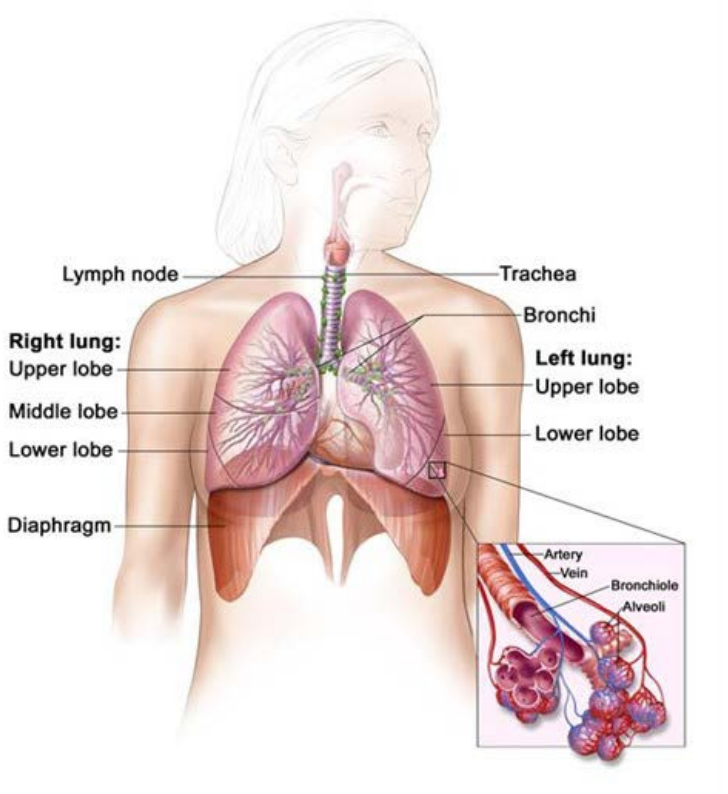
Breathing

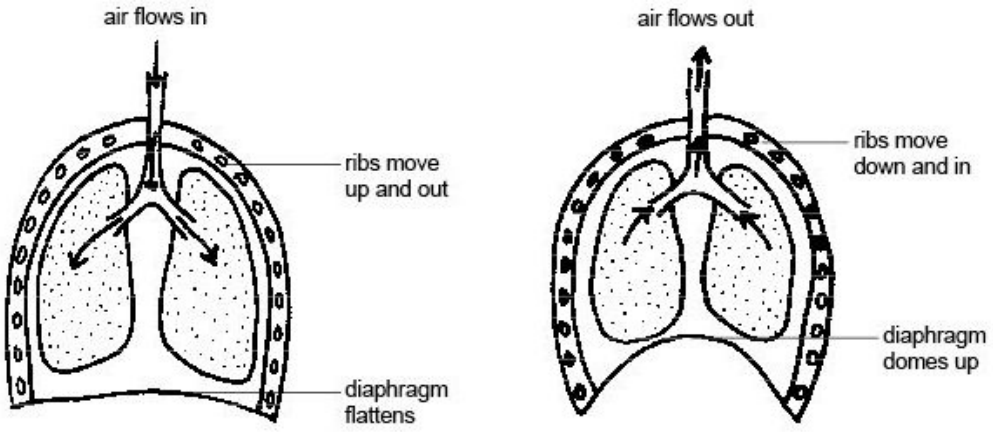
B

ESSENTIAL ANATOMY

An awareness of the basic anatomy of the thorax, lungs and bony landmarks are essential when doing physical examination for breathing.



PHYSIOLOGY



ASSESSMENT

Below are the guidelines provided by the Resuscitation Council (UK) on how to assess breathing:

1. Signs of **respiratory distress**
   - Central cyanosis
   - Inability to complete full sentences
   - Use of accessory muscles to breathe
   - Reduced consciousness
2. What is the **respiratory rate?** (normal range 12-20 breaths per minute)[1]
3. Assess the **depth** of each breath. Is there effective breathing – a good enough rate and volume of air being inhaled and exhaled?
4. **Inspection** - exposure the chest (maintaining patient dignity and accounting for risk of exposure in cold environments). Inspection for bruising, wounds, asymmetrical movement, depth of breathing and any obvious flail chest.
5. **I**f pulse oximetry is available – note reading of inspired oxygen concentration (It's important to note that this does not measure hypercapnia, and should be used with caution in the assessment of burns injuries were inhalational carbon monoxide can give false readings).
6. **Look, listen and feel for breath sounds** by placing your ear to the patient's mouth and your face watching for the rise and fall of the chest on inspiration and expirations. Any abnormal breath sounds? (see airway: signs of airway obstruction)
7. **Percussion** of the chest: Hyper-resonant – pneumothorax, dullness – pleural effusion.
8. **Auscultation** – are there any breath sounds? – bronchial breathing (consolidation), absent (pneumothorax/ effusion). Pre-hospital situations can often be noisy and distracting, this makes it increasingly difficult to use a stethoscope often to the point where the practitioner cannot hear if breath sounds are present or not.
9. **Tracheal position** – This is not a very specific or sensitive sign for a tension pneumothorax. If present it is worth noting however a tension is diagnosed on suspicion of a pneumothorax with circulatory collapse
10. **Palpation** – crepitus, emphysema, tenderness, rib fractures, blood, paradoxical chest movements, chest expansion (equal on both sides?). Is there any surgical emphysema or crepitus (suggestive of pneumothorax until proven otherwise).

'Don't ask how the breathing is, or whether it feels heavy, ask 'does it feel different from normal?''

To summarise the basic assessment of breathing the acronym **RIPPA** can be used.

ASSESSMENT OF BREATHING[1]	
Respiratory Rate	Normal range 12-20 breaths per minute
Inspection	Exposure the chest (maintaining patient dignity and accounting for risk of exposure in cold environments). Look for chest deformity, raised JVP, assess work of breathing, use of accessory muscles, tracheal position
Palpation	Is there any surgical emphysema or crepitus (suggestive of pneumothorax until proven otherwise)
Percussion	Hyper-resonant ~pneumothorax Dullness ~ pleural effusion
Auscultation	Bronchial breathing ~ consolidation Absent ~ pneumothorax

'A patient who states his/her breathing feels different then normal will have thoracic injuries until proven otherwise'

MANAGEMENT

This section details the different methods of breathing management.

'The patient pulling off the oxygen mask saying they can't breathe is about to arrest'

OXYGEN THERAPY

Oxygen therapy given in pre-hospital care is subjective. High flow oxygen therapy has been a feature of pre-hospital care for a long time. Oxygen is sometimes given blindly, without indication and without knowing the exact oxygen concentration being delivered to the patient. This can lead to the patient receiving excess oxygen in turn leading to hyperoxia and the adverse effects of this.

Indications

1. To correct hypoxaemia
2. To prevent hypoxaemia in those who are unwell

How does Oxygen therapy work?

Oxygen is delivered to the patient by various devices, most commonly a Hudson mask, at a set concentration. This concentration of oxygen is normally higher than that of air, and so is transferred across the alveoli, saturating haemoglobin at a faster rate. This is important when haemoglobin is travelling past the alveoli at higher velocities, or gas transfer is reduced.[1]

Why is oxygen therapy important?

Hypoxia describes when there is an inadequate supply of oxygen to the body's tissues, whereas hypoxaemia describes low oxygen concentration in the blood. The primary organs to be affected by the lack of oxygen are the kidneys, heart and brain.

Oxygen therapy is used to treat and prevent the consequences of hypoxaemia. If the amount of oxygen circulating around the body dramatically falls, even for a short space of time, the effects of tissue hypoxia set in. The brain is particularly susceptible to hypoxia. It has been shown that sudden falls in arterial oxygen concentration, to less than 80% can cause impaired consciousness[2] in healthy patients. In patients who are critically ill, even the slightest drop in oxygen concentrations can have devastating implications. One study found that 65% of patients with traumatic brain injury sustained a secondary insult because of hypoxia.[3]

How much Oxygen?

Oxygen therapy should be tailored to the individual's pulse oximetry reading, and when available, their blood gases. High flow oxygen is usually the mainstay of treatment before the patient reaches hospital and is delivered via mask with an oxygen reservoir, delivering 85% oxygen concentration and a flow rate of 10-15 L/min.[4]

Should high flow oxygen be used in everyone?

Concerns exist over the excessive use of oxygen towards the dangers of hyperaemia. This is particularly the case in Chronic Obstructive Pulmonary Disease (COPD). In patients with COPD, receiving excessive oxygen could be detrimental to their recovery. In this patient group it has been shown that titrated oxygen therapy reduced the risk of; death, hypercapnia, and respiratory acidosis compared to high flow oxygen. It found that 9% died (21 deaths) who received high flow oxygen, while 4% (7 deaths) died when using titrated oxygen.[5] This has been supported by previous studies[6,7] where high-flow oxygen was associated with respiratory acidosis and poorer patient outcomes.

The British Thoracic Society states that emergency oxygen should be given to maintain oxygen saturations of 94-98% in those acutely unwell, with an exception for patients at risk of hypercapnic respiratory failure i.e. those with COPD, where saturations should be between 88-92%.[2]

Hyperoxia – how does it affect the body?

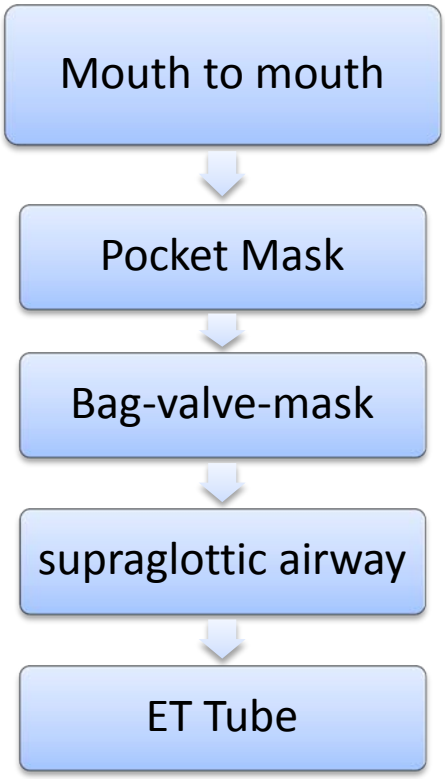
The most significant adverse effect of hyperoxia is to the cardiovascular system; increasing vascular resistance and blood pressure, decreasing cardiac output and therefore decreasing tissue perfusion.[8]

Under normal conditions, a study showed that it took 4-22 hours to produce preliminary signs of lung toxicity during oxygen therapy.[9] Even though hyperoxia has adverse side effects to the body, the insult from hypoxia has much greater implications on the body and therefore high flow oxygen should be given initially. If the clinical picture suggests high flow concentration will hinder their management then titration can be used.

DEVICES

Management of breathing can be done using varying devices, which will be discussed in this section.

- Mouth to mouth/mouth to nose
  - +/- face shield
- Pocket mask
- Bag–valve–mask (BVM)
- Bag + either:
  - Supraglottic airway
  - ET Tube



For those who are unable to effectively ventilate themselves, or are unable to adequately oxygenate, intervention is required. This can range from simple mouth to mask ventilation to a definitive airway such as an endotracheal (ET) tube. The initial management is to use mouth to mask ventilation, although this is an easy and important step it is not as effective as other more invasive ventilation only delivering around 16-17% oxygen. Although it is better than giving no ventilation at all, it is important to move to a better ventilating technique as soon as available and appropriate.

Bodily fluids such as blood and vomit in the airway can make the responder reluctant to ventilate.[10] To overcome this problem a pocket face shield is widely used which protects the user from exposure to fluids, by the use of a one-way valve.

MOUTH TO MOUTH

Mouth-to-mouth ventilation (MMV) during CPR is a controversial issue. The benefit of MMV compared to CPR can be small in terms of survival. One study showed that 16% of patients survived with CPR and MMV, compared to 15% of patients who had just CPR. MMV also has considerable side-effects. Aspiration occurs in 10-35% of patients due to gastric inflation, leading to pneumonitis, acute respiratory distress syndrome and possibly death.

The main concern however is risk of infection to responders, with 50% of physicians refusing to perform MMV on a stranger.[11] There is a risk to responders of acquiring virtually any infection during MMV. Cases of tuberculosis, Neisseria meningitidis, Herpes simplex, Helicobacter pylori, Shigella sonnei and Salmonella infantis have been previously documented.[12] Yet despite the high number of potentially infectious agents there have been only isolated incidents of responders actually acquiring infection

The resuscitation council recommend that rescue breaths be given to a patient, but allowance has been given to rescuers who do not wish to preform ventilation and guidelines can be adapted for these situations.[1]

POCKET MASK

The pocket mask is a small mask that is a simple way of ventilating the patient. It is used widely because of its small size allowing it to be easily carried around. The pocket mask protects the responder from bodily fluids including vomit and blood. The presence of a one way valve prevents expired air being breathed in by the responder and its transparent nature allows visualisation of bodily fluids in the mouth of the patient.[13]

BAG VALVE MASK

What is the Bag Valve Mask?

The Bag Valve Mask (BVM) or sometimes referred to as an AMBU bag provides oxygen and ventilation before a definitive airway is put in place. It is a self-inflating bag that can be attached to a face mask. When the bag is squeezed the air inside the bag is delivered to the lungs. The use of a pressure or one-way valve allows the expired gases to be removed. If the bag is attached to an oxygen supply the amount of oxygen inspired can be increased from that of normal air (21%) to around 45%.[10]

Using the BVM correctly is an important skill to master; poor technique can render the BVM useless.

The masks come in different sizes ranging from paediatric to large adult size. In order for the BVM to deliver effective oxygenation and ventilation it is essential to have a good seal and a patent airway.

Contraindications

A BVM should not be used in a completely obstructed upper airway.[14]

How to use it?

1. **Ensure the airway is open** by the health tilt chin lift manoeuvre or jaw thrust in the case of suspected c-spine injuries. The use of airway adjuncts such as a Guedal device are recommended to aid ventilation.[15]

2. **Position the mask** on the patient's face, covering the mouth and the nose and ensuring there is a good seal. It is important that a good seal is achieved but without applying excess pressure which could damage the soft tissues of the face. The mask can either be held one-handed or two handed depending on the number of people available and therefore whether you need to squeeze the bag as well as hold the mask.[15]

- C grip – with the thumb and index finger on the top of the mask and apply slight downward pressure.
- E-grip – Place the rest of the fingers around the jaw and lift it upwards

The grip used should be the one most comfortable and easiest for your hand size that provides a good seal. If using one hand it should be the non-dominant hand that is used.

For those with smaller hands or there is another person to squeeze the bag a two-handed technique can be used either by:

- Using the same technique as the E-C grip but using both hands
- Using the length of both thumbs to hold the mask on the patient's face, while lifting the jaw upwards

3. **Ventilation** or "bagging"

- Deliver breaths at a rate of 10-12 per minute, with each lasting at least a second[14]
- In the case of Cardio Pulmonary Resuscitation continue with the algorithm 30 chest compressions to 2 rescue breaths

4. **Assess the effectiveness of ventilation**

- Is the chest rising with ventilation?
- Is there a good seal?
- Check placement of airway adjuncts
- Check there is no gastric extension

Common Pitfalls

If the BVM is not working it is important to ask:

- Is the bag working correctly?
- Is the airway adjunct appropriate and positioned correctly?
- Is the position of the patients head correct?

Certain factors can indicate a difficulty in performing and decrease the effectiveness of BVM These include presence of a beard, no teeth, obesity or obstruction, great than 55 years old and a history of snoring or COPD.[16]

Over enthusiastic ventilation via a bag valve mask can lead to gastric inflation, or insufflation. This is usually a concern after initial stabilisation and can be decompressed with a nasogastric tube. Patients with asthma, or children, can dilate their own stomach through hyperventilation, this is decompressed in the same manner.

NB: If supplementary oxygen is available, it should be attached the port at a rate of 10L/ minute

B

LIFE THREATENING BREATHING PROBLEMS

During the primary survey specific life threatening breathing problems caused by chest trauma should be looked for and managed immediately if found. These can remember using the mnemonic ATOM-FC:

Airway obstruction

Tension pneumothorax

Open pneumothorax

Massive haemothorax

Flail chest

Cardiac tamponade

TENSION PNEUMOTHORAX

A tension pneumothorax is a life-threating condition, with 5% of combat causalities with thoracic injuries having a tension pneumothorax post-mortem.[17] A pneumothorax is a collection of air in the pleural space, and subsequent lung collapse, due to rupture of the pleural membranes commonly by a rib fracture.

In a tension pneumothorax the air enters through a 'one-way valve' and so cannot escape, leading to progressive accumulation of air in the pleural space. This expanding air bubble pushes the mediastinum towards the opposite side of the thorax, leading to compression of the superior vena cava, preventing venous return to the heart and leading to traumatic cardiac arrest.

Tension Pneumothorax kills; accurate assessment and prompt management will save lives

Clinical Findings

A patient suffering from a tension pneumothorax will present breathless and complaining of a sharp, chest pain commonly occurring following a fall or road traffic accident.

On examination:

- Decreased chest expansion, with the chest looking hyper-expanded.
- Hyper-resonant to percussion
- Absent breath sounds over the area.
- Hypotension and shock

If the following are present, then a tension pneumothorax should be suspected and managed:

A. Hypoxia and suspicion of pneumothorax
B. Circulatory collapse and shock – hypotension and tachycardia [18]

It is classically taught in a tension pneumothorax that the trachea will be deviated **AWAY** from the pneumothorax side. This is, however, neither specific nor sensitive. Furthermore in a pre-hospital scenario it is often difficult to observe, with views being obscured by helmets or beards or the deviation may be subtle and not visible clinically. In pre-hospital care

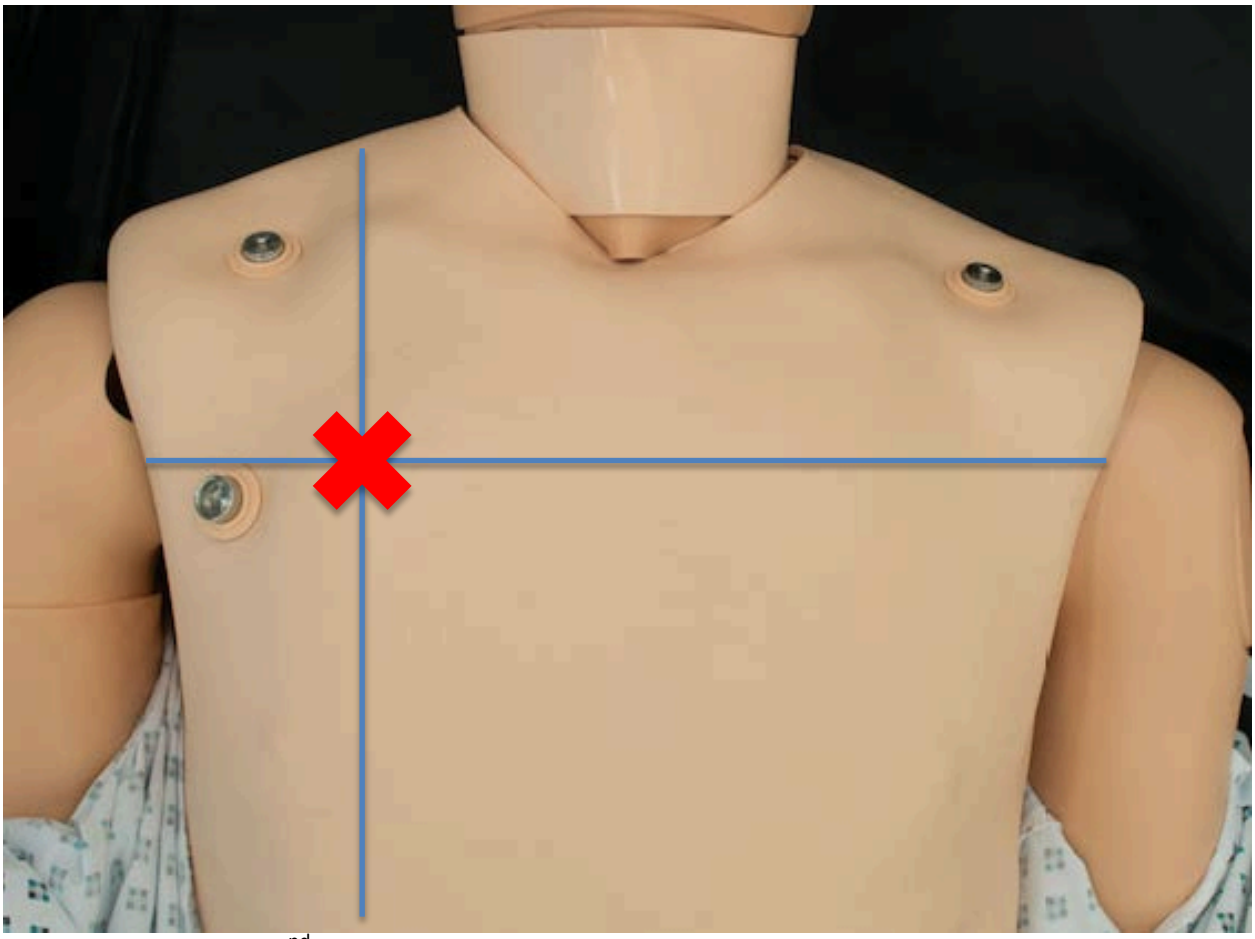
instead of tracheal deviation clinical signs of pneumothorax along with circulatory collapse, shock and hypoxia will lead to the clinical suspicion of a tension pneumothorax.[18]

It is a **CLINCIAL** diagnosis and needs immediate medical management.

Management

The immediate management is a needle thoracostomy. This is where a 14-16G IV cannula is placed into the second intercostal space, mid-clavicular line over the top of the third rib to avoid the neurovascular bundle.

On insertion, a large rush of air should be heard, however in a pre-hospital situation this can often be hard to observe due to the large amount of background noise. The needle should then be taken out and the cannula left open to air to allow drainage of air.



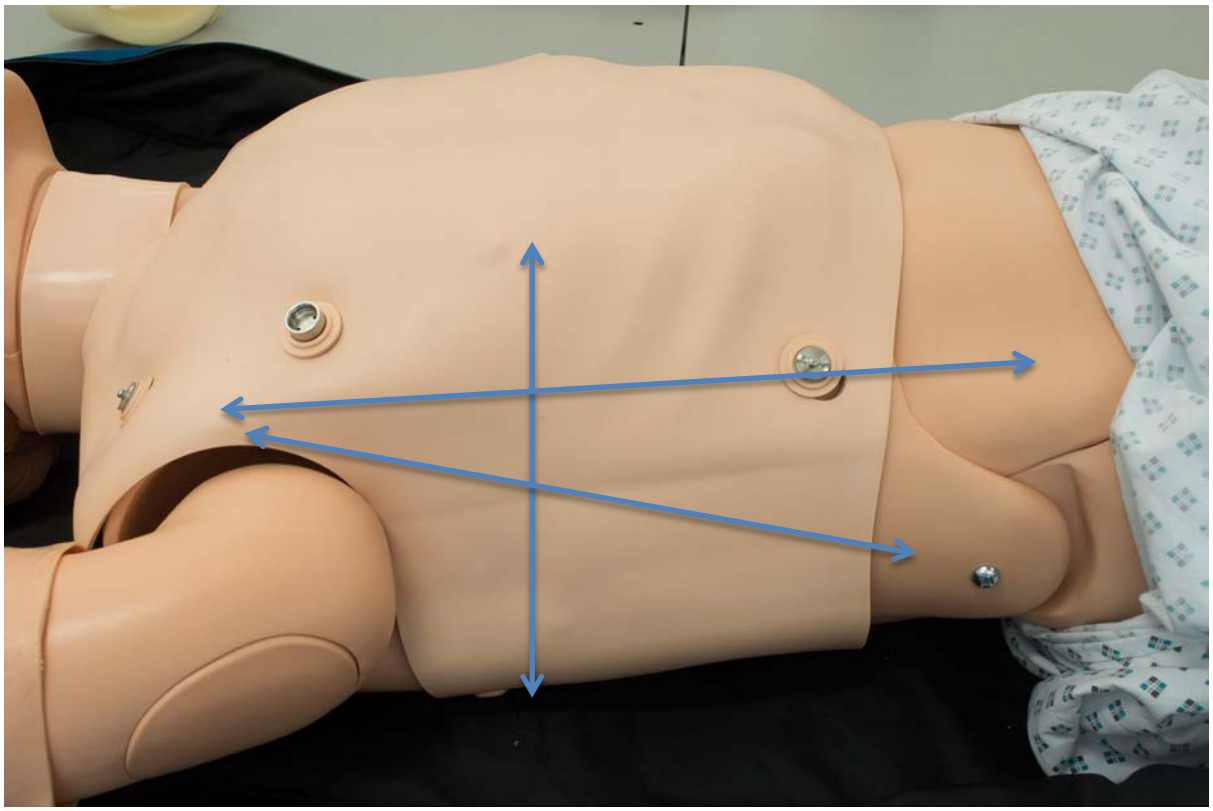
Mid-clavicular line 2nd intercostal space

This procedure is not without complications however, with haemorrhage, lung injury, air emboli and reoccurrence of the pneumothorax.[18] Needle decompressions have a risk of

damage to local structures, including the neurovascular bundles and the great vessels that can lead to severe haemorrhage. This risk can be reduced by lateral insertion of the needle into the 'triangle of safety' at the 4th or 5th intercostal space.[19]

This is in the 'triangle of safety' lined by:

1. A line perpendicular to the floor from the nipple
2. A line following the border of pectoralis major
3. A line anterior to the md axillary line



The procedure might also fail to decompress the pneumothorax due to a variety of reasons:[20]

- The cannula may be of insufficient length to pass through the chest wall, this might particularly be the case in large, obese patients
- The air can leak from the lung faster than it can escape through the cannula, preventing re-expansion of the lung and leading to patient deterioration.
- Tissue or blood can block the lumen of the cannula
- There may be mal-positioning of the cannula. Studies into placement of the needle on the anterior approach showed only 60% of emergency physicians correctly located the second intercostal space, mid-clavicular line [21]

- The cannula can become kinked due to inability to cope with the high intra-thoracic pressures in a tension pneumothorax
- During multiple handovers the cannula may become occluded. Clear communication of the therapeutic steps taken is vital at all points of the handover.

Simple/Finger thoracostomy

This is a rapid and safe alternative to needle thoracostomy, which still remains first choice for many practitioners. As opposed to needle decompression, this does not involve the insertion of a foreign body into the patient; it is also faster to perform and easier to teach.

It has been found to be that simple thoracostomy was a safe and effective technique[22] with a study following 5 years of usage by a helicopter emergency service. 55 patients underwent the procedure and the results showed: significant improvement in oxygen saturation post thoracostomy, no incidence of major bleeding or lung laceration and no cases of recurrent tension pneumothorax.

How to perform a finger thoracostomy

- Locate the anterior axillary line in the 4th or 5th intercostal space
- An incision is made through the skin and subcutaneous tissue.
- You then feel for the top of the 4th or 5th rib, and insert Kelly forceps
- The forceps are used to puncture the chest wall, they are then spread and withdrawn
- A finger is then inserted and moved around to confirm that you are into the thorax and to clear any adhesions. You may hear a hiss of air when puncturing the chest wall; however an advantage of a finger thoracostomy is that you can also feel the lung re expanding and touching your finger.

Needle vs Finger?

http://emcrit.org/podcasts/needle-finger-thoracostomy/

OPEN PNEUMOTHORAX

An open pneumothorax is where air enters the pleural cavity through a defect in the chest wall causing lung collapse and is an immediate, life-threating condition.

This forms when a hole in the chest wall is greater than 0.75 times the diameter of the trachea. Air is then inspired through the defect rather than the respiratory tract. This is because the route made by the chest wall defect is shorter than the trachea and therefore provides less resistance to air movement. This creates an easier passage for air into the chest and if left untreated will lead to inadequate ventilation and oxygenation, potentially progressing to a tension pneumothorax.[23]

Clinical Signs

The patient presents having being stabbed or shot in the chest. It is diagnosed clinically with a hole in the chest wall that is seen to be sucking or bubbling. The patient will be tachypneoic and show an increased effort of breathing. There will be decreased chest expansion to that side, decreased breath sounds and hyper-resonant percussion.

Management

100% oxygen should be given to the patient via a facemask, and the site closed.

The traditional management involves the placement of an occlusive dressing over the wound that is taped down on three sides, leaving one open. This creates a flap-valve to allow air to escape, but not to enter during respiration. This is left in place until a chest drain can be inserted, and the wound closed properly.[23] This can, however, take time to apply and the lack of effective adhesive can often result in failure of the dressing.

The alternative to the three-sided dressing is a one-way valve adhesive dressing, for example the Asherman chest seal™. These are placed directly over the wound to allow air and blood to escape, but preventing re-entry. These dressings allow for fast application and have increased adhesive properties as compared to the three-sided dressing.[24]

When applying the dressing it is still advisable to clean and/or shave the area before application to increase adhesion.

A consensus statement[25] from the faculty of Pre-hospital care advocates the usage of an Asherman chest seal, over a three-sided dressing, seeing the three-sided dressing as ‘often ineffective’. A three-sided dressing should only be used if one-way valve dressings are not available.

B

MASSIVE HAEMOTHORAX

A massive haemothorax is when blood collects in the pleural space. By definition the pleural aspirate should contain a haematocrit value of at least 50% of the haematocrit of the peripheral blood.[26] It is usually caused by either blunt force or penetrating trauma. One of the most common causes of haemothorax is a rib fracture.

Clinical Signs

If a haemothorax is only small, imaging is needed to detect it. But in massive haemothorax, physical signs are usually present, such as: visible thoracic trauma; crepitus; presence of rib fractures; tracheal deviation and the mechanism of injury. As one of the causes of haemothorax is penetrating injury it is important to check the patient's back for any wounds.

Classic signs:

- Reduced chest expansion
- Dull to percussion
- Reduced breath sounds

There are numerous imaging techniques used to visualise a haemothorax; chest x-ray is the standard test as it is used for thoracic trauma. In small haemothoraces a focused assessment sonography in trauma (FAST) scan has a higher sensitivity to that of chest x-ray, better able to detect as little as 20ml of pleural fluid compared to 50-100ml and 175ml for upright and supine chest x-rays.

An ultrasound test is extremely useful when managing critically ill trauma patients. Looking specifically at haemothoraces it has been shown that thoracic ultrasound has a sensitivity of 92% and a specificity of 100% in haemothorax detection.[27] Also, in 84% (42 patients) of cases in this study the ultrasound results were available before the radiograph results.[27] This speed of diagnosis is an important aspect to consider; as without doubt morbidity and mortality is affected directly by the speed at which diagnosis and appropriate management are made.

Pathophysiology

When blood is contained within the pleural cavity this blood is exposed to the movements of the pulmonary system, in particular the lungs and the diaphragm. This causes defibrination where partial clots form. During active bleeding the bodily mechanisms cause

large clots to form, which attach to the lung reducing pulmonary movements. This is problematic for the cardiorespiratory system and therefore it is essential the blood from a haemothorax is removed as quickly as possible.[26]

Management

The patient's clinical picture should be used to guide management, to ensure rapid effective treatment. A large calibre tube should be used to perform a tube thoracostomy. A chest radiograph should be used to confirm positioning of the tube.

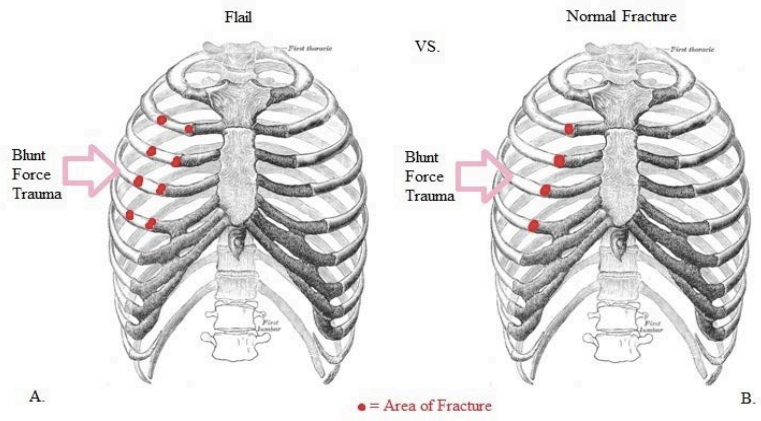
FLAIL CHEST

Flail chest is when a segment of the rib cage (usually two or more broken ribs in two or more places) is separated from the rest of the chest wall, usually as a result of blunt trauma. The ribs affected can no longer move with the rest of the chest wall during normal ventilation.

Normally during inspiration the diaphragm moves upwards and outwards to expand the thorax, which allows the lungs to be filled with air. For the affected part of the chest wall no movement occurs therefore reducing the amount of effective ventilation.

Clinical Signs

Flail chest can be seen on chest radiography, showing at least three or more adjacent ribs broken in two or more places. On clinical examination paradoxical movement of the chest occurs, whereby during inspiration the affected chest segment draw in while the rest of the chest expands outwards.[28] Other signs and symptoms include: bruising; chest pain; tachycardia; tachypnoea and difficulty breathing.



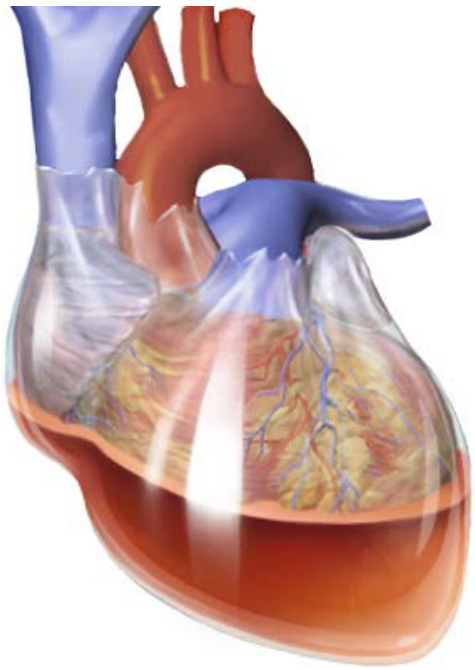
Management

It is important to know that the presence of a flail chest is usually indicative of underlying pulmonary contusion. Trinkle et al reported that flail chest with respiratory insufficiency suggests parenchymal injury i.e., pulmonary contusion.[29]

Pre-hospital management for a flail chest is mainly in the form of analgesia. Placement of a hand, whether your own or the patients, over the flail segment prevents the movement of the segment and provides splintage, this, in turn, decreases the pain. Other pre-hospital management includes other forms of analgesia and location and treatment of other injuries associated with the mechanism of injury such as pulmonary contusions.

CARDIAC TAMPONADE

Cardiac Tamponade is an acute pericardial effusion that puts pressure on the heart. Blood accumulates in the sac (pericardium) surrounding the heart decreasing cardiac output and therefore reducing the amount of blood the rest of the body receives.



Causes

Causes of cardiac tamponade include:

- Dissecting thoracic aneurysm
- Acute myocardial infarction
- Pericarditis
- Penetrating cardiac injury

Clinical Features

The clinical features of cardiac tamponade are incredibly insensitive and in practice the only true measure of tamponade would be an ultrasound scan.

The most common physical symptoms include; shortness of breath, tachycardia and increased jugular venous pressure.[30] Beck's triad first described in 1935 is a triad of clinical features suggestive of tamponade; hypotension, increased jugular venous pressure and muffled heart sounds.

Management

As well as standard critical care management, peri-cardiocentesis is used as definitive treatment for tamponade. There are varying techniques of how this can be carried out and require specific training.

You are walking down the street and see a crowd of worried people gathered around a man who is struggling to breath. He is gasping, loudly wheezing and sitting down on a bench, as you get closer it is clear he is in a lot of distress with his hands on his knees breathing rapidly.

- *What would be your initial approach?*
- *Are there any questions you would want to ask?*
- *He cannot get words out, how does this change your questioning?*
- *How would you manage the crowd?*

You notice he is trying to get into his jacket pocket, inside is an inhaler.

- *What would you now do?*

The patient responds well to the inhaler therapy

- *What would you now do?*
- *How would this scenario change if you had the provision of oxygen and other medications?*

B

This is an example of a pre-hospital asthma attack, asthma is covered extensively throughout undergraduate teaching and the management is similar in pre-hospital care revolving around beta-agonist therapy, oxygen therapy and transfer to hospital.

In this case the patient cannot respond verbally to questions, sometimes it is appropriate to modify questions to closed 'yes' or 'no' questions, you will be surprised at the amount of detail. A third party history off someone in the crowd would be able to give you information on the event details.

To make sure the crowd is not distressing the patient, try and disperse the crowd, while maintaining immediate contacts to reduce the anxiety of the situation. You can also employ members of the crowd to assist. If family members are present they could be used for finding out a brief third party history.

Asthmatic patients treated by emergency medical personnel should be transferred to hospital for further observation and management.

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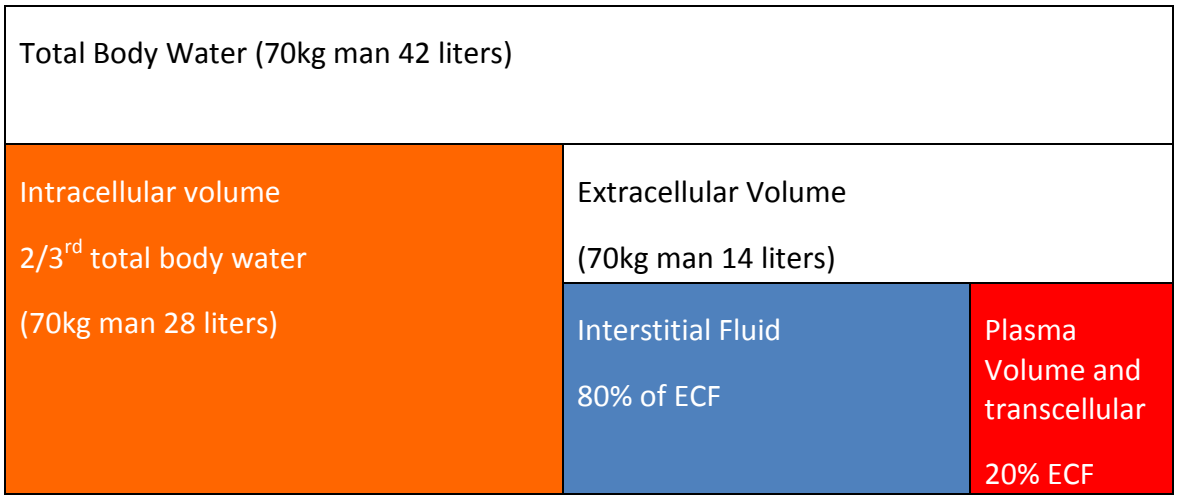
Circulation

The following diagram shows the distribution of fluid throughout the body. Fluid movement between the compartments is driven by osmotic and Starling forces.



Haemorrhage is the second leading cause of death in trauma patients, with mortality rates as high 63% in hypovolaemic shock occurring with a head injury.[1] Loss of fluid can lead to hypervolaemia, which in turn can lead to shock; cardiac arrest and death.

Shock

Shock is the inability of the circulatory system to meet end organ perfusion requirements. This can be due to a variety of causes classically distributive, obstructive, cardiogenic or hypovolaemic; the latter being the most common seen in pre-hospital care.

During hypovolaemic shock there is insufficient blood volume circulating to meet oxygen requirements. The body attempts to compensate by raising the heart rate, increasing the cardiac output and constricting the peripheral blood vessels to maintain oxygenation to the vital central organs, such as the brain and heart.

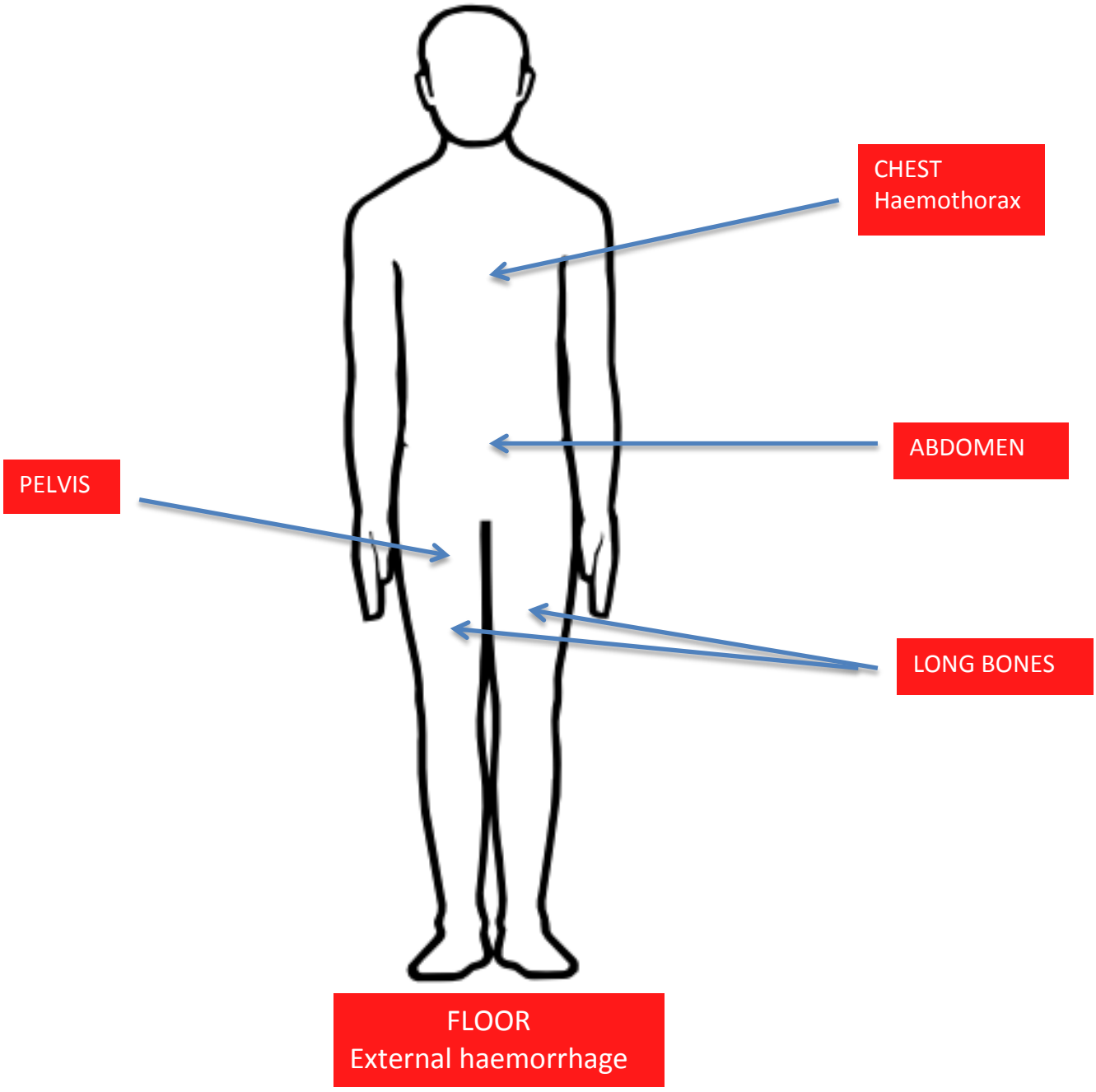
This is a life-threatening emergency. It is vital to be able to assess any circulation problem, signified being able to act quickly and effectively in the pre-hospital environment.

Decreased blood pressure is often not seen until late during hypovolemia, potentially only occurring with over 730ml of blood loss[2]

ASSESSMENT

'On the floor and 4 more'

There are 5 major sites for major haemorrhage that can either be obvious or concealed.



Why are pelvic fractures such a bleeding risk?

There are numerous sources of bleeding in pelvic fractures; the bones, venous plexus and arterial plexus can all be sources of haemorrhage. The pelvis itself has a volume of, on average, 1.5l yet in a fracture there is interruption of the pelvic ring. This prevents tamponade of the bleeding, allowing communication to the retroperitoneal space (which has a further 5l average volume), the thighs and the peritoneum.

Therefore pelvic fractures can be considered bleeding into a free space potentially able to hold the entire blood volume.[3]

Initially, consider the mechanism of injury - is this a scenario where it is expected to have considerable bleeding?	
Inspection	• Look initially for any signs of major bleeding. This could be obvious blood on the floor or serious structural deformity such as a obviously fractured femur or large swelling of the leg • Look at the patient. Are the hands & face blue, pale or mottled? • Alert, Voice, Pain, Unresponsive allows a quick assessment of cranial perfusion. A decreasing level of consciousness is a reliable indication of a secondary cerebral insult, including hypoxia secondary to hypovolaemia
Palpation	• Measure the capillary refill time • Respiratory rate • Palpate the pulses and assess pulse rate and rhythm
Blood Pressure (BP)	• If available then measure the blood pressure, if not pulses allow estimation of the BP
Auscultate	• Auscultation of the chest for presence or absence of lung and heart sounds
Consider the major sites of bleeding	• Including chest, abdomen, pelvis, long bones and the floor

Skin colour

Assessment of skin colour is a simple indication of circulatory status. Pallor and cyanosis indicate poor perfusion to tissues and the patient will feel cool. As blood loss increases the patient will become a more mottled colour.

'You can't fake pale'

Mental State

Blood loss decreases the oxygen carrying capacity of the body, resulting in cerebral hypoxia. This will initially present with agitation, with the patient becoming increasingly confused with increased blood loss. Assessment can be made on the AVPU scale, or a full Glasgow Coma Scale can be used.

Capillary Refill Time (CRT)

This is recorded by pressing firmly on an external capillary bed for a full five seconds and recording the time taken for reperfusion. The normal time for reperfusion is generally considered to be two seconds in adults.[4]

CRT can be performed peripherally on the nail bed or centrally on the sternum or forehead. This can indicate a decrease in perfusion if the time for reperfusion exceeds two seconds.

'CRT takes a moment to check, and a moment to re-check'

Two-second limit?

CRT initially was graded as normal, definite slowing or very sluggish with no time limits given.[5] A time limit of 2 seconds was later included in the 'Trauma Score' based on expert opinion.

Later observational studies of healthy volunteers[5] found that the limit of normal, defined as the time within 95% of volunteers re-perfused, was 2 seconds for men (1.0 average) and 2.9 seconds (1.2 average) for women. More strikingly 4.5 seconds was the upper limit of normal (1.7 average) in the elderly population.

Cold emersion equally doubled the median times for CRT to 2.9 seconds[4] with paediatric studies[6] also generally showing a large increase of 1.53 between a warm and cold room.

Pre-hospital environments in Scotland are seldom warm, and patients may not be healthy individuals. Therefore the limit of 2 seconds must be viewed with appropriate clinical judgment.

C

Is CRT a useful test?

Studies looking at the sensitivity and specificity of CRT in assessing hypovolaemia[5] showed high specificity in males and children, but reduced specificty in females and the elderly. They also found that CRT was only, at best, sensitive in 47% of patients who had not manifested hypotension. When patients had 450ml of blood removed they found the average capillary refill time actually decreased by 0.3 seconds with 6% sensitivity for identifying hypervolaemia. These results led the authors to suggest CRT should not be used in pre-hospital care, with paediatric cases being the exception as a good sensitivity was noted.

However the relevance of this study to trauma situations is worth considering. 450ml of blood does not equate to a significant amount of blood loss, and would often be a lot more in pre-hospital care..

CRT is a non-invasive and fast test, and though not particularly sensitive (46% in the hypotensive grouping) could be used to build up a picture of a hypovolaemic patient. However, this is not a test to use in isolation and other signs and symptoms are needed to clinically diagnose hypovolaemia.

It is worth noting that CRT has not been included in the Revised Trauma score, it is, however, still taught in both BTLS and ATLS.

'Always touch the skin. Think of assessing sympathetic tone. Determine the level of the thermo-border (ie. warm/cold border on extremities). Mark it, follow it up. This determines grade of centralisation'

Pulses and Blood Pressure (BP)

Palpation of the pulses and a BP reading gives a quick and easy method of estimating fluid status and the risk of circulatory compromise in a patient. A high pulse rate and a lowered BP can be a strong indication of severe shock

Pulse

'think rhythm and rate'

As with any pulse assessment the character, rate and rhythm of the pulse should be noted, with a weak and thready character indicating hypovolaemic status. During severe fluid loss the pulses may be absent and this can give an indication for the level of fluid loss. The NICE guidelines[7] indicate that a non-palpable radial pulse is an indication for beginning IV fluid in a pre-hospital environment. In penetrating trauma a central pulse may be used instead.

Make sure to assess the rhythm of the pulse as dysrhythmias can be equally common in hypovolaemia.

BP

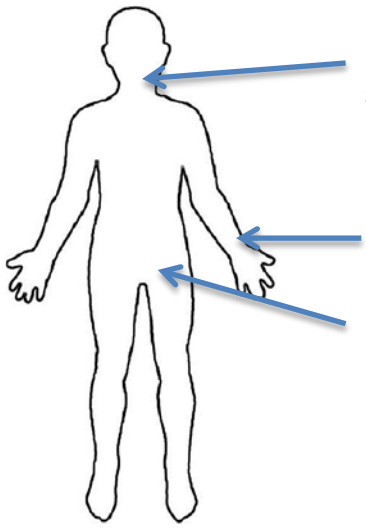
A low BP in isolation is not a indication of shock, however in combination with other clinical signs including a tachycardia, pale skin and a decreased conscious level it can be used to build a picture of the severity of shock. Frequent BP recordings should be retaken as a falling BP, rather then an isolated BP, indicates the development and worsening of shock.

It was shown[8] that systemic hypotension does not occur until the degree of shock is sufficiently profound, with the BP not falling below 90 mmHg systolic until a late stage in shock. This indicates, and led the authors to suggest, that interventions should not be delayed until systemic hypotension occurs as this is a late sign occurring with over 25% of blood loss

Blood Pressure can remain normal in the early stages of shock; a decreasing BP indicates uncompensated shock along with other relevant clinical information

Pulses

Advanced Trauma Life Support classically taught the relationship between the pulses that are palpable, and the blood pressure of the patient.[9]



This is the classical teaching, yet is this correct?

A reply to this model[10] observed hypovolaemic patients using sphygmomanometer showing the ATLS guideline to be concordant with the patient's blood pressure in only 5 of 20 patients. In 10 patients the BP had been overestimated, with the overestimation increasing the lower the BP became.

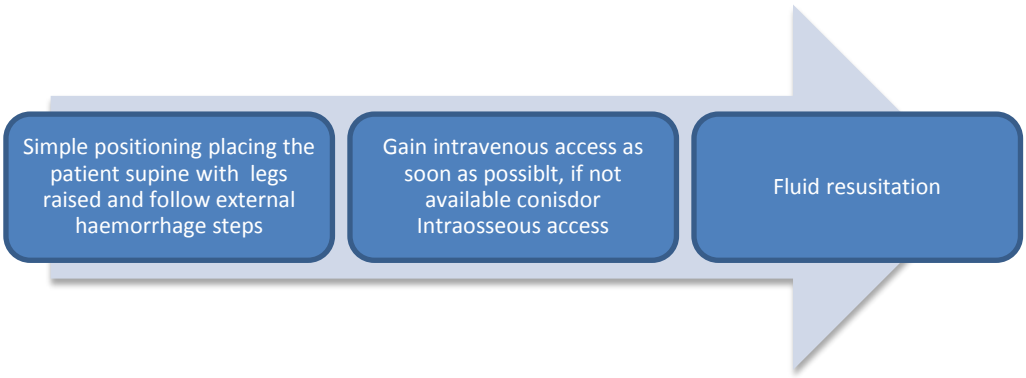
A later study[9] used invasive arterial blood pressure recordings to study the relationship in more accurate detail. This did find that the radial became absent before the femoral, and the femoral before the carotid, yet they also found the ATLS guidelines generally overestimate the blood pressure leading to an underestimation of the level of hypovolaemic.

The authors in both studies suggested the relationship between pulses and blood pressure readings is not accurate enough to be considered clinically relevant, especially in the lower BP ranges.

For an accurate recording of blood pressure a reading with a sphygmomanometer should be taken. If this is not available, the presence of pulses can be used as a rough indication of blood pressure with the radial, femoral and carotid pulses being lost, in that order, with decreasing blood pressure

- Assess Pulse Character, rate and rhythm
- Absent pulses indicate worsening hypovolaemic
- A falling BP is associated with uncompensated shock, with 25-50% fluid loss
- After every intervention, re-assess

MANAGEMENT



External Haemorrhage

If there is obvious haemorrhage then firstly decide if it a catastrophic haemorrhage or not, for obvious external bleeding follow the steps below

Direct pressure and elevation*

↓

Wound packing/windlass technique

↓

Tourniquet

*If catastrophic haemorrhage then proceed with tourniquet as step 1

If no tourniquet is available the windlass technique may be used. This is where a dressing and bandage are applied to the wound. A second bandage is placed over the top of the wound and a pen is placed under and rotated until tight. This can be painful but effective.

If there is an obvious fracture, splinting and reduction are highly effective methods of reducing both haemorrhage and pain.

C

ACCESS

'The best pre-hospital fluid for a patient is their own blood, stop obvious haemorrhage, splint and handle them gently to minimalise bleeding'

There are two methods of access to the patients circulatory system that will be discussed here, intravenous (IV) and intraosseous (IO) and if indicated should be gained as quickly as possible. These will allow the delivery of fluids and can be used as a drug administration route and have been found[11] to lead to an overall reduction in the odds of hospital mortality.

IV cannulation

IV cannulation is the insertion of a catheter into a vein to allow:

- Fluid administration in haemodynamically unstable patients
- Drug administration route

Intravenous (IV) access is a commonly preformed procedure; the number of IV cannulations from emergency medical services has been shown to range from 20%[12] to 60%.[13]

In a trauma situation it can often become more difficult to gain IV access due to peripheral vasoconstriction as a response to lowered circulating blood volume in the hypovolaemic patient. As this is the case, IV access is required early, before peripheral shutdown, and is often doubled to allow access even if one fails.

IV access is not required in every scenario and there are significant complications (see discussion box), therefore insertion should rely on clinical judgement aided by accurate assessment.

How often should we insert a cannula?

IV access is often gained prophylactically to ensure there is access present if the patient's condition deteriorates, as it may be more difficult to gain later. Roughly three quarters of cases[12,13] IV access was found to be gained prophylactically in a study into pre-hospital care. One study showed as many as 83% of cannulas to be prophylactic,[13] with only 17% being utilised for medication or fluids at the scene or in patient transfer.

This prophylactic use would be fine if there were no complications to the procedure, however there are many which are increased in pre-hospital insertions. These include thrombophlebitis, thromboembolism, sepsis, air embolism and arterial puncture. Thrombophlebitis alone was found to occur in as high as 6.09% of pre-hospital cannula insertions conducted by emergency medical technician 14 compared to 2.92% inserted in the emergency department.

With over half of the prophylactic IV access remaining unwarranted, and with significant complications involved, inserting a cannula should not be an automatic process rather based on best clinical judgment at the scene.

'Any access is better then no access, a small venous cannula is much better then a large subcutaneous cannula'

C

INTRAOSSEOUS ACCESS

Due to the importance of gaining vascular access for fluid resuscitation and medication, it is sometimes necessary to insert an intraosseous (IO) needle. This occurs in cases where vascular collapse, secondary to trauma and shock, makes it impossible to gain IV access. Studies have found that at least one functioning IV line could be secured on scene in 92% of trauma patients with 80% receiving two successful IV cannulas.[15] Therefore, to gain access in the 8% in which it could not be secured, other forms need to be used.

IO access involves inserting a needle into the vascular intramedullary space that, in turn, provides direct access to the central circulation via the Volkmann canals[16] that connect the medullary canal and the periosteal blood vessels. IO access is fast and reliable, being gained in 1-2 minutes in 80% of patients,[17] studies[18] showed 88.6% of IO access reported as 'easier' compared to IV cannulation with 72%[19] - 100%[18] success rates for insertion.

The requirement for IO access occurs more frequently in paediatric cases due to difficulty inserting cannulas and the relative softness of bone making IO access easier, with percentages as high as 45.0% of IO insertions being paediatric (under the age of 15).[20]

IO access is indicated, in the pre-hospital environment to '*prevent an emergent situation and in whom obtaining peripheral or central intravenous access is difficult.*'[21]

CONTRAINDICATIONS[21]

- Inability to locate the landmark
- Fractures in the same extremity as the targeted bone
- Previous surgery involving hardware in the bone targeted for IO access
- Infection at the insertion site or within targeted bone
- Local vascular compromise
- Previous failed IO access within 24 hours in the targeted bone

COMPLICATIONS

- Incorrect positioning leading to extravasation or sub periosteal infusion
- Osteomyelitis
- Physeal plate injury
- Local infection, pain, compartment syndrome, fat emboli

Insertion

Insertion of an IO needle can be conducted manually but is more commonly via an infusion device which can come in various forms. The following are the three most commonly used devices for insertion of IO access.

EZ-I0

This is a larger unit consisting of a power drill and needle set. The size of needle used depends on the weight and size of the patient.

Method

1. Once the insertion location has been assessed the skin is cleaned and the limb stabilised.
2. The needle is gently inserted at 90 degrees to the insertion site until contact is felt with the bone.
3. If this is the 5mm mark on the needle is not visible then a larger needle is needed.
4. If the 5mm mark is visible then gentle and steady pressure is applied and the power is activated until:
   1) A sudden 'give' or 'pop' is felt on entry to the medullary space.
   2) The desired depth is obtained.[16]
5. Remove the power driver and stylet from the catheter, aspirate to confirm the placement, flush and dress the site appropriately.

Other Devices

FAST1

This is the only device approved for sternal access. The device is positioned then inserted perpendicular to the manubrium, located by palpation of the sternal notch.[16]

BONE INJECTION GUN

The Bone injection gun is a spring-loaded device delivering a needle directly into the bone. It is approved for use in the tibia and the humerus due to the requirement for a flat surface.[16]

Which method to use

Choice will depend on which equipment you have access to and which areas of access are contraindicated or inaccessible.

Over a seven year test period a Norwegian study[22] found significantly higher success rates with the EZ-IO over both manual and Bone Injection Gun, with success rates of 96% using the EZ-IO compared to 50% using the manual needle and 55% using the Bone Injection Gun.

LOCATIONS

There are various locations used for IO access including: proximal and distal tibia, proximal humorous, distal femur, sternum and iliac crests

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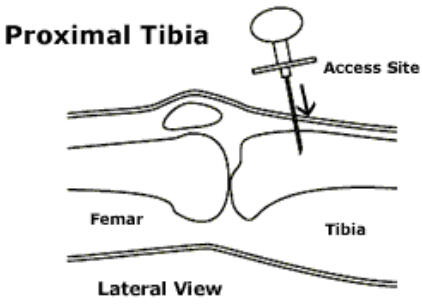
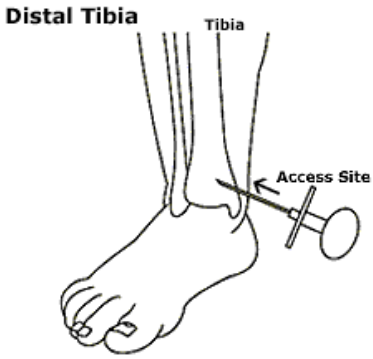


1. Locate the tibial tuberosity
2. Insert the needle 2cm or 2 finger widths medial

For paediatrics insert the needle 1 finger width below the tuberosity or if this cannot be palpated then the insertion site is 2 finger widths below the patella



1. Locate the Medial Malleolus
2. Insert the needle two finger widths proximal

For paediatrics insert the needle one finger width proximal to the medial malleolus.

The patient should be positioned with the elbow adducted and posteriorly located, there are two methods for locating the site for insertion.

- Palpate the midshaft humerus and palpate to the humeral head
- Palpate for the greater tubercle and insert the needle at this site

OR

- Identify the greater tubercle insertion site two finger widths inferior to the coracoid process

This is only preformed with the FAST1 IO device and is placed into the manubrium. The advantage to this is that it is fast and easy to preform and does not interfere with other procedures. This is only preformed in patients over 12.

Which IO site to use?

The decision to which clinical site to use depends on the absence of contraindications, accessibility and the fluid rates needed as humeral insertion has been shown to achieve a higher flow rate compared to tibial[18] though not a statistically significant difference. Piglet studies showed the flow rates to be highest in humerus, femur, malleolus and tibia in that order.[23]

Generally the tibia is the most favored with a large study showing 89.7% in the tibia, 3.4% in the humerus, 1.3% in the femur and 1.8% in various other sites.

FLUIDS PRE-HOSPITAL

After access is gained, the next important consideration in the hypovolaemic patient is the provision of fluids, when to start, what to start and how much to give.

NICE guidelines[24] on pre-hospital fluid replacement in trauma:

- IV fluids should not be administered if a radial pulse can be felt (or, for penetrating torso injuries, if a central pulse can be felt)
- In the absence of a radial pulse, it is recommended that IV fluid should be administered in boluses of no more than 250ml. The patient should be reassessed, and the process repeated until a radial pulse is present
- The administration of IV fluid should not delay transportation to hospital
- When IV fluid is recommended crystalloid solutions should be the routine choice

The aim of fluid resuscitation is to reverse hypovolaemia and restore end organ perfusion to prevent hypoxia. This causes an increase in the blood pressure and cardiac output.

When thinking about administration of fluids it is important to weigh up advantages and disadvantages of giving fluid versus those of withholding.[25]

GIVE FLUIDS	WITHOLDING FLUIDS
Delay to patient transfer	Organ ischaemia
Re-bleeding: • An increase in blood flow can lead to re-bleeding from sites where bleeding may have previously ceased. This is described as 'popping the clot' whereby an increase in hydrostatic pressure causes displacement of the clot leading to re bleeding	Death from hypovolaemia
Increased blood loss: • An increase in both prothrombin and partial thromboplastin time was shown in pre hospital fluid resuscitation • Coagulopathy can often occur due to dilution of the blood, this is associated with a 3.5-5 fold • increase in mortality	

When?

The consensus view published in the Emergency Medicine Journal[25] and supported by the NICE guidelines[24] state that fluids should not be administered if the radial pulse is palpable.

What?

The decision to use crystalloid or colloid solutions is a long running debate.

A 1998 systematic review[26] published in the British Medical Journal of 37 randomised controlled trials found an increased absolute mortality risk by 4% and did not support the continued use of colloid fluids for volume replacement.

Cochrane[27] conducted a 2013 review of colloids versus crystalloid replacement; this found no reduction in the risk of death in colloid use compared to crystalloid in trauma, burns and following surgery.

Due to the increased cost of colloids (£4-£16.50 compared to £1.80 per 500ml for crystalloid[24]), alongside the ease of storing crystalloid solution combined with no mortality benefit shown from colloids the general consensus view[25] is that isotonic saline should be used as the first line fluid in hypovolaemic fluid resuscitation.

How much?

To avoid the problems such as postoperative coagulopathy and exacerbation of haemorrhage with aggressive fluid resuscitation the approach taken is one of **permissive hypotension** whereby blood pressure is allowed to remain below normal, but high enough to maintain end organ perfusion[25]. A 2011 study showed a significant mortality benefit associated with a hypotensive resuscitation strategy aiming for a Mean Arterial Pressure of 50 mm Hg, indicating hypotensive resuscitation as a '*safe strategy for use in the trauma population'* supporting its use.

The current recommendations from NICE[24] state that fluid should be given in 250ml boluses, followed by re-assessment of the patient. If the radial pulse is still not palpable then a further 250ml is administered.

Why don't we administer fluid in every situation?[28]

It was the general consensus in the later part of the twentieth century that the approach to any hypovolaemic casualty was perioperative intravenous isotonic fluids; however a landmark prospective and randomised study published in 1992 went a long way to dissuading this approach. Previous studies had investigated the use of fluids in animals, yet this study used large, matched, human groupings of patients.

They looked at two groups of trauma patients, immediate-resuscitation receiving aggressive IV fluid therapy before surgical intervention, and delayed-resuscitation where IV fluid resuscitation was delayed until after operative intervention.

The study showed a significant difference (P=0.04) between the survival rates in the delayed-resuscitation group (70%) versus the immediate resuscitation group (62%). The authors suggested, based on previous animal studies, the mechanism behind this was:

'Accentuation of ongoing haemorrhage or hydraulic disruption of an effective thrombus, followed by fatal secondary haemorrhage' or *'diluting coagulation factors, lowering blood viscosity.'*

Put simply, administering fluids increases the blood pressure; if the site for bleeding is not adequately plugged then the pressure increase will lead to an increase in the bleeding.

The results gained supported this with mean haemoglobin concentration in the immediate-resuscitation group being lower indicating accentuated bleeding and not purely haemodilution.

The authors concluded by stating:

'Although this study of preoperative fluid resuscitation for hypotensive patients with trauma does not necessarily refute the classic studies cited previously, it refutes the broad interpretation and extrapolation of those experiments to all aspects of management of trauma.'

A 2014 Cochrane[29] review of the value of IV fluids in uncontrolled bleeding due to injury found:

'*No evidence from randomized controlled trials* for or against *early or larger volume of IV fluid administration in uncontrolled haemorrhage. There is continuing uncertainty about the best fluid administration strategy in bleeding trauma patients. Further randomized controlled trials are needed to establish the most effective fluid resuscitation strategy*'

Pre-hospital administration of Blood and Blood products

Emergency services are increasingly incorporating the use of blood products, including blood transfusions and fresh frozen plasma, into pre-hospital resuscitation. It is thought that during situations where major traumatic haemorrhage is suspected there may be call for delivery of blood products over the standard crystalloid therapy to improve oxygen-carrying capacity and lesson the coagulopathy associated with trauma. Advanced Trauma Life support currently support the use of blood products if haemodynamic instability continues after administration of 2 litres of crystalloid.[30]

This is a controversial area and initially there were concerns over the implementation of pre-hospital blood transfusions due to expense, adverse reactions, short half-life and problems storing the products.

Pre-hospital infusions were successfully implemented in the military[31] and were shown to be both feasible and improve mortality rates. In a study[32] into military usage, transfusion was offered if a patient was haemodynamically unstable after 2l of crystalloid resuscitation. This showed that pre-hospital blood transfusion was justified in certain patients and found negligible adverse effects. They concluded it was a safe, practical and helpful intervention.

Further feasibility has been shown in the civilian population, a study in the usage in the Australian helicopter emergency services showed no transfusion reactions.[33] It was also shown that wastage of red blood cell units compared favourably to emergency departments and 97.8% of the non-transfused blood was available for re-issue after return to the blood bank.[34] A further study into the outcomes of patients administered blood products conducted in Australia showed that there 'may be a survival benefit' to pre hospital transfusions after delivering to 73 patients of a 18 month period.[35]

Introduction into the London Air Ambulance as part of their massive haemorrhage protocol over a 6-month period showed 50 patients receiving blood transfusions. This improved the rate of secondary cardiac arrest secondary to hypovolaemic but did not result in a survival benefit. This study also showed that pre-hospital teams were able to safely deliver blood transfusions at the scene and still comply with NHS legislation.[36]

The call for further investigation into this is clear. Currently a randomised control trial, the COMBAT study, is being conducted in Denver Colorado, due to complete in 2017 looking at the provision of pre-hospital blood and blood products as compared to the standard crystalloid therapy. There is also the PAMper study, also in America, looking at the 30-day mortality effect of the transfusion of 2 units of plasma in patients with haemorrhagic shock.

A recent systematic review[37] concluded that even though some studies showed benefits to pre-hospital blood transfusion these had many methodological issues and further studies are still required, specifically in the civilian setting.

In conclusion, it seems that delivery of pre-hospital blood transfusions is a field that is currently being investigated. With the current provision in the military services and certain civilian services it is certainly a realistic and feasible option for pre-hospital care yet the question remains if there is benefit to the patient receiving the transfusion. At the current time it seems there is a lack of evidence towards the effect on survival rates of pre-hospital transfusions, something that is currently being investigated.

'Don't be afraid to give blood if you have to'

C

You are on placement at a rural GP practice. At the end of the day, a call comes to the practice that a farmer has had an accident and there is a lot of blood. There is no more information, apart from the location, which is 10 minutes away. You and the GP set off immediately and support has been requested, but is at least 30 minutes away. You are equipped with a fully provisioned sandpiper bag to the location.

- *While travelling to the scene what thoughts would you be having?*
- *What could you be doing in transit to prepare?*

You arrive at the scene; the patient has his right hand caught in a generator. He is in a lot of pain but alert with a pulse rate of 100 bpm and a palpable radial pulse. There is profound bleeding from his trapped right hand.

- *What would your initial approach be to the scene?*
- *How could you attempt to control the haemorrhage?*
- *Are there any simple measures you could take at this point?*

You gain IV access in the left antecubital fossa. As you do you notice the patient is becoming less responsive and the radial pulse is no longer palpable.

- *What could you administer?*

Help has arrived, the patient is continuing to decline and they need to get him free immediately.

- *How could this be achieved?*
- *What are you considerations at the scene?*

Occasionally in pre-hospital care tough decisions have to be made. In this case it may be necessary to conduct a field amputation to be able to care for the patient. This is best conducted quickly using the most effective equipment available, which could be anything from a scalpel to a hacksaw.

Before making such a radical step, take time to stop, re-assess and see if anyone in the group has any further ideas. In some cases it has been known that, at this late stage, for a team member or even the spouse of the patient to come up with an inspired idea to be able to get the patient free.

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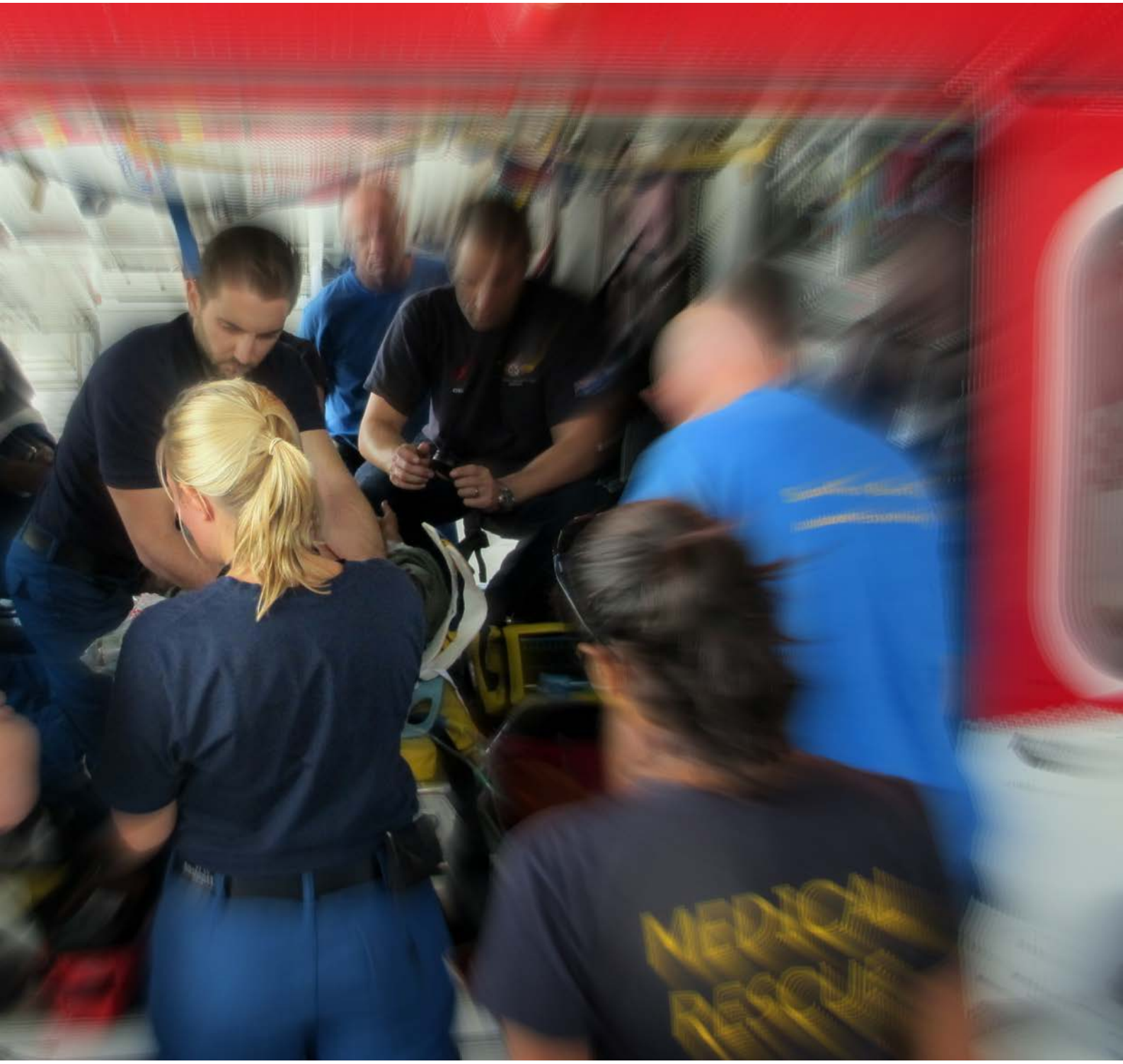
Disability



HEAD INJURY

Head injuries are common in a pre-hospital situation and are associated with significant morbidity and mortality. Once a head injury is identified, prompt management can save lives, so accurate assessment and management is of vital importance.

A primary head injury, leading to brain damage, can be the result of a direct blow to the head, while there can be numerous secondary causes including hypercapnia, hypoxia, hyperglycaemia and hypoglycaemia.

- **Primary** – Skull fractures, focal brain injuries, contusions, extradural haematomas, subdural haematomas, diffuse brain injury
- **Secondary** – these are possible to prevent, a large part of the preceding ABCDE paradigm is addressing factors before they cause a secondary brain injury.

Physiology

Intra cranial pressure and the Monroe-Kellie doctrine[1,2]

The bones of the cranium form a fixed box containing the brain tissue, cerebrospinal fluid (CSF), blood and extra-cerebral fluid. The Monroe-Kellie doctrine states that the sum of the volume of these components is constant due to the fixed nature of the cranium. This means, as one compartment expands it requires a decrease in the other compartments or else intracranial pressure (ICP) will rise.

The blood and CSF volumes are the only components that can be reduced to compensate, but as the need for compensation grows available space can be quickly exhausted leading to a rapid rise in the ICP.

- A trauma situation can lead to increased intracranial blood, this is initially balanced by CSF movement to the subarachnoid space, but only initially, ICP will then increase as the compensatory mechanism is overwhelmed.

Cerebral Perfusion Pressure (CPP) = Mean Arterial Pressure (MAP) – Intracranial Pressure (ICP)

If the intracranial pressure rises, the cerebral perfusion decreases. If the MAP is already low, as in hypotension, then ICP needs to rise less to decrease CPP. Mortality is twice the normotensive rate in head injuries in hypotensive patients.

Raised ICP

A raised ICP can lead to herniation of the brainstem through the foramen magnum. This places pressure on the blood supply and structures that surround the brain and is often fatal.

This can present with numerous symptoms, including abnormal posturing, decreased conscious level, vomiting due to compression of the vomiting center, headache and palsy of CN III and VI.

As the situation progresses, the patient becomes increasingly drowsy and confused. A late sign of the increasing pressure, and of imminent brainstem herniation, is the Cushing response. This consists of the triad of raised blood pressure, decreased heart rate and irregular breathing due to the compression of structures controlling cardiac and respiratory function.

D

ASSESMENT

1. Recording of the Conscious Level via AVPU (Alert, Voice, Pain, Unresponsive) or/and serial Glasgow Coma Score (GCS) recordings

2. Pupillary size, symmetry and reactions

3. Test blood glucose as both hyper- and hypo-glycaemia can account for a decreased conscious level and if a testing kit is available, it is a quick and easy test to conduct and treat.

4. Look for signs of a base of skull fracture including: bruising; contusions or swelling around the head; clear or bloody otorrhea; or rhinorrhea (indicative of a cerebrospinal fluid leak due to a basal skull fracture).

5. Focused neurological examination – Look for posturing, spontaneous movement and then assess tone and power and reflexes in all limbs including plantar reflex.

Why is this important?

Accurate assessment of conscious level and pupil status is vitally important to assess patient severity of illness. It can allow accurate assessment of the odds of a poor outcome. Studies[3] have shown that patients presenting with GCS below 3 and fixed and dilated pupils have a significantly decreased chance of survival. Further research[4] concurred that an unfavorable outcome is strongly associated with low GCS score combined with one or both un-reactive pupils. There was also a significantly increased odds ratio of a poor outcome for both a low GCS and for bilaterally non-reactive pupils when present independent of each other.

How to assess conscious level

The Glasgow Coma Score[5]

Eyes Opening	1- None 2 - To Pain* 3 - To Speech 4 - Spontaneous – (*indicates arousal mechanisms in the brain are active)*
Best Verbal Response	1 - None 2 - Incomprehensible – moaning and groaning 3 - Inappropriate – random speech patterns with 4 - no conversational speech 5 - Confused – answers questions, but disorientated 6 - Orientated – awareness of self and environment
Best Motor Response	1 - None 2 - Extending to pain* 3 - Abnormal Flexion to pain* 4 - Flexing to pain* 5 - Localizing to pain or touch* 6 - Obeying

- Severe Head Injury - <8
- Moderate Head Injury – 9-12
- Mild Head Injury – 13-15

*Pain Stimuli can be elicited in a variety of methods. Pressure can be applied to the finger bed with a pencil; supraorbital pressure, jaw angle pressure and a sternal rub can all be used can. Finger bed pain is a better method for assessing eye response as supraorbital or jaw angle can induce grimacing, causing eye closure.[5]

D

'It's all about the motor score'

Guidelines often suggest that if the GCS < 8 then intubate, this is discussed in detail during the airway section of this handbook. If a patient has a low GCS score you must be aware that gag and cough reflexes may be absent and the patient may not be able to maintain their own airway. If this is the case then they will require endotracheal intubation.

Glasgow Coma Score and AVPU

There are two commonly used methods of assessing neurological status of patients in a pre-hospital environment, the simple AVPU scale and the more comprehensive Glasgow Coma Score.

Conscious levels can give an indication of the development of intracranial pathology, either primary from direct head injury or secondary injuries including hypoxia, hepatic or renal failure, ketoacidosis and hypoglycaemia.[5] Equally reporting the conscious level at the scene can allow comparison to serial measurements taken to see if there is any change indicating deterioration in cognitive levels informing management decisions. A decreasing motor score has been shown to have a significant increase in the odds ratio of poor outcomes.[4]

The Glasgow Coma Score (GCS, first described by Teasdale and Jennett in 1974)[5] is a method of assessing and monitoring head injuries in patients. It involves observations made including eye movements, best verbal response and best motor response. The GCS gives a reliable recording of the level of consciousness and the depth of coma and is in widespread use around the world.

- Best Response – 15
- Comatose patient - <8
- Totally unresponsive - <3

'One large step for mankind – from GCS 15 to 14 in GCS! The [most] important [change] I think'

Problems with the GCS

The GCS score is not routinely first line in a pre-hospital scenario; instead a simplification is used called the AVPU score (Alert, Voice, Pain, Unresponsive).
This is due to the speed of assessment. Conducting a full GCS assessment can take time, while an AVPU assessment allows a rapid neurologic assessment of the conscious level, a GCS can then follow for a complete assessment if time allows.

A pre-hospital environment is often time pressured and this, combined with the tricky environment, can make recording of a GCS increasingly difficult to conduct accurately, leading to the use of AVPU as an alternate.

The GCS is not appropriate in all situations. If the patient could not speak or move beforehand there is not much relevance to them not speaking or moving after an accident. Splints or fractures may immobilise the limbs meaning they cannot move. The eyes may be swollen preventing eye opening and intubation or a surgical airway may occlude speech. These would all give a lower GCS recording giving a misleading result.[5]

AVPU
I*s the patient…* [6]

- **Alert and orientated?**
- **Responds to voice?**
- **Responds to pain?**
- **Unresponsive?**

Advantages:

Rapid assessment of conscious level allowing immediate recognition of problems
Does not require specific training
Easy to conduct
Less reliant on operator interpretation

Disadvantages:

Insensitive – the components of AVPU are broad, and therefore unsuited to long-term assessment of conscious level. Recordings of the GCS to AVPU relationship found a range of overlap between GCS scores in each AVPU category[7] (McNarry[6] indicating the insensitivities of the test.

D

How does AVPU relate to GCS?

Studies[7,6] have looked into the relationship between the AVPU scale and the GCS. Both compared a large number of patients GCS scores to AVPU recordings looking at the stage of AVPU compared to the median GCS recordings. McNarry and Goldhill[6] found AVPU was associated with scores of 15, 13, 8 and 6 respectively while in a slightly larger study Kelly et al[7] found correspondence to scores of 15, 13, 8 and 3.

Pupil Assessment

- Equal size and shape?
- Response to bright light?

'Serial assessments and don't forget to check the pupils'

This is an important investigation to conduct; it is quick, requires minimal equipment and can give a strong indication of intracranial pathology.

It has been shown[4] that patients with compromised pupil reactivity have an increased odds ratio for a poorer outcome. It was equally shown that having bilaterally unreactive pupils had an odds ratio for a poorer outcome twice that of a unilateral unreactive pupil.

Physiology and Pathophysiology[8]

Both pupils should be equal in size, shape and reactivity. The sphincter and dilator muscles govern the size of the pupil. The sphincter muscle is controlled by the parasympathetic fibres of cranial nerve III (CN III), while the dilator muscle is under sympathetic control from post-synaptic neurons of the superior cervical ganglion. These cause the pupils to constrict in bright light, and dilate in the dark that can be tested by shining a light directly into the eyes.

A developing intracranial injury can lead to a sluggish pupillary response due to compression of nerve fibers.

A unilaterally dilated and fixed pupil is an important sign to assess as this can indicate brainstem compression and impending brainstem herniation. This is due to compression of CN III parasympathetic fibres, which are the most superficial fibres and therefore the first to be compressed. Lack of parasympathetic activation prevents the pupil from constricting, thus causing unopposed sympathetic action leading to a fixed dilated pupil.

If these are noticed the patient requires urgent specialist management

Base of Skull Fractures

A base of skull fracture is a fracture involving the floor of the cranial vault. Facial fractures are common, in a single year in the United States there was over 1.5 million craniofacial or cervical spine injuries following automobile crashes[9]. Delay in diagnosis can lead to multiple morbidities including blindness, paralysis and death.

On Examination:

- **Ecchymosis**

Battle's sign - Bruising developing behind the ears developing days after a base of skull fracture

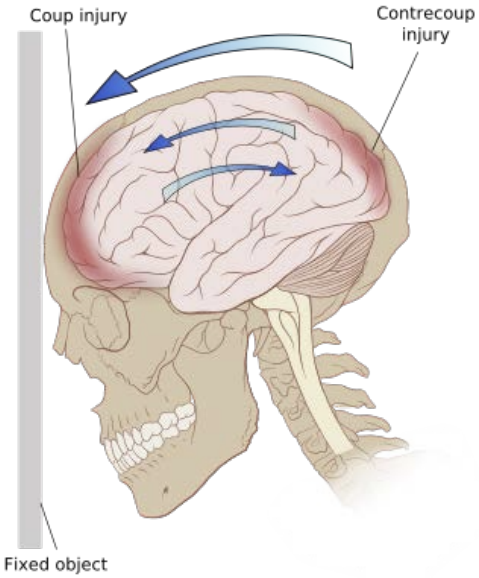
Raccoon eyes – Bruising around the eyes

- **Cerebrospinal Fluid Leak** - this can be from the nose (rhinorrhea) or from the ears (otorrhea)

- **Haemotypanum** – this is the presence of blood in the tympanic cavity, if the eardrum has ruptured then this could be seen as bloody discharge from the ears.

Focal Brain Injuries[10]

These occur at a specific site in the brain and include extradural, subdural heamatomas and parenchymal contusions. Focal brain injuries are produced by collision to the skull, leading to compression of the tissue underneath the site called a *coup* injury, or the tissue opposite the site called a *countercoup* injury. These occur with sudden deceleration forces, such as in a car accident.



There is some information that can be gained from the history. Epidural haematomas, due to tear in a Dural artery (classically the middle meningeal artery), can present with a lucid interval or a period of hours to days without symptoms[11] before lapsing to unconsciousness. This is opposed to a subdural haematoma, due to tearing of the bridging veins between the cerebral cortex and the Dura, where the clinical presentation can range from asymptomatic to coma from the onset. The elderly, anti-coagulated and alcoholics are at increased risk of a subdural, which can occur with minimum trauma.

In a pre-hospital scenario all forms of focal brain injury require admission to a tertiary centre with neurosurgical care for early evacuation of haematoma and pressure relief.

Diffuse brain injuries[10]

These encompass axonal damage, vascular damage, ischaemia and oedema.

Diffuse axonal damage

The general mechanism of diffuse axonal injury is sudden acceleration and deceleration. Due to fixation of axons to the skull base and other structures the acceleration and deceleration leads to diffuse shearing forces transmitted throughout the axons in the brain. Under severe strain maximum elasticity of the axons is overwhelmed, causing widespread damage. Most commonly,[12] this effects; the cerebral cortex, corpus callosum and the pontine-mesencephalic junction. The damage will then cause oedema to develop, raising the ICP and leading to death or further secondary injury.

Diffuse axonal injury is associated with immediate onset of coma with no lucid interval,[13] significant morbidity and mortality.

This requires urgent transfer to a tertiary center with neurosurgical care.

D

MANAGEMENT

The mainstay of management is stabilisation and transfer as soon as feasible to a tertiary centre with a neurosurgical consultant review.

The patient should be positioned at 30° of head elevation post trauma as this has been shown to lead to a constant reduction of ICP and a slight improvement in CPP.[14]

After this the primary aims[15] of head injuries management are preservation of airway and avoidance of hypovolemia.

- If there is airway compromise intubation and ventilation should be undertaken by trained personnel. Alternatively, if the airway is clear, placing the patient into the lateral position, could serve to lower the risk of aspiration without intubation.

- Two large IV peripheral cannulas should be inserted and hypovolemia managed appropriately with small crystalloid boluses if hypotension occurs. Hypotension is an independent risk factor for mortality.

Patients should be continuously assessed for hypoxaemia with pulse oximetry and hypotension with a systolic and diastolic blood pressure reading.[16]

Sedation and analgesia should be carefully managed to avoid the hypotensive effects of the medication, however, analgesia does have an important role to play in management.

GLUCOSE

It is said, and remains an important saying to remember "ABC…DEFG!" (Don't Ever Forget Glucose). A variety of medical conditions and presentations can indicate a high or low glucose level, with an altered mental status being a leading complaint that can be attributed to deranged glucose.

Glucose is a common pre-hospital emergency. A study showed that in 6631 pre-hospital patients tested with rapid blood glucose testing, the prevalence of acute diabetic complications was 3.1% with 213 cases of severe hypoglycaemia and 29 severe hyperglycaemia disorders.[17]

In a pre-hospital scenario trauma can lead to initial rise in blood glucose. In fact this can be used as an indicator of major trauma[18, 19] with studies showing a low sensitivity, but a high specificity (94%) for major trauma.[19]

When confronted with a patient with a decreased conscious level it is important to remember that a glucose problem could be the cause and if a glucose testing kit is available to use, test and treat appropriately

Treatments for hypoglycaemia are easy to administer and readily available and as such testing is all the more important. 15-20g of simple carbohydrate such as oral glucose, for example lucozade or jelly beans, IM glucagon and even IV glucose can all be delivered and can have a large therapeutic effect for patients.

ABC – DEFG = ABC Don't Ever Forget Glucose

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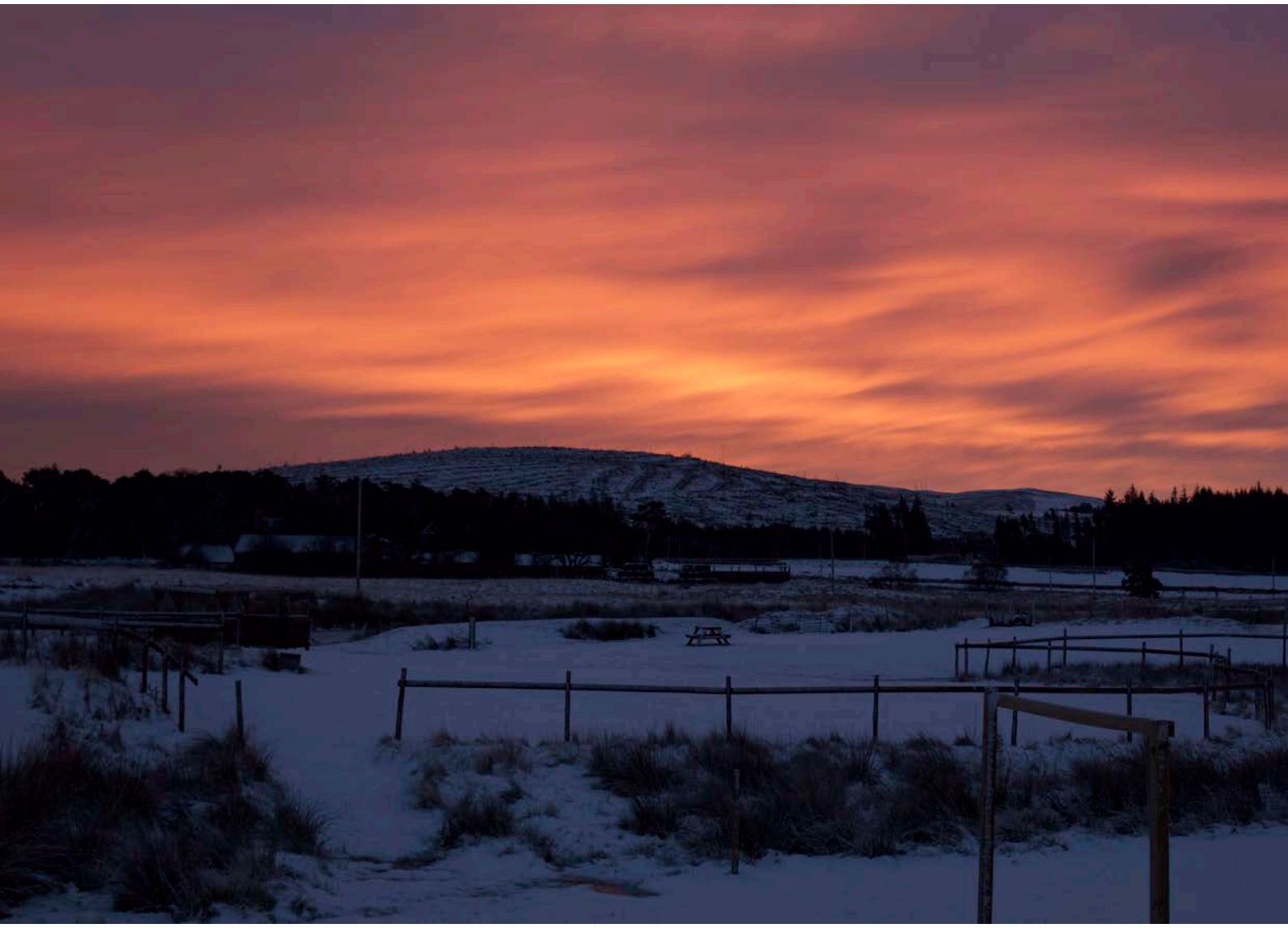
Exposure



E

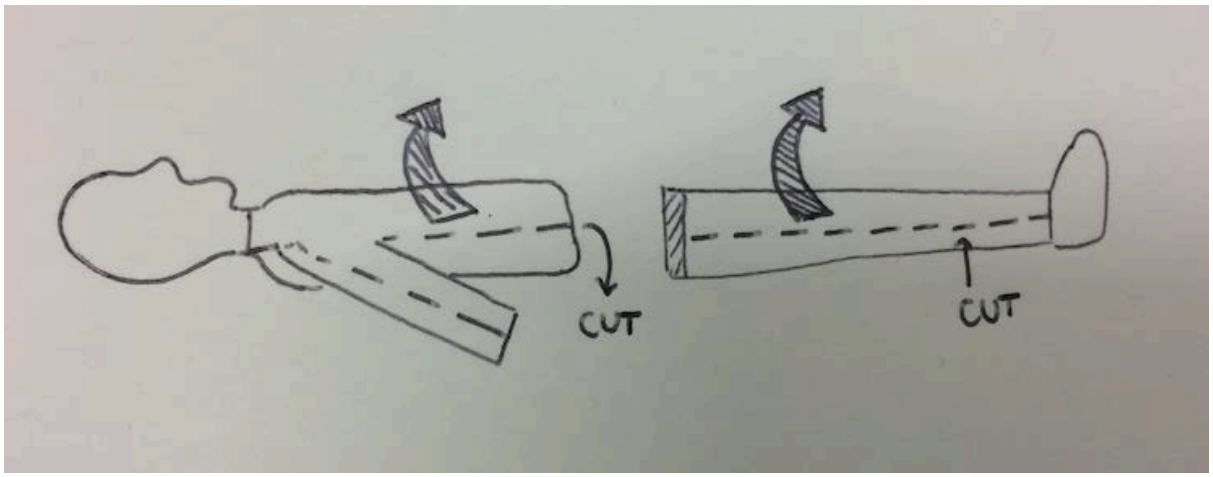
Exposure / environment is part of the primary survey ABCDE paradigm[1] and is not to be confused with the secondary survey. The exposure / environment assessment aims to reveal signs of life threatening conditions such as a purpuric rash, bleeding, trauma etc.

Individual sections on; hypothermia; head injury; glucose and meningitis can be found in this Exposure and Environment section.

How to exposure a patient?

'Don't assume, Look!'

It is sometimes necessary to exposure the patient to looks for signs of life threatening conditions (this should be respectful of the patient's dignity and with an awareness of heat loss). If it is appropriate and necessary to expose the patient the diagram below shows where cuts should be made. The cuts are made in a clamshell fashion; this allows the clothes to be laid back onto the patient with the aim to reduce exposure to the environment.



'Get the patient off the ground, have 360-degree access, expose completely then cover again'

LOG ROLLS

A log roll is a method to move a patient without flexing the spinal column. The manoeuvre aides assessment, transfer and extrication of a patient while maintaining spinal immobilisation.

When are log rolls used?

They are used to allow:

- Transfer of the patient to an extrication board
- Full examination of the back and spine to assess for wounds not visible when the patients is lying supine

Problems with Log Rolling

Log rolling is an established technique amongst pre-hospital care practitioners and is used routinely in ABCDE assessment. Yet, there is opinion that log-rolling may be detrimental to some patient cases, in particular those with pelvic fractures. This is because log rolling involves movement, and even small and controlled movements, as in the case of a log roll, can work against the patient's physiological response to injury.

First, movement can dislodge clots[2] that are forming, promoting further bleeding, therefore, increasing the risk of the patient becoming haemodynamically unstable. Second, movement of any kind in an injured patient can be excruciatingly painful. This pain can in turn increase the sympathetic drive and lead to an unhelpful increase in blood pressure.[3] Both these problems are unwelcome in a haemodynamically unstable patient.

Log rolling is used as a way the patient can be moved while maintaining spinal immobilisation. A consensus statement[3] from the Faculty of Pre-hospital care noted there is little evidence available on whether spinal immobilisation is maintained during a log roll. The evidence that is available suggests that spinal alignment may not be maintained even with the use of a spinal board during a 90° log roll. This led the faculty to recommend that the long spinal boards should only be used for extrication rather than spinal immobilisation. This is will be discussed later in this section.

How to log roll?

In order to carry out a safe log roll for both patient and responders, a minimum of four 'responders' are required; one person maintaining manual inline stabilisation of the head and three people at the patient's side performing the log roll. If transferring to an extrication board or scoop stretcher an extra person is required to position the board next to the patient to allow easy transfer. This person may also be asked to inspection the back of the patient as part of the secondary survey.

If four people are not available then a log roll can be conducted with two or three people; one maintaining manual inline stabilisation and one or two on the body.

This does have an increased safety risk compared to the four person technique, yet the log roll may have to be performed for care of airway, breathing, circulation or extrication. The ABC always takes priority over disability, and for full assessment and management it may require a log roll. If four people are available, then using all four is highly desirable. If a log roll is necessary for control of A, B or C then it should always be conducted, even if there are fewer than four people. Control of A, B or C outweighs the increased risks associated with log rolling with less than 4.

The person at the head of the patient, providing manual inline stabilisation is also in charge of the manoeuvre and provides directions to the rest of the team on how to conduct it.

Those four people involved in performing the actual log roll are responsible for each of the four body segments below:

- Head (maintaining manual inline stabilisation to prevent/protect c-spine injury)
- Chest
- Pelvis
- Legs

If necessary, the log roll can be repeated on the other side.

Method

1. **Choose one person, responder 1, to take control of the head and maintain manual inline stabilisation.** The person at the head is in charge of the group and gives commands to perform the log roll. This person should also make sure everyone in the group knows what they are doing. Clear instructions and good communication are essential for a successful log roll.

2. **Responders position themselves ready for a log roll.**

One person at the level of the shoulders, one at pelvis, one at legs. Check that there is nothing in the patient's pockets before the log rolls occurs.

Responder 2, 3 and 4 are then selected as to height order with 2 being the tallest and 4 being the shortest.

Responder 2 places one hand across the patient's body at the shoulder and one hand on the greater trochanter

Responder 3 places one hand on the anterior superior iliac spine and one hand on the proximal thigh

Responder 4 places one hand under the knee and one hand under the ankle

3. **Command given by the leader to roll to X°**

4. **Extrication board or secondary survey carried out.**

    a. If using an extrication board, this is slid down the side of the patient (NB: it is important that if using a scoop stretcher it has to be sized to the patient's height beforehand).
    b. Secondary survey conducted; inspecting and feeling for wounds not visible when the patient is lying supine.

5. **Command to lower patient back down given**

The Log roll can then be repeated on the other side if necessary

Communication

Clear communication is essential to performing a log roll successfully. Unambiguous language should be used to prevent any misunderstandings when following commands.

For example; using the phrase 'Ready-brace-roll' rather than '1-2-3' aims to get everyone of the team log rolling the patient at the same time. When using the instructions '1-2-3' if not articulated well there tends to be a split between members of the team, in that half will roll the patient on 'three' and the rest on the implied fourth beat '1-2-3-roll.' This can mean different parts of the body move at different times and therefore potentially nullifying the effect of manual inline stabilisation.

Language and communication used in the log roll should ensure everyone knows exactly what is expected of them when performing a log roll.

Leader:

- Everyone we are going to log roll Mrs X towards the patient's right hand side.
- The log roll will be to 45°
- The commands for this will be 'ready-brace-roll,' with us moving on the word 'roll.'
- Does everyone understand the commands? (wait for response from team)
- Is everyone ok to proceed? (wait for response from team)

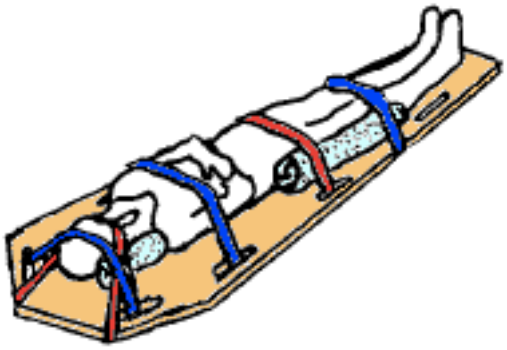
Execute the commands log rolling the patient up and then the same commands again when log rolling the patient back down.

Key Points for a successful log roll:

- Manual inline stabilisation of the head
- Fluidity of movement
- Good communication
- Good preparation

LONG SPINAL BOARD

A long spinal board or extrication board is primarily used in pre-hospital care for removal of the patient from the scene. It was recommended in a consensus statement by the Faculty of Pre-hospital care[3] that spinal boards should be used only for extrication and not for spinal immobilisation. Once the extrication is complete, a scoop stretcher should be used to transfer the patient on to a vacuum mattress, ready for transport.



Problems with the long spinal board[4]

A systematic review[5] published in 2005 looked into the adverse effects of spinal immobilisation on a spinal board when used on healthy individuals. It listed numerous negative effects of the spinal board including:

- Pressure sores
- Inadequate spinal immobilisation
- Pain and discomfort, predominantly because a patient has to lie against a flat hard surface
- Resultant pain and tenderness leading to unnecessary radiographs
- Decrease respiratory capacity

One of the main problems associated with the long spinal board is the development of pressure sores. Whilst on a spinal board, the patient has to lie against a flat, hard surface for an extended period of time, increasing the risk of pain and pressure sore development. The mechanical pressure applied during spinal board use, worsens tissue perfusion, which is already aggravated by the primary injuries. The most common sites for problems include the occiput, thoracic spine and sacrum.

A case control study by Mawson et al[6] showed a clear association between the time spent on a spinal board and the likelihood of pressure sore development. It is worth noting that there are many confounding variables that could also contribute to pressure sore development, these include hypotension or reduced consciousness.

A Cochrane review[7] discussed the risks of unnecessary spinal immobilisation, including iatrogenic pain, pressure sores and respiratory depression. A study showed that in adults aged 65 to 75 years that there was a significant increase in respiratory effort whilst using a spinal board compared to a vacuum mattress[5] and It has been stated that immobilisation in a supine position can decrease respiratory capacity by 15-20%.[8] This is especially a problem in the obese, elderly and those with cardiorespiratory compromise.

A study found that 21% (19 patients) with cervical pain or tenderness while on a spinal board were resolved once they were transferred off the board.[6] Both pain and pressure sore development can be reduced with the use of a vacuum matraess.[3] The vacuum mattress will be discussed later in this section.

The spinal board is no longer an acceptable means of spinal immobilisation. Lumbar support for a patient on a spinal board is lacking, with a noticeable gap present between the patient and the board. This means the spinal board does not provided adequate support to prevent secondary cord spine injury and, therefore, cannot be described as effective spinal immobilisation.

In the past spinal board was gold standard for spinal immobilisation. It is now accepted that the spinal board does not provide adequate spinal protection and has numerous adverse effects therefore should only be used for extrication.[3]

SCOOP STRETCHER

The scoop stretcher is a stretcher commonly used for patient transfer; usually to transfer the patient onto a vacuum mattress ready for transport to definitive care. It has been suggested that the scoop stretcher can be adapted for spinal immobilisation with the use of head blocks and tape, but if this time exceeds 45 minutes then use of a vacuum mattress is indicated.[3]

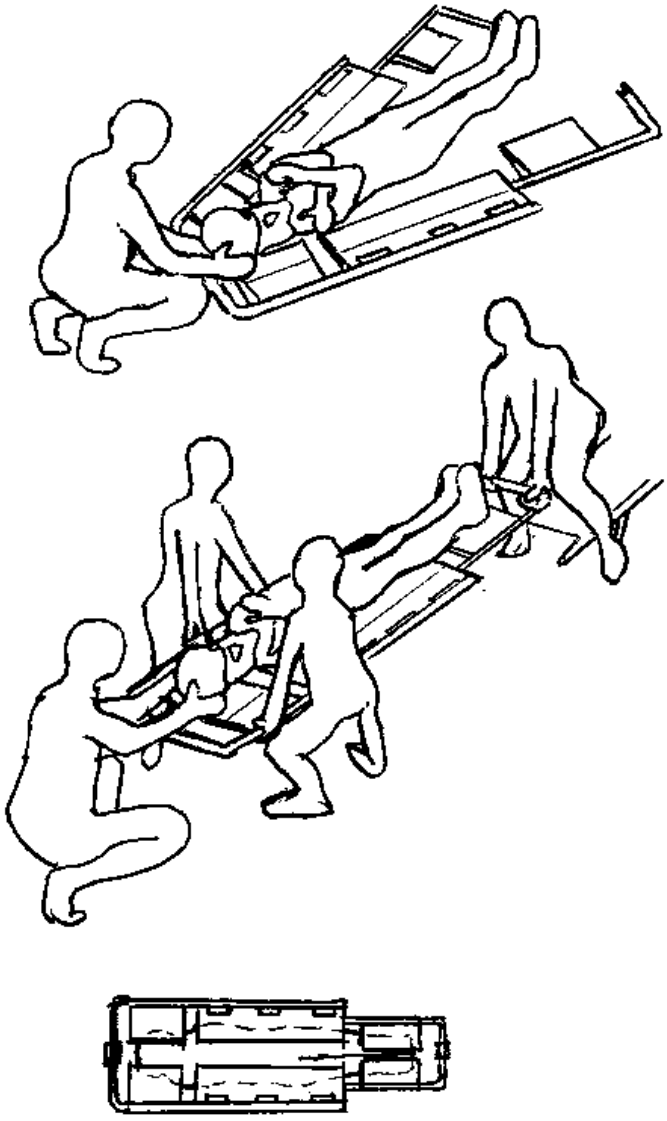
The scoop stretcher is ideal when transferring patients with suspected c-spine injury. It only requires a low 10° log roll compared to the 45° log roll for the long spinal board. This small movement is a key advantage to the scoop stretcher; while minimising patient movement, it is still sufficient to place the blades of the stretcher underneath the patient.

The scoop stretcher is primarily for patient transfer, and so its main limitation is it's unsuitability of long distance transport. Other disadvantages include weight limit and the difficulty to use head blocks for c-spine immobilisation.[3]

Technique

For the scoop stretcher you will use the log roll technique previously discussed in this section.

- **Size the scoop stretcher** - Lie the stretcher beside the patient to adjust the length as appropriate
- **Split the blades** and lie either side of the patient (when carrying the blades to the other side of the patient DO NO WALK OVER THE PATIENT, walk around the patient with the blades)
- **Log roll** to 10° and slip the blade in beside the patient
- **Clip the blades together** (clip the blades at the head first, as it is easier to adjust the length at the feet)
- Secure the body with straps
- Secure head with head blocks and tape
- Vacumat blankets can be used prevent lateral shift of the spine[9]



When using the scoop stretcher a 'scoop-to-skin'[9] approach is used, where all clothing should be removed (If the patient is exposed to the elements and removal of clothing would risk hypothermia measures should be taken to reduce heat loss). This follows the 'single movement principle'[3] whereby the patient should be packaged in a certain way to allow minimal handling once at the hospital, this also decreases localised pressure from clothing.

What is the 'single movement' principle?[10]

Describes how an early single movement can prevent excessive handling of the patient later on. This aims to maintain haemostasis, minimise spinal movement and dislodging of the 'first clot.' During this single movement all assessment and interventions should be carried out before placing the patient back down on a transfer stretcher.

VACUUM MATTRESS

The vacuum mattress was invented in the 1960s by Loel and Haedril and has been one of the most significant advancements in how pre-hospital practitioners transport patients from the scene to the hospital.[11]

It is a device used to transport patients to definitive care, while providing rigid support for spinal immobilisation. It's most significant advantage over other techniques is in providing a comfortable means of patient transport.

ADVANTAGES[10]	DISADVANTAGES
Spinal immobilisation	Cannot be used for extrication
Comfortable transport	Expensive
Moldable to different shapes	Require maintenance to avoid device failure
Insulatioin from the environment	
Support if the patient is tilted laterally	
X-rays can be taken through the mattress	
Can be used in water (it floats)	
Light weight	
Rigid support for pelvic injuries	

Importantly, patients are less likely to develop pain[7] and the spinal immobilisation offered by the vacuum mattress is superior compared to other methods of transport and spinal immobilisation. A study[12] showed that under a gradual tilt the vacuum mattress prevents excessive movement in the longitudinal and lateral directions compared to the long spinal board. Pressure symptoms associated with the long spinal board are also less of an issue in the vacuum mattress[3]

How to they work?

The vacuum mattress, sometimes called 'VacMat,' is made of a durable plastic outer shell, which contains polystyrene beads.[13] When the pump is applied and air is sucked out, the polystyrene balls are pressed together and the vacuum mattress becomes rigid and moulds to the shape of the patient

Technique

To use the vacuum mat you will need to be familiar with carrying out a log roll and using a scoop stretcher.

- Use the technique previously discussed to log roll the patient onto a scoop stretcher
- Place the patient on the vacuum mat and remove the blades

- Mould the vacuum mattress around the body
- Remove the air via the pump
- Strap the patient in and ensure triple immobilisation of the head via head blocks and straps

NB: other types of vacuum devices can be used for immobilisation of limb trauma, spinal injuries and transfer.

HYPOTHERMIA [14]

'It gets cold'

'It's cold out there even when the sun shines; think [about the] wind effect and then protect patients, especially the elderly'

Hypothermia occurs when core temperature drops below 35°C, this can occur during cold exposure. It can be classified as **mild** (33-35°C), **moderate** (28-33°C) and **severe** as below 28°C. It is a rare cause of death; with annual mortality rates found in Ireland [15] at 18.1 per million and death certificates show hypothermia cause 300 deaths annually in the United Kingdom. It has been shown that severe hypothermia, secondary to environmental exposure has a mortality rate between 30 and 80%. [16]

It is an important consideration in pre-hospital care, especially in the north of Scotland, with large, remote areas attracting outdoors enthusiasts to the variety of activities available.

Hypothermia can complicate any situation; in a trauma situation, delays to assistance can lead to long exposures in cold environments. Alongside the problems directly from the trauma, this can lead to hypothermia, which in turn can lead to cardiac arrest and death. Hypothermia has been shown to increase mortality rates in trauma when compared with those with normal core temperatures.

Physiology [14, 17, 18]

The body has various homeostatic mechanisms to maintain a constant core temperature meaning that the amount of heat lost to the environment is altered in relation to the external temperature.

Heat is lost from the body in a variety of mechanisms:

- **Conduction** – direct contact with a cooler object
- **Convection** – due to air currents over the body
- **Radiation** – heat transfer from a area of high temperature to an area of low
- **Evaporation** – water evaporating from the skin or lungs in breathing
- **Respiration** – combination of all the above, but breathing is an important method of heat loss

Exposure to the cold, from submersion in cold water or exposure to cold temperatures stimulates the thermoregulatory centres in the anterior hypothalamus; this causes a variety

of responses including sympathetic activation, endocrine activation through ACTH and TSH, muscle stimulation, and adaptive behavioural actions. This leads to either an increase in heat production or decreasing heat loss.

Cooling of the brain can effect decision making and lead to confusion and apathy, over time, this can lead to coma. Yet, this can also be protective, due to the decreased cerebral oxygen requirements, resulting from lower metabolic requirements.

As the heart cools, abnormalities in the electrical conduction can lead to arrhythmias including atrial fibrillation (AF) and ventricular fibrillation (VF). The cardiac output drops and bradycardia occurs.

Medical conditions affecting the skin surface decrease control over temperature and can cause hypothermia, for pre-hospital management burns are the important consideration. Intoxication, namely alcohol, can also increase the susceptibility to hypothermia.

Presentation of Hypothermia

The following tables give two different views of the symptoms that may be encountered. Hypothermia has multiple effects on all body systems and knowledge of what occurs and which degree of hypothermia this relates to is important in care and management of the patients.

System	Mild	Moderate	Severe
Cardiovascular	• Tachycardia • - Peripheral vasoconstriction	• Bradycardia – due to decreased spontaneous depolarization of pace-maker cells • J waves on ECG 	• Myocardial irritability leading to Atrial fibrillation • Ventricular fibrillation at 24-28°C • Extreme bradycardia • Asystole <24°C
Neurological	• Confusion	• Loss of fine motor skills • Slurred speech	• Unconsciousness • Areflexia • Fixed dilated pupils • Decreased metabolism
Coagulopathy	• No change or possible hypercoaguable state	• Platelet dysfunction • Increased physiological anticoagulants	

37.5°C	Normal Body Temperature	• Patient feels cold • Alert • Numbness in peripheries • Put on more clothing and seek shelter • Increased movement
35°C	Mild Hypothermia	• Shivering • Pale and cool • Mood change and irritability • Confused, drowsy, lethargic. Patient may appear drunk • Amnesia • Refusal to accept problem • Decreased co-ordination • Increased heart rate • Hyperventilation • Ataxia • Cold diuresis – vasoconstriction raises mean arterial pressure inducing a diuretic like effect on the kidneys via renal resistance to ADH
32°C	Moderate Hypothermia	• Uncontrolled shivering • Increasingly confused/decreased conscious level • Incoherent speech • Hypotension • Bradycardia • Decreased respiratory rate due to decreased metabolic rate • Cardiac arrhythmias – AF or other atrial and ventricular rhythms • Remove clothing as they think they are to warm called ‘paradoxical undressing’ • CNS depression leading to hypoventilation and hyporeflexia • ECG changes – J wave formation • Unreactive dilated pupils
28°C	Severe Hypothermia	• Muscle stiffness and rigidity, apparent rigor mortis • Fixed dilated pupil • Loss of consciousness • No shivering • Bradycardia • Cold skin, blue coloration • Irregular heart beat • Pulmonary oedema • Unresponsive • Apnoeic • Complications including DIC, pancreatitis and ileus • Cardiac arrest

ASSESSMENT[18, 19, 20]

Diagnosis of hypothermia is made with a core body temperature of below 35°C. This is ideally recorded from more than one site such as rectal, oesophageal and bladder temperatures. After the initial diagnosis continuous measurements from multiple sites is encouraged to monitor the temperature progression; the wilderness society recommend repeated epitympanic temperature measurements.[18]

It is, however, incredibly difficult to be able to record temperature accurately in the pre-hospital environment. The only true recordings of temperature are made via oesophageal or central venous temperature, however, these are hard to record and aren't practical to perform. Therefore use of epitympanic thermometers can be used to give a temperature, however remember that this, potentially, may not be accurate.

Measurements obtained with infrared cutaneous thermometers are often inaccurate in hypothermic patients.

Checking the pulse rate is important, however this can be difficult to read in hypothermic patients and so should be observed for a full 60 seconds.[19]

But how about if you don't have a thermometer?

The Clinical Swiss Staging system is used to indicate the stage of hypothermia determinant on vital signs. This breaks hypothermia into five stages to allow clinical assessment that will govern the future approach to the scenario.[21]

Stage of Hypothermia		Core Temperature (°C)
I	Clear consciousness, shivering	35-32
II	Impaired consciousness without shivering	32-28
III	Unconsciousness	28-24
IV	Apparent death	24-13
V	Death due to irreversible hypothermia	<13

Not dead until warm and dead

Due to the decreased metabolic rate secondary to the low core temperature hypoxia can be tolerated for a longer period of time due to increased ischaemic tolerance of the brain. This means that in severe hypothermia resuscitation can be successful even after a period of hours.

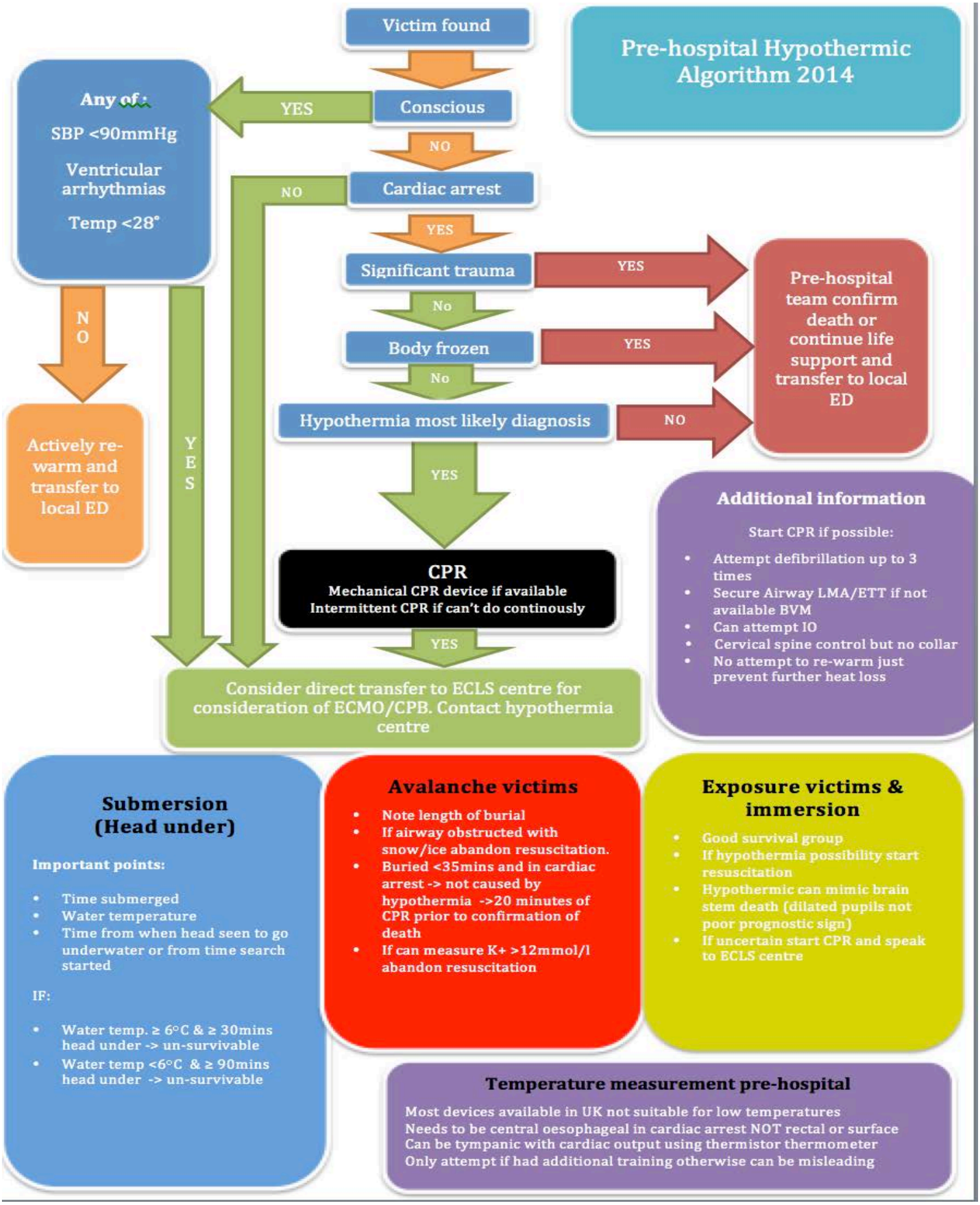
A Case study[22] showed that after rewarming via cardiopulmonary bypass via a cannula in the femoral vessel asystole changed to ventricular fibrillation to sinus rhythm without defibrillation. This occurred over a temperature increase from 22°C to 26.7°C. The patient had been found 'drifting' in the sea, which was 12°C, and had been confirmed to be in asystole two hours before rewarming via cannula and a further half an hour until sinus rhythm was regained without any defibrillation. Equally amazingly the patient was later discharged without any neurological deficits.

There have been other examples,[16] often in children due to a higher incidence of submersion events in this population, which have shown similar effects.

It is cases like this that lead to the adage:

'A hypothermic patient is not dead until they are warm and dead'

MANAGEMENT[18,21,23]



Stabilise
Insulate
Transfer

'Keep them warm and happy'

Pre-hospital treatment of hypothermia involves provision of basic life support if required, rewarming strategies and transport to appropriate secondary or tertiary care. Management should always begin with a safety assessment, as hypothermic environments can often be dangerous environments for the rescuers. A full ABCD assessment with any findings addressed.

If there are no signs of life begin CPR

Gentle handling is necessary at all points due to the risk of dysrhythmias

Stage I

This is managed by simple measures. Provide shelter, warm sweet drinks, change of clothing if wet and provide further insulation. Activity and shivering should be encouraged to increase heat production.

Stage II

Careful handling is of utmost importance, due to the risk of arrhythmias with inappropriate handling, if no c-spine suspicion, management in the horizontal positioning being recommended.

If able to swallow, with a preserved gag reflex, warm, sweet drinks can be given and transfer to a hospital with ICU provision should be arranged.

Stage III

Careful handling is needed to avoid life-threatening arrhythmias. It becomes difficult to gain access due to peripheral vasoconstriction, so, early IV access should be obtained. If IV access is not accessible, intraosseous access is indicated. Rewarming strategy should begin and insulation against further heat loss organised. Transfer to a tertiary centre, preferably with cardiopulmonary bypass should be provided.

Stage IV

Resuscitation should be started as soon as the diagnosis of cardiac arrest is confirmed. CPR should be started and continued throughout. Due to the numerous cases of fully successful resuscitation, even after a prolonged cardiac arrest,[16,22] CPR should not be terminated early.

Intubation, by trained and experienced practitioners, or use of a LMA can provide airway assistance with ventilator support

Afterdrop[23]

The afterdrop is a continued fall in the core temperature after removal from the cold environment due to an increase in conductive heat loss from when the peripheries re-perfuse. This is important to remember during medical care as a further drop can increase the risk of ventricular fibrillation (VF).

Limiting limb movement, managing in the horizontal position and through active rewarming, prevents this. Equally the hypothermic patient should not be allowed to stand or walk for at least 30 minutes after protection from heat loss.[18]

Continuous or intermittent CPR?

It is classically taught that CPR should be continued until the patient responds, definitive treatment is available or the rescuer cannot continue. However, due the protective mechanism of cold on cerebral oxygen demands, there are cases of full recovery following long delays in CPR.

In a pre-hospital scenario it may be impossible to maintain CPR throughout extrication and transport to hospital. The Wilderness Medical Society[18] recommends that CPR may be delayed or given intermittently in evacuation if continuous CPR is not possible. Guidelines[24] published 2015 in Resuscitation recommend that, only when continuous CPR is impossible, delayed or intermittent CPR can be used.

The recommendations from Gordon et al:

- CPR can be delayed by up to 10 min to allow rescuers time to move the casualty to a safer location
- If core temperature is 20-28°C, perform at least 5 min CPR and <5min without CPR
- If core temperature is <20°C, perform at least 5 min CPR and <10min without CPR
- If core temperature is unknown, perform at least 5 min CPR and <5 min without CPR
- Resume continuous CPR as soon as feasible

Airway

Airway management is considered in patients who are not breathing or not protecting their airway, often due to decreased conscious levels. Endotracheal intubation or a supraglottic airway device may be indicated in these patients.[18]

Heat management[18]

After initial assessment and resuscitation, if required, maintenance of core temperature is the next consideration.

Insulation – this protects from further heat loss. Methods include extra clothing, blankets, sleeping bags and insulation pads. The patient should be insulated from the ground with sleeping pads due to the large amount of heat that can be lost through conduction.

Wet clothing – wet clothing should be removed only when the patient has been protected from the cold, therefore, if protection is not available clothing should not be removed.

Rewarming[18,23]

To prevent further cooling, lowering the VF threshold, and to reduce the afterdrop risk, active warming should begin in the field. Patients with an altered consciousness will usually require active re-warming. The patient can be encouraged to shiver; however this causes increased energy usage. Warm, hot, sweet drinks provide warmth alongside calorie support for shivering.

If available heat packs can be used, though not with direct skin contact, due to the risk of thermal injury, these can be placed on the neck, thoracic inlet, axillae, abdomen and groin and allow heating.

Warm humidified oxygen, 40-46°C may be given if available through a mask as a useful adjunct to other management. This acts to prevent further respiratory heat loss.

Fluid therapy[18]

As circulating blood volume is decreased in moderate and severe hypothermia; this needs replacing to prevent hypovolemic shock when vascular space is subsequently increased with peripheral vasodilation on re-warming. This fluid should be warmed to 40-42°C and the bags insulated with normal saline being the fluid of choices

Cold (>35°C)

Encourage activity, put on more clothes

Mild Hypothermia (35-32°C)

- Insulation
- Shelter
- Warm sweet drinks
- Remove wet clothing if other clothing is available
- If uninjured and alert then there is no need for hospitalization

Moderate Hypothermia (32-28°C)

- Active warming- heat packs, forced-air
- IV/IO access
- Fluid replacement – saline heated to 40-42°C
- Transfer to hospital, if haemodynamically unstable then ensure an ICU and cardiopulmonary bypass if available.

Severe Hypothermia (<28°C)

- Treat as per above
- Intubation or use a supraglottic device followed by ventilation
- CPR if no signs of life
- Transfer to hospital preferably with cardiopulmonary bypass

You've been called to see a patient high in the Cairngorms. It is winter and he became lost whilst out walking - this was several hours ago. His wife, who he was due to meet at the bottom of the hill, alerted the mountain rescue service. On arrival he is mottled, pale and unclothed. His clothing is in a pile next to him where he took them off. He is now unresponsive.

- *How would you prepare for this call out?*
- *What would you look for in the pulse?*
- *How would you assess the patient?*
- *Has he got mild, moderate or severe hypothermia?*
- *What measures could be taken to prevent further heat loss at the scene?*

A recording of a body temperature of 19°C is taken. He does not have a palpable pulse.

- *What would your immediate management be?*

The helicopter cannot land in the conditions therefore the patient will have to be transported out on a stretcher.

- *How could this affect the current management of the patient?*

Hypothermia is a serious emergency. The environments where hypothermia can occur present a variety of challenges both in resuscitation and evacuation, and therefore require a thorough preparation and scene safety assessment. The level of hypothermia can be graded through various methods but the clinical presentation of this patient suggests severe hypothermia.

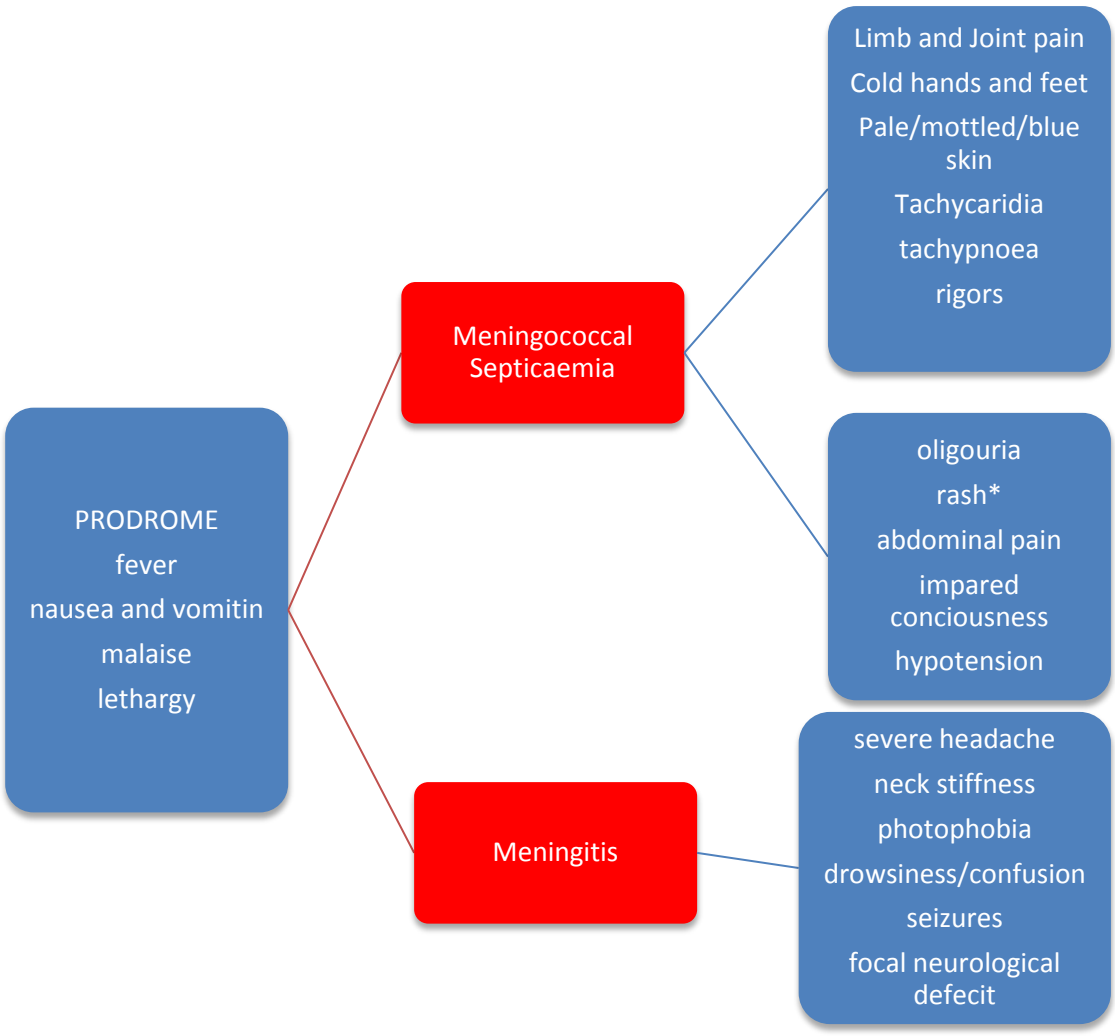
There has been debate on the efficacy of intermittent CPR during hypothermia, and in this situation, whereby he is being stretchered a significant distance, complete CPR would not seem to be an option. The current guidelines state that intermittent CPR can be started when continuous CPR is impossible. In this case this would consist of 5 minutes CPR followed by less than 10 minutes without CPR. This would allow for a sequence of transport, followed by CPR, followed by transport, and so on.

A patient isn't dead until they are warm and dead. Full recovery has been noted after a sustained period of asystole, therefore long extrications may not be a barrier to a good patient outcome.

Meningococcal Disease[25]

Meningococcal disease has two main clinical presentations, meningitis and septicaemia. Bacterial meningitis is an infection of the meninges from a variety of bacterial causes, while meningococcal septicaemia is where there is uncontrollable bacterial proliferation in the blood. Meningococcal septicaemia can often present separately from meningitis and vice versa.

Assessment



*a rash from meningococcal septicaemia. This is a clear and important sign to recognise and act appropriately, this may not be present in meningitis.

Management

If the respiratory rate is raised or there are signs of shock and hypovolemia then oxygen and fluid therapy should be started.

There are two situations where parenteral antibiotic therapy with intramuscular or intravenous benzyl-penicillin can be started in the pre-hospital environment:

1. If there is a high clinical suspicion of meningococcal disease with a non-blanching rash.
2. If urgent transfer is not available and meningococcal disease is suspected without a non-blanching rash, you can begin antibiotic therapy, but do not delay patient transfer

If meningococcal disease is suspected then urgent transfer to secondary care is required

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Fractures

ASSESSMENT

Unless there is catastrophic haemorrhage, follow the ABC algorithm to complete the primary survey. Catastrophic haemorrhage is immediately life threatening and should be arrested before commencing the ABC assessment. This has been adopted following military experience with combat situations demonstrating that catastrophic haemorrhage would kill a patient before airway or breathing problems did.[1]

Examination of fractures not causing catastrophic haemorrhage is included in the secondary survey. The secondary survey is a head to toe examination of the patient. This is conducted on completion of the primary survey.

Musculoskeletal examination follows the basic principles of 'look, feel, move.' When conducting this examination, care should be taken to prevent further pain or distress to the patient.

Specific areas to assess for fractures include:

- Sites of suspected fracture from the mechanism of injury
- Clavicles and shoulders
- Upper limbs
- Pelvis
- Lower limbs
- Back

'If a patient can walk, it is unlikely they have a significant disability'

FRACTURE ASSESSMENT	
1. Before starting the assessment consider the mechanism of injury – which fractures are most likely? 2. Take a focused history - If the patient is conscious or there is a witness, ask what happened? Ask where it is painful? 3. Look at the position the patient is lying in – does this aid your clinical suspicion? 4. Assess the degree of pain the patient is suffering	
LOOK - Identify any bony abnormality of the limb	• Look for an obvious deformity, open fracture or gross swelling • Look for any scars, bruising, bleeding, swelling and tenderness • Look for any signs of pain from patient that could indicate a fracture e.g. they may be clutching their the affected limb or trying not to move it • Is there any loss of function? • Look for asymmetry, compare one side to the other • Colour of the whole limb – is it pale?
FEEL	• Feel for warmth and sensation • Check for neurovascular compromise by checking the peripheral pulses and sensation distal to the injury (this must be clearly documented) • What is the capillary refill time? Compare it to the unaffected limb (capillary refill time will increase with decreasing perfusion) • Assess whether the affected area is painful and tender
MOVE	• *This part of the examination may be inappropriate if too painful or if it exacerbates the injury* • Is there reduced range of movement? • Is there reduced function?

Do not let limb fractures **DISTRACT** attention from other less visible life threatening fractures

MANAGEMENT

As soon as external haemorrhage is controlled, basic wound management, analgesia and traction should be applied. The basic principles of fracture management are discussed below.

It is important to remember that before and after doing anything to the affected limb neurovascular status must be assessed.

IMMEDIATE MANAGEMENT
• Stop any external haemorrhage • Immobilise the affected area • Give adequate analgesia • If pelvic or long bone fracture get IV access (both these are cause of major blood loss and so IV access can be a life-saving intervention)

Neurovascular compromise is an indication for immediate reduction of the fracture.

Other basic management:

- Prevent further contamination by bandaging the wound
- Take a photograph before covering the wound up to prevent undressing and redressing the wound to show other clinicians
- Explain to the patient what you are doing as you go along – the patient will already be in pain and anxious. Cooperation of the patient is helpful when using splinting techniques.

ANALGESIA[2]

The most effective form of pain relief in fractures is early immobilisation and re-assurance; this can have a similar or greater effect then medication.

Fractures, however, are extremely painful and so adequate analgesia should be given, usually intravenously. As well as relieving pain from the primary injury pain relief is needed for packaging, extrication and transport.

- **ENTONOX** – if available can be used. Unless there is a circulatory shock, pneumothorax, head injury or cutting equipment is used (Entonox is combustible because of it's oxygen content)[2]
- **MORPHINE** – IV morphine is effective but can cause vomiting, hypotension, respiratory depression and reduced consciousness

- **KETAMINE** – at a low dose this drug has been shown to be useful in prehospital care for patients who have a changed level of consciousness or hypovolaemic [3]
- **PERIPHERAL NERVE BLOCK** – e.g. femoral, median, ulnar nerve

Analgesia will be discussed in more detail in a later section of this manual

IMMOBILISATION AND SPLINTING

Splinting and immobilisation provide support and protection. They have many beneficial effects including:

- Reducing pain by reducing the mobility at the fracture site
- Reducing blood loss by anatomical alignment of bleeding bones and preventing the disruption of a clot
- Restoring neurovascular function
- Reducing the risk of fat embolism

When immobilising a fractured limb it is important to:[4]

- Reassess neurovascular status before and after anything is done to the affected limb
- Immobilise the joints above and below the affected area

Application of splints should follow the manufacturer's instructions for that particular splint. Open fractures, discussed later should be decontaminated by irrigation and a dressing applied before splinting occurs.

When to splint a fracture?[4]

INDICATIONS	CONTRAINDICATIONS*
1. A limb need immobilising because of a fracture or pain 2. Reduce pain 3. Prevent further neurovascular injury	4. Open fractures 5. Compartment syndrome

*these are relative contraindications and whether to splint a fracture or not is usually guided by clinically findings and experience

BOX SPLINTS

A box splint is a simple device used to splint leg fractures, particularly ankle and tibial fractures. They are made of a three-padded side with a foot piece, and aim to prevent adverse movement.

How to apply

Box splints are quick and easy to apply. Additionally they can be modified to allow for neurovascular assessment. The central padded side is placed under the affected limb, and then the remainder of the padded sides are folded, so the splint looks like a box around the limb. The foot piece holds the ankle at 90°. The limb is now ready to be strapped to create a firm support for the leg. Be aware that tightening the straps too much may hinder the circulation distally.

VACUUM SPLINTS

Vacuum splints use the same technology as the vacuum mattress. It is made of a durable plastic outer shell, which contains polystyrene beads. When a pump is applied and air is sucked out, the polystyrene balls are pressed together and the vacuum mattress becomes rigid and moulds to the shape of limb. These splints are prone to damage, and any sharp object puncturing the outer shell of the vacuum splint and render it useless.

TRACTION SPLINT

Primarily used for femoral fractures, the traction splint aims to reduce the fracture near to anatomical position while immobilising it.

Traction is the use of weight to apply force to the tissues surrounding a broken bone. It allows realignment of broken bones as well as reducing pain. In the case of a traction splint, the device applies longitudinal pressure across the affected area by using the pelvis and ankle as anchors.

Traction does two important things; it reduces pain and restores the normal alignment of the fractured bones. Traction on the thigh pulls it back to a cylindrical shape rather than the spherical shape caused by the muscle spasm. This leaves less space for blood to pool into as the volume of a cylindrical is less than that of a sphere. Subsequently, by reducing the fracture, bleeding from the bone and soft tissues can be reduced.

There are various types of traction splints including; Kendrick traction device, Donway splint and Sager splint. The table[5] below allows comparison of the

advantages and disadvantages of the two must common traction splints for the lower limb.

KENDRICK TRACTION DEVICE	SAGER SPLINT
• Femoral fractures (open or closed) • Can be used if suspected pelvic fracture • Contraindicated in ankle fracture due to the use of the ankle strap	• Unilateral or bilateral femoral fractures (open or closed) • Contraindicated in pelvic fracture

How to apply a traction splint:

- Manual Responder 1 must apply manual stabilisation to the leg above and below the affected area. This stabilises the ends of the bone ready for full traction.
- Responder 2 can expose the leg by removing the clothing, including shoes and socks.
- Assess **neurovascular status** before applying the traction splint
- **Apply the ankle strap** – after the ankle strap is in place responder 2 takes over manual stabilisation via the ankle strap and elevates the leg while supporting the ankle (*elevation and manual stabilisation is not required when using a sager splint or Kendrick splint).*
- **Measure the traction splint** (the splint should be slightly longer than the leg if it was in normal alignment, the unaffected leg can be used as a guide).
- **Apply the traction splint-** do not apply too tightly otherwise circulation can be affected, and do not apply too loosely, otherwise immobilisation will not be sufficient.
- **Apply mechanical traction**
- **Reassess neurovascular status**

If applying a specific traction splint please refer to the manufacturer's guidelines.

HOW ELSE COULD YOU SPLINT A FRACTURE?

Pre-hospital care involves working in less than ideal environments, with minimal kit available. Therefore, improvised splinting for fractures is a valuable skill to have. Improvised splinting techniques include splinting the affected leg to a rigid structure such as: walking poles, tree branches, or the other leg in the case of a lower limb fracture. The latter provides a natural splint without needing any extra equipment, and is a simple and easy way to manage a lower limb fracture. For the upper limb use of clothing such as sturdy coats can help immobilise a fracture, the sleeve of a jumper being used as a sling. It just takes some thought and imagination.

UPPER LIMB FRACTURES

Upper limb fractures vary widely, but in general terms are less likely to cause haemodynamic compromise or kill immediately compared to a femoral fracture. May patients often cradle their affected arm or self-immobilise with the sleeve of their coat jacket. In other situations an upper limb fracture may be one of many injuries in a poly-trauma patient. Important of correct management is paramount to restoring function and reducing pain.

For upper limb fractures a simple triangular sling is often used to alleviate pain. Vacuum splints and short box splints can also be used for upper limb fractures.[6]

LOWER LIMB FRACTURES

Untreated fractures of the lower limb are life threatening. They can cause significant blood loss; approximately 1000ml – 1500ml for a closed femoral fracture and 500 – 1000ml for a closed tibial fracture.[7] The blood loss from an open femoral fracture can be in excess of this and therefore is an important cause of hypovolaemic shock.

In these cases, the <C> ABC algorithm adopted by the Military should be used; where catastrophic haemorrhage takes precedence over airway. Application of a tourniquet may be appropriate to control the bleeding. For further information on management of such a haemorrhage please refer to the 'Catastrophic Haemorrhage' section of this manual.

Mechanism of injury

Lower limb fractures are common, particularly due to road traffic collisions and sporting injuries, hence their prevalence in pre-hospital care medicine. When coming to assess a fracture it is important to know the mechanism of injury as this can provide clues to the nature of potential fracture. For example; where on the body a car hits a pedestrian reveals what the most likely injuries are, if hit at the pelvis a pelvic fracture would be a reasonable assumption.

OPEN FRACTURES

Open fractures are those where the fractured bone communicates with the environment through broken skin. Open fractures have potentially greater long-term complications than their equivalent closed fractures. The increased risk of infection through contamination puts tissue viability at risk and so full function of the limb may not be restored.[8] The degree of contamination is depended on the environment that is exposed to.

Prophylactic antibiotics should be given within the first hour of injury. It has been demonstrated that a time of greater than 66 minutes to antibiotic administration was an independent predictor of subsequent infection[9] and suggested that the single most important factor for reducing infection rate is the early administration of antibiotics.[10]

Generally, these fractures should be decontaminated by irrigation followed with a sterile dressing applied prior to splinting and transport to definitive care. Photographs can be taken of the fracture, before it is bandaged, to reduce subsequent removal of dressings and reduce the risk of infection. This is also useful for medico-legal reasons as it is easier to justify management with evidence of what was at the scene.

CRUSH AND COMPRESSION INJURIES[11]

When there is significant trauma to the muscles, this can lead to death and breakdown of the muscle fibres themselves. This causes a release of the toxic contents into the blood stream that can lead to rhabdomyolysis, hyperkalaemia, myoglobulinaemia and hypovolemia. Therefore in crush injuries, intravenous fluid resuscitation should be considered early in management.

PELVIC FRACTURES

Due to the vast amount of blood that can be lost into the pelvis, fractures of the pelvic ring are a major life threatening injury. The mortality for pelvic fractures is significant; for those who reach hospital the mortality is between 5% and 11.9%[12] with an even higher mortality rate for open pelvic fractures.[13]

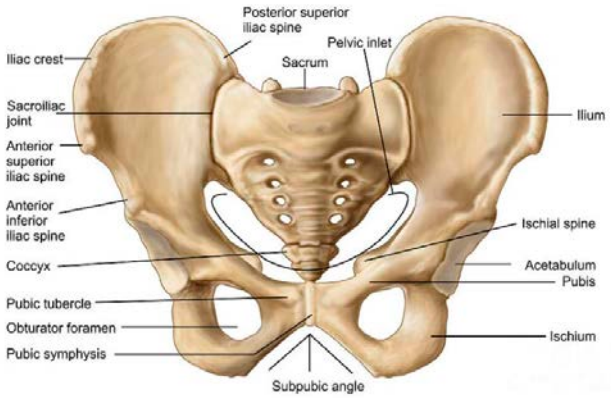
Studies suggest that the mechanism of injury causing pelvic fractures, as well as the bleeding risk of the pelvis, can contribute to negative outcomes. The huge amount of energy required to cause a pelvic fracture can also cause various other life threatening injuries to the body.[14] Serious abdominal injuries are one such consequence.

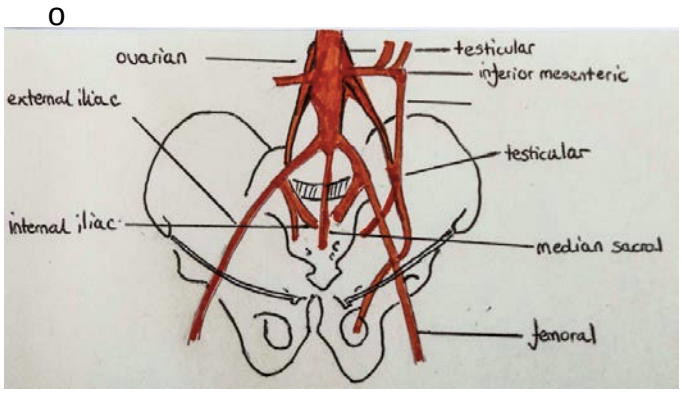
Accumulation of such injuries is associated with increased negative outcomes and has a huge bearing on death rates.

It is also important to note that pelvic fractures can occur from minimal force in the elderly osteoporotic population.

ANATOMY

It is integral to understand of the bony landmarks and blood supply to the pelvis.





What cases stay with you?

'The ones where you meet people who are talking and then die…many of these in our service are unrecognized pelvic injuries…'

ASSESSMENT OF PELVIC FRACTURES

In pre-hospital care, understanding the mechanism of injury helps you in directing your assessment and management of a patient, especially when time is extremely precious. Pelvic fractures should be suspected when there is a high energy impact; most commonly seen in road traffic accidents (20-66% result in pelvic fractures).

In these cases, the <C> ABC algorithm should be used; with catastrophic haemorrhage taking precedence over airway. To control excessive bleeding, pelvic fractures should be reduced prior to continuing with assessment.

Clinical assessment alone has been shown to be a poor indictor for pelvic fracture diagnosis, and so the mechanism of injury should be used as the most important diagnostic tool for suspicion of a pelvic fracture. If there is a positive mechanism of injury but little clinical findings, pelvic fracture should not be discounted.

Patients with pelvic fractures can present in various states of consciousness. If the patient is alert, asking if they have any pelvic pain is a common and useful way of judging whether a responder should be suspicious of pelvic fracture. A study[15] showed that 67% of alert patients complaining of pelvic pain did actually have a pelvic fracture.

Why are pelvic fractures a bleeding risk?

There are numerous sources of bleeding in pelvic fractures; the bones, venous plexus and arterial plexus can all be sources of haemorrhage. The pelvis itself has an average volume of 1.5l yet in a fracture there is interruption of the pelvic ring that prevents tamponade of the bleed. This allows direct communication with the retroperitoneal space, which has a further 5l average volume, or alternatively blood can enter the thighs and the peritoneum further increasing the potential space for blood loss.

Therefore pelvic fractures can be considered bleeding into a free space and is, as Suzuki et all[16] say: *'potentially capable of accommodating the patients entire blood volume'*

ASSESSMENT OF PELVIC FRACTURES	
Questions to ask before examination	• What is the mechanism of injury of the accident? Clues from the scene assessment and history • Was there high energy impact involved? • When examining the patient it is important not to use any excessive movement • Is the patient alert? Can they feel pain in their pelvic area, lower black (sacroiliac join assessment), groin and hips?
Physical Examination[12]	• Any obvious deformity of pelvis or legs? • Any leg length discrepancy? • Bruising, wounds or swellings over the bony prominences, perineum or pubis? • Any scrotal swelling? • Any visible bleeding? • Look specifically for bleeding from the rectum, vagina and urethra (hidden bleeding is difficult to detect in the pre-hospital care environment)

DO NOT SPRING THE PELVIS

'Springing' the pelvis describes applying alternating compressive forces to the pelvis, and is an old fashioned method for detecting pelvic fractures, This method is no longer used; a prospective study showed that with a specificity of 71% and sensitivity of 59% in detecting pelvic fracture, it is an inadequate method.[17] It may also promote more bleeding into the pelvis.

MANAGEMENT

Early reduction and immobilisation of a pelvic fracture can be lifesaving. There are various ways to stabilise a pelvic fracture; circumferential wrapping,[13] pelvic c-clamp, external fixation or open reduction and internal fixation. Some of these methods are impractical in the pre-hospital environment. In order to prevent life threatening haemorrhage in a pre-hospital environment management needs to be simple and rapid. Circumferential wrapping via a pelvic binder is the most common technique employed.

Why is reduction of the pelvis beneficial?

Returning the pelvis to anatomical has numerous beneficial effects:

- Arrests bleeding and closes communication with the retroperitoneal space
- Minimises movement of the pelvic bones; reducing pain and preventing further damage

THINK PELVIC FRACTURE - A patient with high-energy mechanism of injury and haemodynamically unstable from an unkown cause

PELVIC BINDER

In pre-hospital care pelvic fractures are managed by applying a pelvic binder until definitive care is available. They are used when suspicion of a pelvic fracture is high. There are many different types of pelvic binder with different health trusts preferring different designs. There is currently no evidence to recommend one type over another.[18] The aim of a pelvic sling is to apply adequate compressive forces to the pelvis to facilitate reduction of the pelvic fracture, bringing the pelvis back to or as to near to normal anatomical alignment as possible. This goes some way in the arrest of haemorrhage and reduction of pain.

Timely application of a pelvic binder is essential. If applied too late the movement involved in applying a pelvic binder can dislodge clots and promote new haemorrhage. The visible presence of a pelvic binder also acts as a reminder to responders that the patient should be handled with minimal movement.

Types

There are two main types of pelvic binders used in pre-hospital care, the SAM sling and the T-Pod

Points to consider

Below is a table covering considerations when applying a pelvic binder:

Minimal Movement	To prevent dislodging the 'first clot' or further haemorrhage.
Applied directly to skin	It is recommended to apply the binder next to skin or thin underwear to allow more accurate placement and prevent the removal of the binder when clothes are at the hospital.[38] Though there is little evidence to support this.
Applied before extrication or transfer	To emphasise early application and try to reduce movement of the pelvis during transport.
Early application	Apply before clotting mechanisms are triggered so prevent dislodging clots or provoking new haemorrhage

Where is the pelvic binder placed?

The pelvic binder should be paced at the level of the greater trochanter. A cadaveric study[19] showed that placement at the greater trochanter reduced the diastasis of the pubic symphysis greater than any other anatomical placement.

image reproduced with kind permission from SAM Medical

Responders should be trained in the application of the pelvic binder to avoid misapplication.[18] A retrospective study[20] looking at the accuracy of pelvic binder

placement showed that the most common site of misplacement was above the greater trochanters (39%). This is may be because of the difficulties faced in the pre-hospital care environment in locating the greater trochanters, or just the practicalities in applying the pelvic binder.

Technique

AIM: return the pelvis to or as near to normal alignment as possible

There are various different ways of applying a pelvic binder; the decision behind which binder to use should be based on the mechanism of injury. For example; moving the pelvic binder up from the natural hollow of the knees may not be advisable if there is lateral instability in the pelvis. In which case another technique should be used.

- Ensure you have located the anatomical landmark of the greater trochanter
- Prepare the pelvic binder by folding one of the straps so that it can be easily be passed underneath the patient
- Applying the pelvic binder:

1. Use the **natural hollow of the knees** to pass the pelvic binder under the knees to the other side, and then using a see saw action advance the binder up under the legs to the correct position at the greater trochanters
2. Use the **natural hollow of the back** (usually only used if the patient is slim enough and there is no clothing to obstruct application). Advance the pelvic binder downwards to the correct position.

A consensus statement[18] by the faculty of prehospital care has stated that log rolls or transportation on a spinal board should be avoided in patients with severe pelvic fractures and may not be beneficial to all fractures. This is in line with the 'single movement' principle used in prehospital care. If a log roll is required all assessment; pelvic binder application and placement of the scoop stretcher should be done at the same time to prevent repetitive movement.

When do you remove a pelvic binder?

The pelvic binder should only be removed when:

- Radiography confirms there is no pelvic fracture
- A more definitive stabilisation technique is available

Improvisation

Improvised pelvic binders include; belts, bed sheets, jackets, or even adapting the Kendrick splint

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[7] Lee C, Porter KM. Prehospital management of lower limb fractures. *Emerg Med* 2005; 22(): 660-663.
[8] Cannada LK. *Open Fractures. http://orthoinfo.aaos.org/topic.cfm?topic=A00582 (accessed 15 July 2015).*
[9] Lack et al. Type III open tibia fractures: immediate antibiotic prophylaxis minimizes infection. *Orthopaedic Trauma* 2015; 29(1): 1-6.)
[10] Patzakis MJ, Wilkins J. Factors influencing infection rate in open fracture wounds. *Clinical Orthopaedics and related research*1989; 243(243): 36-40
[11] Lee C, Porter KM. Prehospital management of lower limb fractures. *Emergency Medicine Journal* 2005; 22(9): 660-663. doi:10.1136/emj.2005.024489 (accessed 24 July 2015).
[12] Lee C, Porter K. The prehospital management of pelvic fractures. *Emerg Med* 2007; 24(2): 130-133. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2658194/ (accessed 16 July 2015).
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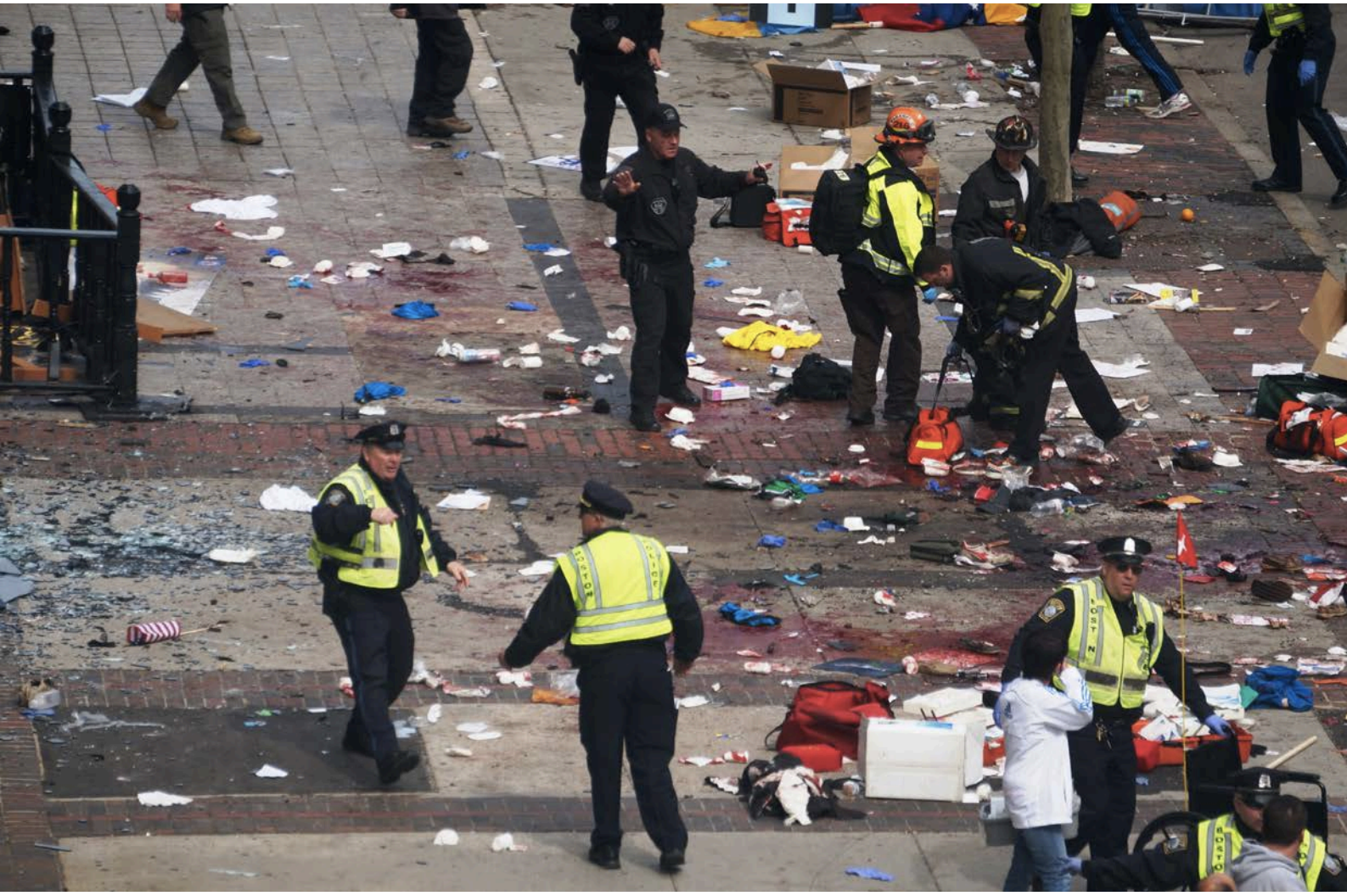
Important Considerations



- Analgesia
- Burns
- Paediatrics
- Pregnancy
- Mass Casualty Situations
- Secondary Survey

ANALGESIA

This section is intended to provide a flavour of the importance of analgesia in pre-hospital care, but it is by no means an extensive guide on pre-hospital care analgesia. Any administration of drugs should be carried out within your clinical competence and experience.

It is good practice to provide adequate and appropriate analgesia for severely injured pre-hospital care patients. As well as easing pain it reduces anxiety and allows better management of the patient.

The analgesia given is dependent on the competence and experience of the responder, and any prescription should be within the remit of their clinical experience.

It is important to distinguish between the use of analgesia for pain relief and its use for sedative purposes. Analgesia should be given appropriately and avoid sedation unless that is also the intent.

Points to consider when giving analgesia:[1]

- The fear that analgesia may mask clinical signs is not a valid reason to withhold analgesia
- Drugs should be drawn up in syringes and labelled in a standardised way – name, concentration, date and time
- A small test dose should be used to check for sensitivity and then doses titrated accordingly
- Clinicians tend to underestimate pain levels[2]

Methods of Pain Relief

There are various methods of pain relief utilised in pre-hospital care. The type of pain relief employed depends on severity of pain and cause of the pain.[5]

- **Reassurance**

- **Physical measures**:
  - identify pain
  - splinting
  - relief of pressure

- **Inhalation**:
    - Entonox (mixture of 50% oxygen and 50% nitrous oxygen)
- **Intra-nasally**
- **Intravenous**
- **Intra-osseous**

When providing pain relief it is important to explain to the patient or relative what is going to happen. Reassuring a patient is a simple but effective way of relieving anxiety and agitation.

Why is pre-hospital pain relief important?

Analgesia in pre-hospital care provides pain relief; eases anxiety and facilitates patient assessment and management. Pain is a significant issue in pre-hospital care patients, and on approaching a patient, it should be assumed they are in pain.[1] A study[3] on patients in pre-hospital care showed that 42% of patients had acute pain and 64% of the patients had intense to severe pain.

Despite these figures, pre-hospital care pain management can be variable, inadequate and uninformed. It has been stated that only 23.4% of extremity trauma patients were given analgesia when 82% had significant pain.[4] As well as not receiving timely analgesia the doses given can often be inadequate and ineffective.[4] The development of evidence based guidelines for pre-hospital care analgesia should improve its provision.

As well as the obvious relief of pain, there are numerous other benefits to pre-hospital analgesia. Pain is associated with increased anxiety levels; which in turn can lead to the patient being uncooperative during management. This could lead to prolonged extrication and delay in definitive treatment. Other physiological responses to pain can be detrimental to the patient. Also, analgesia given in the pre-hospital setting is described as having an 'up-triaging' effect when they reach hospital.[4]

Types of Drugs[1,4,5]

Below is information about the differing types of drugs used for pain relief. Doses are not supplied as these are beyond the remit of this manual and should be checked with local and up to date guidelines. For further information on paediatric analgesia refer to the 'paediatric' section of this manual.

Drug	Routes	Other information[4]
MORPHINE	IV, IM	• Standard analgesic supported by evidence base • Antiemetic (e.g. metoclopramide) may be given
KETAMINE	IV, IM	• Wide safety margin • Stimulant effects • Risk of apnoea (administer dose over 1 minute to avoid this) • Preferred in mass casualty situations • Avoids haemodynamic effects associated with opioids.[6]
ENTONOX	Inhalational	• It takes 4 minutes of continual inhalational for full effect • Contraindicated – pneumothorax, increased ICP, GI obstruction
FENTANYL	IV	• Easier to titrate than morphine • Some prefer it's use in neurotrauma[4]

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BURNS

The management of burns is an important topic in prehospital care. In the United Kingdom alone there are about 175 000 burns presentations to the emergency department every year.[1]

It has been previously stated[1] that lack of pre-hospital guidelines have led to inadequate management of burns and it is felt that pre-hospital practitioners often feel inadequately trained to deal with burns patients.[2]

PHYSIOLOGY

The severity of a burn injury depends on its depth and extent. The skin can be simply divided into the epidermis (5%) and dermis (95%), with the deeper the burn the poorer prognosis.

The skin acts as a physical barrier to the environment; a burn compromises this barrier and can lead to an increased risk of infection and fluid loss. The body's ability to retain protein and fluids is impaired and can lead to hypovolaemic shock if sufficient surface area is affected. The inflammatory response to a burn can also cause swelling of soft tissues; this is particularly problematic in the oropharynx and soft tissues of the neck.

CAUSE OF BURNS[6]

Management of burns can vary depending on the cause; so finding the mechanism of injury is important. Below are details about the main causes of burns:

Thermal – the most common type of burn. Thermal burns, such as those from a house fire, can have systemic consequences alongside the physical burn.

Chemical – chemical burns continue to burn even if the burn source has been removed. It is important to determine the causative agent; its concentration; duration of contact and whether any chemical has been ingested or inhaled. Excess irrigation with water away from the source of burn is important.

Electrical – this is a rare but important cause of burn; causes include high voltage electrical cables and lightning. The severity of burn is determined by voltage; site of injury and length of contact. Current will arc through the path of least resistance, namely the body's soft tissues. Finding the entry and exit point of the electric current is important as it will provide information about the structures potentially affected.

SIMPLE MEASURES

By-standers are often the first to manage a burn. It is important to perform these simple first aid measures[3] correctly as they can aid prognosis.

SIMPLE MEASURES	
STOP the burning process[2]	• Remove the source of burning • If easily removal, burnt clothes should be removed • Remove any constrictive jewellery • Chemical burns should be doused with large amounts of water
COOL the burn	• Douse the burn with water for approximately 20 minutes[4] (optimal cooling time is still debated) • Provides pain relief[5]
COVER the burn	• Take a photograph of the burn beforehand • If blistered the wound should be covered with a dressing or plastic film to keep the wound clean • Do not wrap circumferentially as this has a constrictive effect and can worsen the burn • Covering a chemical burn may theoretically worsen the burn

ASSESSMENT & MANAGEMENT[5]

When assessing a burns victim it is important to use the standard ABCDE paradigm[2] recognising that other life threatening injuries may co-exist with burns. As part of your assessment is it important to determine the severity of burn, dependent on location, depth and surface area covered.[6] As well as the standard ABCDE assessment, specific attention should also be paid to the consequences of burns injuries. The table below details these:

ASSESSMENT	Clinical Findings	MANAGEMENT
Airway	• Airway obstruction from swelling of the soft tissue of the neck and oropharynx[6] • Inhalation injury - soot, singed nasal hairs, facial or neck burns, mechanism of injury, confined space, hoarse voice, stridor	• High flow humidified oxygen (15L/min)[2] can be given if inhalational injury • Intubation may be necessary (think about the predictive clinical course). Are they unconscious?
Breathing	• Assess the chest – full thickness burns? • Circumferential burns may constrict breathing	• Escharatomies may be needed to decompress the chest • High flow oxygen • Pulse oximetry should be used with caution. Carbon monoxide toxicity will not be detected on pulse oximetry reading.
Circulation	• Check pulse rate • Assess tissue perfusion – look at the colour of unburnt skin, is it cold? • Check capillary refill time	• IV access – for analgesia and fluid resuscitation. Access should be gained through non-burnt skin • Fluid resuscitation
Disability	• Assess GCS • Inhalational injury can cause the patient to be unconscious • Hypoxia	
Exposure	• Assess the extent of burns • Estimate the percentage of burns • Remove any constrictive or burnt clothes	• Be aware that burns victims are losing vast amounts of heat through their broken skin, so you should have a high suspicion on hypothermia

Fluid Resuscitation

Fluid resuscitation is an important feature of burns management, as it aims to both stabilise the patient and prevent hypovolaemic shock. Effective fluid resuscitation can decrease the risk of acute renal failure that is associated with significant burns.

All adults with burns >20% surface area and children >10% surface area should receive fluid resuscitation

Cannulation on burns patients can be difficult, especially if all possible cannulation sites are covered by burnt tissue. It is suggested that two attempts should be made, and if unsuccessful it should be reattempted when in hospital or alternative access should be gained such as intraosseous.[2] This is because the responder can become task focussed, prolonging time at the scene, when it is more important to get the patient to definitive care. Delay in transport can put the patient at increased risk of hypothermia. This need to get the patient to hospital without delay must be balanced with the immediate needs of the patient. The British Burn Association states that fluids should be given at the scene if >1 hour from definitive care, to prevent hypovolaemic shock.[7]

Pain Relief

Burns are painful; simple measures such as cooling and covering the burn can help reduce pain. Medication like morphine can be administered intravenously to relieve pain and allow transport to definitive care.

SEVERITY OF BURN

The severity of burn[6] determines management and prognosis. This can be assessed by:

- Burn depth
- Burn location
- Surface area of burns
- Mechanism of injury (inhalational injury is associated with confined spaces)
- Patient characteristics (patient's at the extremes of age are most likely to suffer from the complication of burns)

Burn Depth[8]

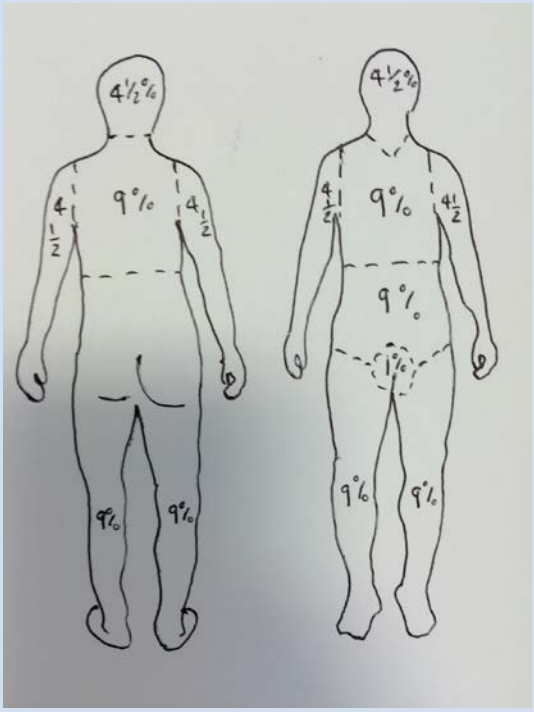
The burn depth is an important determinant for prognosis and should guide management. It is important to remember that burns are dynamic and their depth changes with management. Burn depth is classified into:

DEPTH	Clinical Findings
Epidermal	Erythema e.g. sun burn, painful
Superficial partial thickness burn	Pale pink, blanches to pressure, blisters very painful 
Deep partial thickness burn	Blotchy red, no capillary refill, reduced sensation
Full thickness burn	White, no blisters, no capillary refill, insensate

Total Body Surface Area

Establishing the percentage of burns sustained is important for resuscitation and initial management. When calculating surface area of burn, erythema should not be included.

The percentage of burns sustained can be established by the following means:[9,6]

METHOD	Further information
Wallace rule of nines 	• Quick method • Convenient • Good estimating medium to large burns • Divides the body into areas of 9% (each air is 9%) or multiple of 9% (18% for each leg). • Genitalia is 1% • Should only be used in adults as it is inaccurate in children
Lund and Browder chart	• Most accurate method • Inconvenient in pre-hospital care • Separate child and adult charts are used (a child has a relatively larger head when compared to adults)
Palmar Surface	• This states that the patient's palm (including fingers) is 0.8%, this is approximated to 1% to make estimating percentage burns easier • Accuracy of this method decreasing with increasing size of burn • Palm of the responder's hand can be used (must account for the varying sizes)

Although the Lund and Browder chart (if used correctly) is the most precise way of calculating percentage burns[9] its use in prehospital care is inappropriate and should be reserved on admission to definitive care. Simple methods such as the rule of nines and palm of hand are more convenient and often used.

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PAEDIATRIC PRE-HOSPITAL CARE

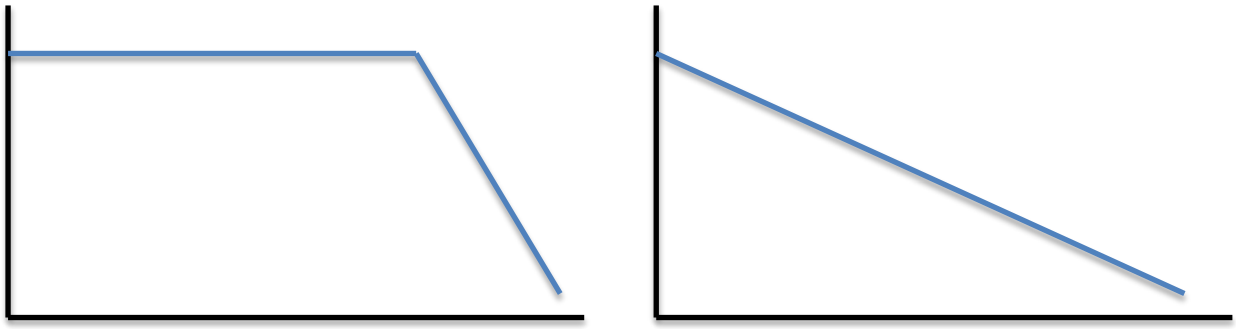
The paediatric population can account for up to 10% of all medical service activity,[1] it is therefore vital to understand how dealing with a paediatric patient impacts on practice in a pre-hospital environment.

When caring for a child in a pre-hospital scenario there are a few important considerations before you begin. Firstly, you must remember the parents as well as the casualty; be honest with them, keep them up to date and allow them to be as present as possible. This is not only reassuring for both parents and patient, but can be a source of important information about the event leading up to the injury and past medical history.[2] The next consideration is that of the anatomical and physiological differences between children and adults.

PHYSIOLOGY

Child versus Adult[2,3]

- Due to decreased fat, increased elasticity of connective tissue and more flexible skeleton impact force is transmitted widely throughout the body, resulting in multisystem injuries.
- Large surface area to body ratio leads to increased heat and fluid loss
- Poor protection of liver and spleen leads to increased susceptibility to injury
- Large head to body ratio increasing risk and severity of head injuries
- Maintain blood pressure despite up to 30% blood losses
- Children may be increasingly difficult to evaluate due to crying and irritability, that may not be concordant with level of harm



PAEDIATRIC **ADULT**

An important concept to remember is that paediatric patients are very good at compensating for illness.[3] This means that in the early stages of illness the cardiovascular and respiratory systems can compensate, meaning that the condition

remains stable. As the compensatory mechanisms fail the condition deteriorates rapidly and often fatally. For pre-hospital care this means that if there are signs of stress in the paediatric patient, they require rapid assessment, treatment and extrication.

Children often die of different medical causes to adults, primarily hypoxia, while cardiac causes are rare. This accounts for the difference in the algorithm for Basic Life Support (BLS) with a greater emphasis on rescue breaths compared to chest compressions.

Weight

Many of the drug dosages and fluid guidance is reliant on the patient weight, it therefore is important to consider the potential weight of the patient.

Advanced Paediatric Life Support previously recommended the use of **(Age+4) x 2** as a method of working out an estimate of the patient's weight. This has been replaced by three formulae:

- Weight 0-1 = (Age (months)/2)+4
- Weight 1-5 = (Age (years) x2)+8
- Weight 6-12 = (age(years) x3)+7

The following table gives a guide towards what the normal respiratory and heart rate are for various ages. Knowledge of normal allows assessment of abnormal

Age	Respiratory Rate	Heart Rate
<1	30-40	110-160
1-2	25-35	95-140
2-5	20-25	80-120
5-12	20-25	80-120
>12	15-20	60-100

EPIDEMIOLOGY

A large study,[4] looking at 3184 pre-hospital interactions with emergency medicine personnel showed the majority (54.4%) of cases in all paediatric age ranges were in the trauma category, mostly vehicle accidents, while the major causes in the very young were medical disorders. These confirm further studies[5] which showed around 50% of all emergency calls for the paediatric population to be trauma related.

AIRWAY[6]

ANATOMY

Children have smaller airways than adults, with a larger tongue in relation to the airway, leading to a greater chance of obstruction. The child's airway is also softer and more pliable then an adult airway, impacting on management of the airway with conservative manoeuvers being used before large movements.

Due to the decreased size of the airway, small obstructions can make a large difference; therefore small changes can lead to a significant airway compromise. The large occipital size causes head flexion resulting in an obstruction of the airway.

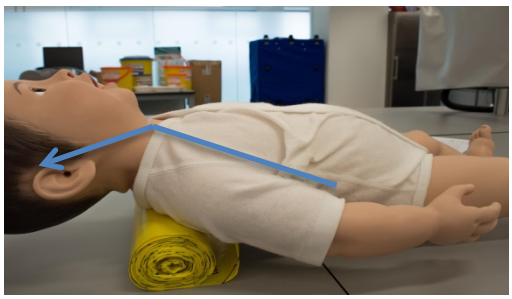
ASSESSMENT

Observation can provide many clues about airway problems in a child. First, listen for any noisy breathing including stridor, gurgling, stertor and wheeze. You can calculate the respiratory rate and see if it is raised. A child with airway or breathing problems will often sit in the tripod stance leaning forward with arms or hands on the legs or knees.

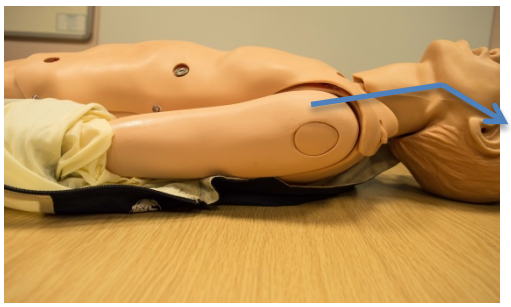
MANAGEMENT[2, 7]

Children (<1year)

Due to anatomical differences related to occipital size triple airway manoeuvres are often inappropriate and can cause further obstruction, instead slight movement by pulling up on the chin to create the 'sniffing position is all that is required to align the oral, pharyngeal and laryngeal axes.



A towel can be placed under the shoulders; this raises the shoulders, preventing the relatively large head from causing neck flexion maintaining a neutral position.



Children (<8 years)

For small children, over a year, slight extension is used, but care is taken not to hyperextend the airway.

A chin lift or jaw thrust is then used if the airway is not clear, but no head tilt is recommended.

Children are obligate nose breathers, meaning they prefer to breathe through their nose. Therefore blockage of the nasal passages has a large impact on the patency of the airway and increases respiratory effort. Suctioning of any blockage is an important step in airway management if suction is available.

Adjuncts

Guedel insertion differs between adults and children; in an adult the insertion is with the curve facing upwards, and then rotated through 180 degrees. However in a child the Guedel is inserted with the curve downwards and not rotated. It is also preferable, due to the large tongue size, to depress the tongue on insertion.

If the airway is still not patent then endotracheal intubation or a surgical airway (if over 12 years old) may be considered, however this must only be undertaken by trained personnel.

BREATHING[2,3]

Children have increased respiratory and heat rates compared to adults - As children grow these rates decrease to regular adult values. It is, however, important to know the normal values for different ages of child, allowing for accurate pre-hospital assessment

Age	Respiratory Rate	Heart Rate
<1	30-40	110-160
1-2	25-35	95-140
2-5	20-25	80-120
5-12	20-25	80-120
>12	15-20	60-100

Assessment

Children, due to increased compliance of the chest walls and the narrowness of the airway have some characteristic signs of increased breathing effort.

- Supraclavicular, substernal and intercostal recession

- Nasal flaring
- Seesaw breathing
- Grunting
- Tracheal tug
- Use of accessory muscles

If these signs are noted then initiation of management and subsequent transfer is required. Children fatigue faster than adults with increased work of breathing - This can lead to exhaustion, signified by decreased effort and the child becoming increasingly tired and floppy.

Assess for the chest rise: in a young child this occurs in the lower chest and abdomen.[2]

Pulse oximetry can be used, however, this should be carefully analysed, as a child with impending respiratory failure may still maintain normal oxygen saturations. Equally with severe blood loss the SpO2 may read normal even with low oxygen delivery due to the fact that Sp02 is a recording of oxygen saturation and not of delivery.[3]

Management

Oxygen therapy should be given to paediatric patients with respiratory or airway problems. Ideally this is via a facemask, however this can often be scary for children leading to resistance and hyperventilation, so gentle re-assurance and parental help can be useful. A study conducted in the United States found nasal cannulas the most used method of oxygen delivery[1] with facemask the second.

How much oxygen?

High flow oxygen is indicated at a rate of 10-15 l/min for children with respiratory or airway difficulties. This is delivered through a facemask.[8]

If the child shows sign of fatigue with decreased respiratory effort and rate then assisted ventilation through a bag valve mask can be used given at a rate of 8 to 10 per minute given at the volume to raise the chest to prevent gastric dilation.[2]

CIRCULATION

The signs of shock; low blood pressure and high heart rate, are often late signs of circulatory failure in children. This is due to paediatric patients' ability to compensate up to a 25-30% loss of blood volume.[2] Therefore subtle changes in the heart rate and peripheral perfusion have increased importance in paediatric patients.

Assessment[2,6]

Due to the fact systolic blood pressure can be maintained long into shock other factors have to be assessed to give an indication of circulatory status:

- Pulse rate, pallor, capillary refill time (tested centrally, on the sternum)
- Cool extremities, decreased pulse volume
- Dehydration status – decreased urine output, absent tears, dry mucous membranes, generally ill appearance

This shows the lowest acceptable blood pressures for various ages of children, a systolic below this is indicative of shock.[6]

Age	Lowest acceptable blood pressure
Neonates – 0-28 days	60 mm Hg
Infants – 1 month to 1 year	70 mm Hg
Children – 1 year to 10 year	70 mm Hg + (2 x age in years)
>10 years	90 mm Hg

As shock leads to a decrease in end organ perfusion this will also present with various signs including pallor, tachypnea and agitation.

Management

Access should be gained, two wide bore cannulas inserted if possible in serious trauma. In children, with decreased vessel size, it can often be difficult to gain IV access. This is shown comparing success rates in IV access in children over 13 and under-13, being 94.4% compared to 76.9%.[4] If IV access is not possible, intraosseous (IO) insertion is indicated[8] with the relative ease of insertion allowing rapid circulatory access. IO access has high success rates in pre-hospital cases[8] and IO access can be doubled to allow additional access. Advanced Trauma Life Support (ATLS) currently recommends IO insertion in children under the age of 6 when rapid venous access cannot be gained.

Fluid therapy

In most paediatric patients, fluid boluses of 20ml/kg are recommended in medical emergencies while in trauma 10ml/kg is used, using normal 0.9% saline, to correct shock.[2]

DISABILITY

There are numerous causes of a decreased conscious level in a child and a basic assessment allows for evaluation and management.

Assessment

Alert, Voice, Pain and Unresponsive (AVPU) can be used to give a fast assessment of neurological evaluation. A Glasgow Coma Scale can often be hard to perform on a child, however, there is a modified paediatric version of the scale.[9]

Best Eye Response	1. No eye opening 2. Eye opening to pain 3. Eye opening to verbal command 4. Eyes open spontaneously
Best Verbal Response	1. No vocal response 2. Inconsolable, agitated 3. Inconsistently consolable, moaning 4. Cries but consolable, inappropriate interactions 5. Smiles, oriented to sounds, interacts
Best Motor response	1. No motor response 2. Extension to pain 3. Flexion to pain 4. Withdrawal from pain 5. Localizing pain 6. Obeys commands

Pupils should be assessed for size, reactivity and equality between both sides.

The posture of the patient has increased importance in paediatrics:

- 'Floppy' child – this can indicate exhaustion and severe illness
- Stiff neck, arched back (opisthotonus) – this can indicate menigism
- Decerebrate – muscles held in rigidity due to severe brain damage. This arms and legs are held straight out and the toes held pointing downwards.
- Decorticate – the arms are bent into the body with wrists and fingers held on the chest. This is also a sign of severe brain damage

Management

As disability is often secondary to multisystem effects it is advised to begin high flow oxygen in children with a decreased conscious level. If there is evident hypovolemia then fluid resuscitation should be commenced and early transfer to the appropriate secondary care is of upmost importance.

Remember ABC-DEFG – **D**on't **E**ver **F**orget **G**lucose in any patient, particularly those with a decreased conscious level.

EXPOSURE[2,3]

The high surface area to volume ratio of children, combined with decreased insulation, means that children, can become hypothermic very easily. Awareness of this and adequate clothing and insulation if needed can help minimalise heat loss when managing a paediatric patient in the pre-hospital environment.

*'A child in the back of an ambulance who is still quiet despite being separated from parents and poked with needles - should scare the s*** out of you'*

Pain is a common presenting symptom in pre-hospital care and treatment of it is an important consideration for all practitioners. It has been shown that children (under 19 years) were less likely to receive adequate analgesia then adults. Those under 2 years received it even less frequently than older children, with 17% receiving analgesia compared to 38%.[10] It has also been shown that children, describing the same levels of pain as adults[11] are half as likely to receive opiate analgesia than adults.

This could be for a variety of reasons. It can often be difficult to interpret pain,[12] practitioners can be unfamiliar with children and paediatric protocols[10] and there is often increased concern for adverse effects of analgesia.[13] The reluctance to prescribe analgesia is amplified for opiate medication, with fear over dependence and side effects[12] increasing reluctance of use.

Assessment

One reason cited for inadequate analgesia is the difficulty of assessment. There are numerous tools used to assess pain in children.[14] Most children over 5, and some younger, are able to self-report pain using appropriate tools.[15] A study conducted into pre-hospital paediatric pain assessment found a significant increase in pain assessments when cards showing the happy face/sad face pain assessment tool were distributed to pre-hospital physicians.[16]

- Happy face/sad face[16]– the patient picks the face that describes the level of pain[17]

In children younger than 5 years physiological mechanisms such as pulse rate, blood pressure, sweating, pallor and dilated pupils can be used to assess pain.[14]

Children found to be in pain should be prescribed analgesia immediately[14]

Pain Relief

Non-medical measures such as reassurance and splinting are very useful in providing pain relief alongside medical management.

Rapid administration of analgesia can relieve pain; reduce respiratory distress and allow for patient transfer. Optimal management in severe pain will often require opioid analgesia delivered intravenously or via intraosseous access.[18] Non-steroidal anti-inflammatory drugs (NSAIDS) can be used alongside IV opiates in severe pain, or alongside oral opiates for mild to moderate pain.

Paracetamol – 20mg/kg loading dose

Ibuprofen – 10mg/kg loading dose

IV morphine dose - 0.1 mg/kg

Codeine is contraindicated in children less than 12 years and not recommended in those below 18 years.

Pain relief can also be given orally, intranasal, transdermal or inhaled (with nitrous oxide being a commonly used method of analgesia[19] as there is no need for access and a lower side effect profile). If nitrous oxide is not effective then opiates may still be required.

For young infants provision of oral sucrose is useful for procedural pain with the analgesic effect lasting 5-8 minutes.

If a child is in pain, give appropriate analgesia. Aide-mémoires can help for dosage and if in doubt, 'start low and go slow' to see an effect.

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PREGNANCY

In pre-hospital cases involving a pregnant woman there are two lives to manage; that of the mother and that of the foetus.

The best treatment for the foetus is good care and resuscitation of the mother

Trauma and Pregnancy

Trauma complicates up to 8% of all pregnancies.[1,2] Of 372 pregnant trauma patients over a 4-year retrospective study[1] there were 35 foetal deaths equating to a foetal death rate of 9.4%. This is in keeping with other studies[3,4] showing rates of foetal death in trauma between 9-15% of pregnant trauma events. Foetal loss is increased in relation to trauma severity; life-threatening trauma has a significant association with foetal loss, occurring in around 40-50% of cases.[2]

A frequent cause of foetal death in trauma is placental abruption.[1] This occurs predominantly in severe trauma, but can occur with any degree of trauma. Placental abruption (PA) occurs at rates of 3.5% of pregnant trauma patients and is associated with a 50% incidence of foetal death. PA may occur without external signs of trauma and may present with any of; vaginal bleeding, a hard and tender uterus, abdominal pain, large for dates fundal height and hypovolemic shock.

Other complications include onset of labour (5.9%), premature rupture of membranes (0.8%), uterine rupture (0.8%), placental praevia and amniotic fluid embolism.

There are other conditions including eclampsia, miscarriage and haemorrhage, which can present in the pre-hospital environment.

PHYSIOLOGY

There are a number of normal physiological changes that occur in pregnancy that can impact upon pre-hospital care:[5]

Physiological Change	How?	Pre-hospital impact
Decreased residual volume and functional residual volume	Through pregnancy the diaphragm is pushed upwards causing lung shortening. Rib flaring and ligamentous relaxation is used to compensate for this	Predispose to hypoxia and feeling short of breath. Pre-disposition to atelectasis

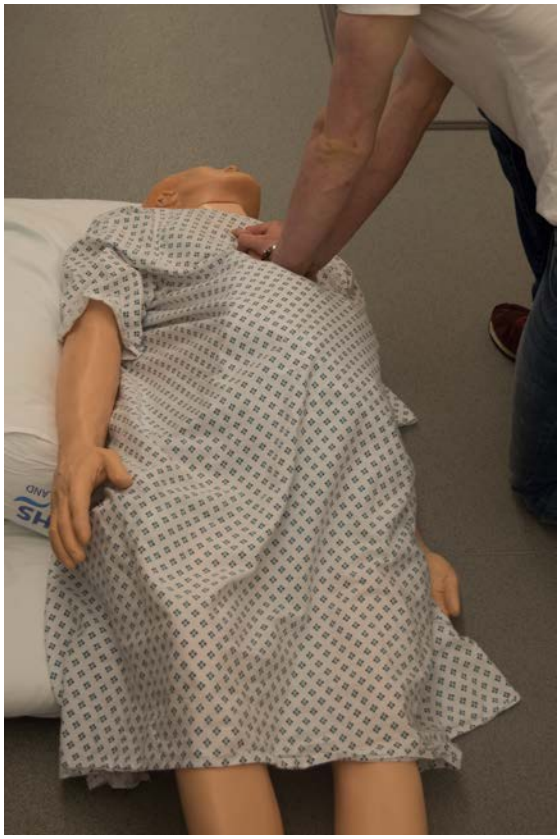
Increased oxygen requirements	Increase of 10-20% non-pregnant levels	Require increased ventilation with early high flow oxygen required
Tidal Volume and respiratory rate increases	Increases the minute volume	Causes a chronic hyper-ventilatory state and a compensated respiratory alkalosis
Cardiac output and circulating volume increase. Decrease in vascular resistance	Catecholamine release at the end of the second trimester leads to an increased cardiac output while progesterone in the second and third trimester causes a relative resistance to renin and angiotensin II leading to vasodilation	This can mask hypovolemia, meaning a pregnant lady can lose up to 35% of blood volume before showing signs of hypovolemia
Pregnant abdomen	Normal foetal growth	This can mask the signs of intraperitoneal injury including guarding, rigidity and rebound tenderness
Decreased gastroesophageal sphincter control, delayed gastric emptying and increased gastric pressure	Progesterone suppresses gastric motility, prolonging transit time	Increased risk of aspiration
Aortocaval compression syndrome[6,7]	Placing the patient supine leads to compression of the inferior vena cava reducing venous return and therefore reducing cardiac output by 30-40%. This leads to hypotension, loss of consciousness, cardiovascular collapse and foetal depression. This can occur in women in the second half of pregnancy	Management is to tilt the patient over 15 degrees into the left lateral position. In a spinal injury the patient is secured to a backboard which can be tilted placing sandbags, towel or a sheet under to raise and tilt the patient
Reduced efficacy of chest compressions[7]	Aortocaval compression leads to a decreased cardiac output from chest compressions, with 10% being produced as compared to 30% in a non-pregnant female patient	Cardiopulmonary resuscitation is less likely to be successful in a women 20 weeks pregnant or more

MANAGEMENT

Primary survey[6]

The primary survey should occur as for a non-pregnant casualty; however, supplemental oxygen should be started early, due to the reduced oxygen reserves in pregnancy.

Particular attention should be paid to patient positioning. This is to avoid aortocaval compression, an important consideration in pre-hospital care, which can drop cardiac output by 30-40%. Care should be taken to avoid positioning the patient supine and instead treat in the left lateral position or sitting upright if possible.



Left Lateral positioning with pillows under the patients right hand side, decreasing the aortocaval compression. CPR can be conducted in this position.

The raised cardiac output and decreased vascular resistance in pregnancy can mask hypovolemia, therefore masking shock until a late stage.

Secondary Survey[8]

This must include a complete examination of the pregnancy including:

- Full obstetric history
- Foetal assessment including fundal height, which may be enlarged in intrauterine bleeding
- Heart rate, which should be between 110-160bpm
- Feel for presence of uterine contractions and foetal movements

Once the patient is stable seek an obstetric review

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MASS CASUALTY MANAGEMENT

A mass casualty is an incident in which emergency medical service resources are overwhelmed by both the number and severity of casualties. This can be from large events, such as a natural disaster, a terrorist incident, down to any event where there are too many casualties for the personnel available. This could even include a two person crew attending an accident with three severely injured patients, as the resources are still overwhelmed by casualty numbers.

A mass casualty will most often involve numerous medical professionals, alongside other members of the emergency services including firefighters and police. Clear communication between the team, and between the different services involved, is of vital importance.

Initial approach[1]

The first priority is that of safety; your safety and that of the team. This can be extremely difficult in mass casualty situations so complete assessment of the scene and its hazards prior to approach is of utmost importance.

Due to the complex nature of many mass casualty events there may be a number of different teams from different services; establishment of a clear command structure allows for an organised approach to the situation. The fire service is in charge of the scene, controlling scene safety and rescue of the patient. The police will control access to the scene and create a safe cordon for entry. This allows the medical team to focus on casualty assessment and management.

It is necessary to estimate the number of casualties and the resources that will require. If you are not able to meet the requirements for equipment this can shape management planning and help in the triaging of casualties.

1. Scene safety assessment, including exit strategies if conditions change and become unsafe
2. Establish incident command
3. Clear communication with other emergency services
4. Have a clear evacuation plan for patients and the method of extrication to be used.
5. Estimate the number of casualties and resources required
6. Organise the triage system to be used

Management

The main pre hospital action taken in major incidents is that of triage and immediate life support. Definitive care is conducted in the nearest appropriate hospital with the main concern at the scene being immediate measures to save life or limb only.

The tasks required at the scene can be remembered by the useful mnemonic CSCATTT

C	**Command**
S	Safety
C	Communication
A	Assessment
T	Triage
T	Treatment
T	Transport

Triage[1, 2, 3]

The first stage of medical management is triage.

Due to pressure on available resources (personnel, time and equipment) triage is vital, allowing prioritisation of patients dependent on the injury severity. The challenge is separating the critically injured who require immediate care from those not critically injured.[3] During triage only immediate, time proficient life saving interventions should be performed.

- Separates those who need rapid medical care to save life or limb
- Reduces burden on medical facilities, estimates state on average only 10-15% of disaster casualties are serious enough to require hospitalization [1]

- Allows distribution of casualties among available hospitals

A simple triage system allows the use of a fast, reliable and reproducible method to triage casualties. A number of different triage sieves are available.

These separate casualties into casualties with the traditional categories used being immediate, delayed, minimal and expectant.

- **Immediate** – require attention within minutes to 2 hours to avoid death or major disability
- **Delayed** – wounded, but whose general condition is stable to allow delay in treatment without endangering life, limb or eyesight
- **Minimal** – minor injuries who can effectively care for themselves with minimal medical care
- **Expectant** – These have injuries such as cardiac arrest, respiratory arrest or continued seizure that can overwhelm the medical services. The category may be invoked for usage if resources are overwhelmed and resources should not be expended on this category if there are a large number of other casualties requiring care.

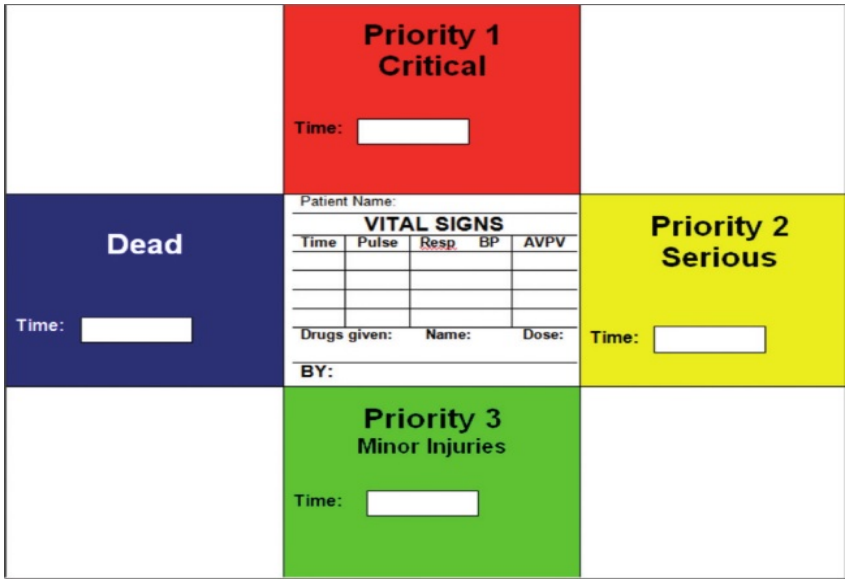
Triage Sieve

An example of, and the most commonly used, triage sieve is the **START sieve**. This has the great advantage that even non-medically trained people should be able to use this system, thus increasing the personnel available and allowing earlier deployment of the medical team into roles requiring their expertise.

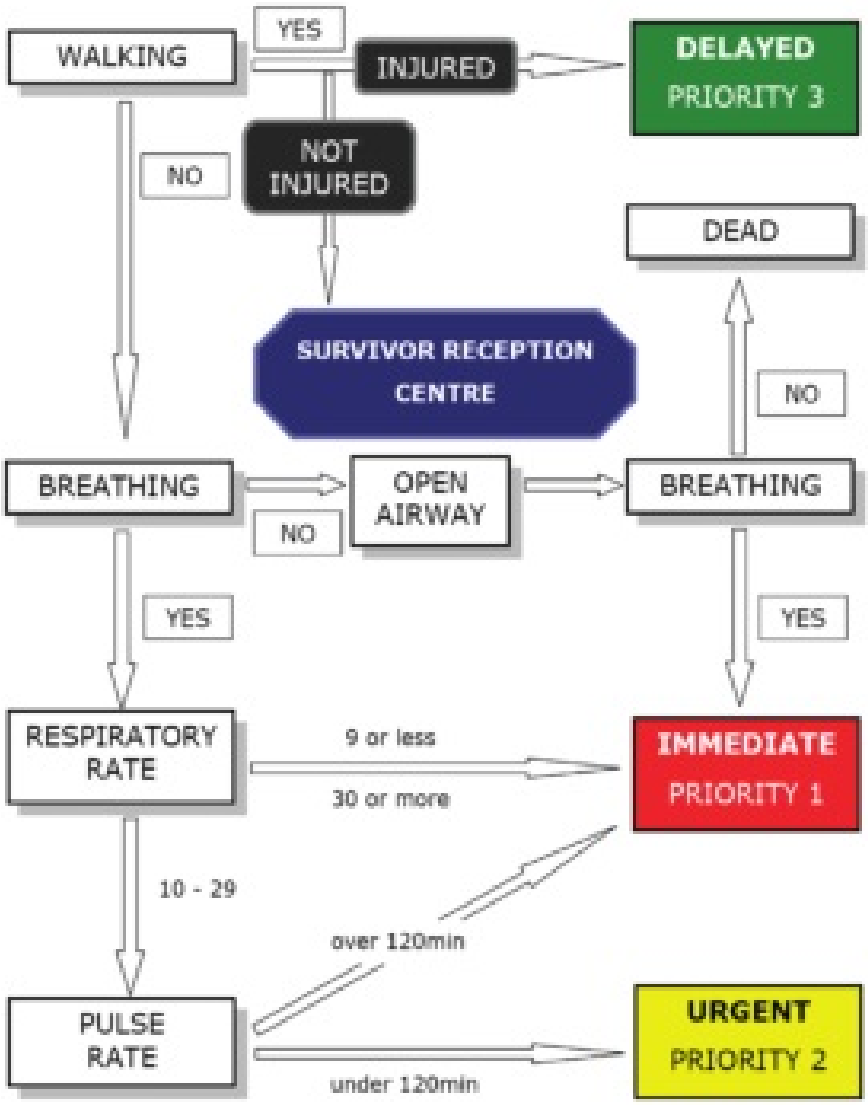
The triage system separates patients into groupings dependent on injury severity.

- Black – "dead" category – Deceased persons; patients are not breathing and immediate airway repositioning is unsuccessful
- Green – third (delayed) priority – less serious casualties that do not require treatment
- Yellow – Second Priority (urgent) – require definitive treatment within four to six hours.
- First (immediate) Priority – require immediate life saving procedures

The triage officer then labels the patient appropriately dependent on category. A folding label can be used to show the category, as well as recording vital information on this. If these aren't available anything that is easy to use, see, resistant to the environment and easily attached to the patient may be used.[2]



Triage Sieve

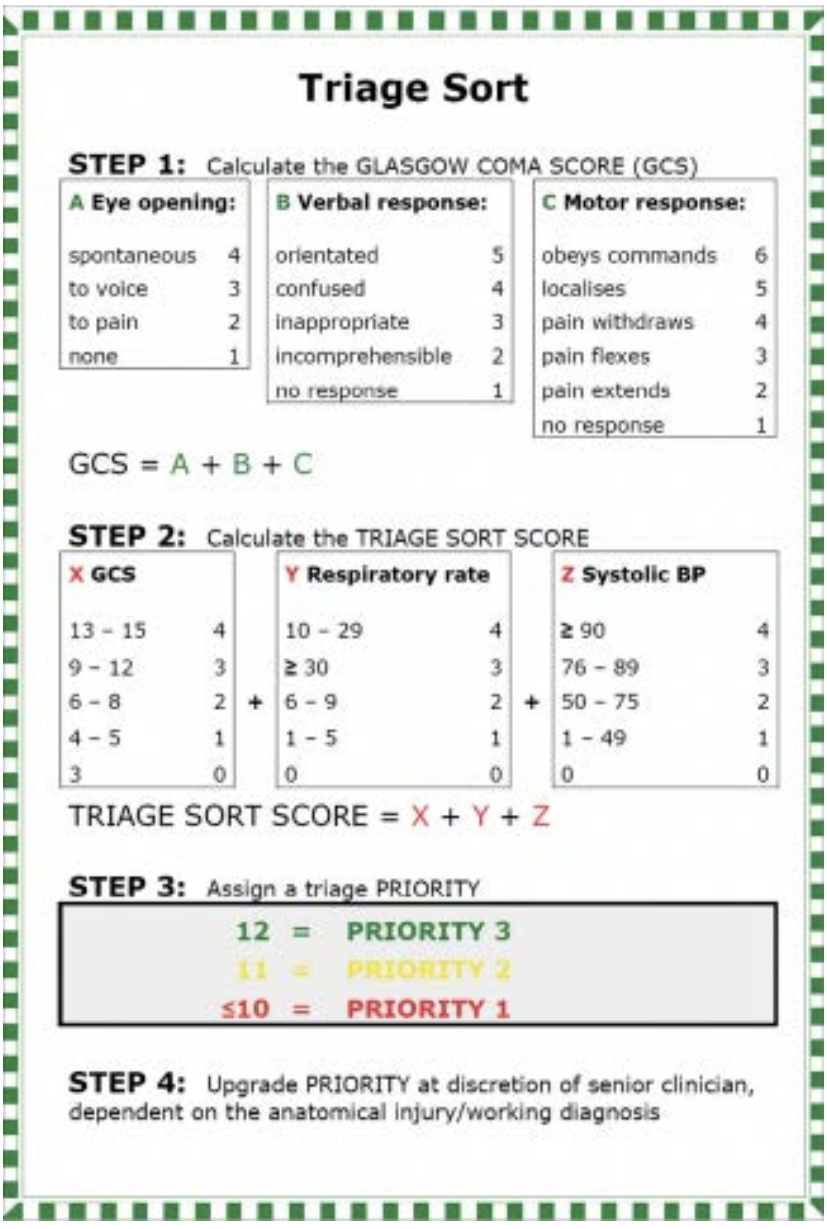


Capillary refill test (CRT) is an alternative to pulse rate, but is unreliable in the cold or dark: if it is used, a CRT of > 2 seconds indicates **PRIORITY 1**

After the triage sieve the triage sort is conducted whereby the priorities for evacuation are set.

- **Deceased** are left at the scene
- **Immediate** (priority 1) are transferred as soon as possible
- **Delayed** (priority 2) are transported after all immediate
- **Minor** (priority 3) are not evacuated until all immediate have been evacuated

Patients are then transported to the appropriate hospital. This is best spread between available hospitals to reduce the burden on each to a manageable level.[1]



You are part of a team, called to help on the A9, where a school bus has crashed off the side of the road and rolled down the embankment. When you arrive it is clearly worse than reported. The bus has rolled down a sizeable hill but is lying the right way up. You know there should be 30 passengers on board, 25 students and 5 staff. You are part of a team of 5 emergency medical professionals and are on the scene after the fire service and police.

- *What would be the first steps on arrival at the scene?*
- *What are the roles of the police and fire service in a mass casualty situation?*
- *How would you set up your equipment?*
- *What might your initial approach be considering this is a mass casualty situation?*
- *Are there any documents or resources you would wish to have?*

On triage you come across a patient who is not breathing, they have no pulse.

- *What would you do?*

On triage you come across a patient who is not breathing, yet they do have a pulse. You try a simple jaw thrust to which the patient responds.

- *What would you do next?*

On triage you come across a patient screaming in agony for his broken leg begging for help.

- *How do you manage this situation?*

After triage is complete you have a patient with a severe head injury, the local hospital has a trauma centre, but no neurosurgical consultant. The nearest neurosurgical department is a further hour away.

- *Where would you send your patient?*

Triage of a mass casualty scenario involves making fast decisions in highly pressured environments. To make this easier there are triage sieves that can be used to quickly and objectively categorize patients dependent on severity. This can involve tough decisions such as leaving people for dead and moving onto the next patient. It is important to follow the sieve and not get side-tracked by beginning non-essential procedures that will rapidly deplete your time and resources.

Organization at a large scene is important, keeping an area for immediate medical assistance, one for the walking wounded waiting for evacuation and having a specific equipment drop point allows for organization of staff and resources.

Deciding where patients are being taken to can present some interesting challenges. Deciding where it is appropriate to send a casualty will depend on the casualty and what they require as some centres may not be equipped to adequately care for them. In a mass casualty incident care must be taken not to overwhelm a single centre, often patients are distributed between local hospitals to reduce the patient load in secondary care.

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[1] Ramesh AC, Kumar S. Triage, monitoring, and treatment of mass casualty events involving chemical, biological, radiological, or nuclear agents. *Journal of Pharmacy and BioAllied Sciences*2010; 2(3): 239-247.

[2] Smith W. Triage in mass casualty situations. *CME* 2012; 30(11): 413-415

[3] Frykberg ER. Medical Management of Disasters and Mass Casualties From Terrorist Bombings: How Can We Cope?. *The Journal of TRAUMA Injury, Infection, and Critical Care* 2002; 53(2): 201-212. : 10.1097/01.TA.0000021586.40033.BA (accessed 21 July 2015).

THE SECONDARY SURVEY

The secondary survey is conducted following the primary survey (ABCDE algorithm), resuscitation and management of life-threatening problems. The secondary survey involves taking a focused history and carrying out a head-to-toe examination of the patient, in order to manage specific non-life threatening injuries not identified in the primary survey. In trauma with major life threatening injuries it may not be possible to conduct a secondary survey until the patient is in hospital and has been stabilised.

This is not the same as an exposure examination which is part of the primary survey and can reveal signs of life threatening conditions, such as, a purpuric rash indicative of meningococcal septicaemia and many more detailed in Exposure assessment section.

Throughout the secondary survey there should be continual monitoring of the patient's vital signs. If the patient's condition changes reassessment via the ABCDE algorithm should be triggered.

What it includes:

1. Reassessment of vital signs
2. Focussed history
3. Physical examination – Head-to-toe examination

Vital Signs

Reassess vital signs, and obtain values for; respiratory rate, pulse rate, blood pressure, oxygen saturations, temperature and consciousness (using GCS or AVPU)[2] if not already done so in the primary survey. These will be helpful aids when determining the patient's progress by acting as a baseline.

History

A focussed can be taken from the patient if alert, or more commonly a relation or bystander. The basis of this history is covered by the mnemonic:

Allergies

Medication

Past medical history/ pregnancy

Last meal

Event leading up to the injury/ environment related to injury

Physical examination

The **head-to-toe examination** is a complete assessment of any potential other injuries sustained by the patient, it should take no longer than 2 or 3 minutes. Where appropriate clothing should be removed and a log roll performed. The patient should be palpated for tenderness over the whole body, and any pain, loss in sensation or deformity should be noted. Below is a guide for points to be considered when carrying out a secondary survey.

PHYSICAL EXAMINATION[1,2]	
General Inspection	• Overall inspection of body position and self-protecting movements
Head and face	• Inspect the head and face for any bruises, swellings or deformities • Inspect the eyes for any injury or deformity. If not already done so assess the pupillary responses • Examine the skull for any signs of deformity • Inspect for nose, eyes and mouth for any signs of blood or clear fluids • Any broken teeth • Check for Battle's sign (bruising behind the injury indicating basal skull fracture)
Neck	• Check if there is any tenderness or deformity of the c-spine • Manual inline stabilisation and immobilisation of the cervical spine may be needed
Chest	• Inspect the chest for any wounds, bruises or abnormal movements • Palpate the chest for any deformities – swellings, rib fractures • Auscultate for air entry and added sounds *(NB: the use of a stethoscope in the prehospital care environment can sometimes be challenging due to noisy adverse environments)*
Abdomen	• Examine the abdomen for any wounds, bruises, abnormal movements or distension • Is there any abdominal tenderness? • Is there bruising – 'seat-belt' sign?
Upper limbs	• Examine for any deformities, bruises,

	colour or fractures • Check capillary refill time • Is there normal function and sensation? • If there are fractures – remember to check neurovascular status, apply splints if appropriate
Lower back	• Any spinal tenderness or obvious injury? • Check for wounds • Inspection of the back is done via a log roll, at the same time preparing placement of the patient onto a transfer device
Pelvis	• Do NOT spring the pelvis • Is there any obvious deformity or the pelvis? • Think about the mechanism of injury when considering a pelvic injury (see Pelvic fracture section)
Genital Region	• Inspect to see if there is fluid or bleeding from the vagina or urethra • Is there any scrotal swelling or obvious deformity?
Lower limbs	• Examine for any deformities, bruises, colour or fractures • Check capillary refill time • Is there normal function and sensation?

It may also be useful to ask the patient questions while you conduct the head to toe examination. These include:

'Are you in any pain?'
'Where is the pain?'
'What else is bothering you?'

These all allow the patient to describe where a problem is that you may be missing, or allow you to address the patients major concerns and problems.

Findings from the secondary survey should be documented and injuries managed appropriately.

[1] St John Ambulance. *The Secondary Survey. http://www.sja.org.uk/sja/first-aid-advice/what-to-do-as-a-first-aider/how-to-assess-a-casualty/the-secondary-survey.aspx (accessed 17 July 2015).*
[2] Queensland Ambulance Serivce. *Assessment/Primary and secondary survey. https://ambulance.qld.gov.au/%5Cdocs%5Cclinical%5Ccpp%5CCPP_Primary%20and%20secondary%20survey.pdf (accessed 17 July 2015).*

Career Interviews

Dr Pamela J Hardy FCEM, MRCPCH, FIMC RCS(Ed)
Lead Consultant in Emergency Care, Dr Gray's Hospital, Elgin
Consultant in Pre-hospital Care; HEMS Doctor, Derbyshire Leicestershire Rutland Air Ambulance; Chair, Scotland Regional Faculty of Pre-hospital Care

1. How does pre-hospital care fit with your career?

It's not always been easy and at times considered by NHS employers as a hobby! Here (rural Scotland) and now it is better recognised and supported and my job plan allows me to spend one weekend a month in a dedicated pre-hospital HEMS role in the East Midlands - something I have been doing since 2008.

I also do work for the Royal College of Surgeons of Edinburgh (RCS Ed) as an examiner for the pre-hospital exams and represent the Royal College of Paediatrics & Child Health (RCPCH) on the Intercollegiate Board for Training in Pre-Hospital Emergency Medicine (IBTPHEM). These are recognised activities within consultant job plans.

2. What was your career pathway?

Chequered!

I initially trained in paediatrics with a view to doing Paediatric Emergency Medicine (PEM) but before that was a recognised sub-specialty, so I then did EM training and stayed in a mixed adult / PEM role having started to develop my interest in pre-hospital care (PHC). But along the way I aspired to be everything from a train driver (steam) to a neonatologist and paediatric cardiologist. Medicine wasn't my idea - I wanted to be a midwife and marry a farmer.

From a pre-hospital perspective I started like many by volunteering and working as a BASICS responder. I was one of the founder members of the Faculty of Pre-hospital Care in 1997, sat the Diploma in Immediate Medical Care in 1998 and my Fellowship in 2001. I am now a Member of the Faculty of Examiners of the Royal College of Surgeons of Edinburgh.

I became the Royal College of Paediatrics and Child Health Representative on the Intercollegiate Board for Training in Pre-hospital Emergency Medicine in 2009 - the body that in 2011 was successful in its application to the GMC for Pre-hospital Emergency Medicine (PHEM) to become a recognised sub-specialty. This was a huge milestone in the development of PHEM in the UK.

I started doing shifts with an air ambulance unit back in 1999, but took on a more substantive role with Derbyshire, Leicestershire & Rutland Air Ambulance in 2008 and continue to fly there regularly and provide support as a Clinical Supervisor and PHEM trainer.

I was also Clinical Director of an Ambulance Service for a couple of years alongside my consultant post – management roles are definitely not my forte!

3. How would you define pre-hospital care?

Doing everything you can within the limits of the setting to deliver medical care early enough to make a difference and get the patient to the right place to continue that care - sometimes that's a Major Trauma Centre having made loads of interventions, sometimes that's helping a patient needing palliative care to remain at home.

4. What inspired you to become involved in pre-hospital care?

Coming across an accident on my way home wearing a cotton frock and sandals, with no kit and feeling totally useless. And doing an elective in my final year with an ambulance service close to relatives in America because I was too scared to travel 5 hours by myself to the neonatology placement I had arranged! So my uncle took me to the local ambulance / fire station and I had a great time!

5. What advice would you give to those looking to be involved in pre-hospital care?

Do it! But be patient and get a good grounding in relevant hospital jobs - it's not easy to get involved in an undergraduate / junior level due to the unpredictable nature of jobs, the need to be supervised as in any undergraduate / junior post and the fact that much of it is still provided on a voluntary basis by clinicians responding as and when needed in their own time. But there are ways to get involved including Voluntary Aid Societies, event cover and increasingly training and observation opportunities.

6. What are the greatest challenges involved in pre-hospital care?

Dealing with the unexpected in an unsupported and often unusual environment; having to make quick decisions and deal with the consequences.

7. What is the most difficult case you have been involved with?

There have been one or two – probably completing an amputation in a patient trapped in a grain auger and helping rescue and treat a severely injured child – the wording of the certificate of commendation we received still brings a lump to my throat. It's not often in your medical career you actually feel like you have made a significant difference and sometimes it's only when you see it in a context like this that you see maybe you did. And it's never an individual thing – a huge amount of team-work went into both these jobs and all the others I have been involved with, from pilots getting us there in challenging weather, and getting the patient to the hospital to the ambulance and Fire & Rescue crews, Police and many others. It's definitely a team effort.

8. Where do you see pre-hospital care developing in the next 10 years?

Following the developments of the last 10 years, I think it will go from strength to strength as a truly multi-disciplinary specialty recognising the huge contribution of our ambulance and nursing colleagues. It has just been agreed by the GMC and RCS Ed that the FIMC (Fellowship in Immediate Care) RCS Ed can be accessed by non-medical personnel, so groundbreaking progress!

The Faculty of Pre-hospital Care (FPHC) is also moving forward with bringing together many providers such as mountain rescue and voluntary aid organisations, event medical providers and remote and offshore specialists to promote a culture of shared learning and best practice, as well as publishing consensus statements, endorsing courses and developing Diplomas in other aspects of pre-hospital and transfer medicine.

9. Do you think there is a role for undergraduate teaching in pre-hospital care? And if so what would it be?

Absolutely! We are already beginning to see it appearing in some undergraduate curricula as well as some local training opportunities including opportunities to share training with post-graduate and operational emergency services personnel through Regional FPHC educational programmes.

Opportunity to spend time with operational ambulance crews is invaluable and should be supported by undergraduate training. Many HEMS units now also have car-based provision, especially overnight and could provide a training platform for undergraduates on occasions. As many if not more lives can be saved by people volunteering to become a community first responder, initiatives such as this are ideal for undergraduates to make a start in their pre-hospital careers.

Dr John Ferris
MBChB FRCEM MRCSEd DipIMC RCSEd BSc(Hons) MedSci
Consultant in Emergency, Pre-hospital & Retrieval Medicine

1. How does pre-hospital care fit with your career?

I am a Consultant in Emergency, Pre-hospital and Retrieval Medicine in Scotland. A proportion of my salaried time within my NHS post as a Consultant is to provide both pre-hospital and retrieval medicine within Scotland by working with the Emergency Medical Retrieval Service (EMRS). I also work for a number of other Air Ambulances and for BASICS in my spare time.

2. What was your career pathway?

After foundation training I undertook ACCS and then higher Emergency Medicine training. I was lucky enough to train in an Emergency Department where pre-hospital critical care is provided by an ED team including supervision of training by Consultants. After I gained my CCT I spent 2 years working full-time in PHEM with London's Air Ambulance, Essex & Herts Air Ambulance and EMRS in Scotland.

3. How would you define pre-hospital care?

Pre-hospital care is the all-encompassing care of patients before they reach a hospital. It ranges from remote mountain rescue or expedition medicine, to voluntary first aid, ambulance service care and pre-hospital emergency medicine. Each component is a vital link in the chain of survival for critically ill or injured patients. Every clinician has a role to play in halting or reversing the dying process.

4. What inspired you to become involved in pre-hospital care?

I realised very early in my career that seriously injured patients should not have to wait until they arrive at a hospital before advanced care is provided. At this time pre-hospital medicine was very poorly understood and certainly not recognised in the UK. Many doctors were skeptical about physicians working outside the hospital. Organisations like London's Air Ambulance fought to demonstrate to the rest of the medical world that doctors can enhance the care of patients as part of a pre-hospital team - this inspired me to get involved.

5. What advice would you give to those looking to be involved in pre-hospital care?

PHEM can appear very difficult to get involved with as a junior doctor. It can seem like an impossible circle to break – you need experience to be useful but you can't get experience because of your stage of training. My advice: find a mentor - a senior clinician who works in PHEM in your region and can advise you of the many and various opportunities that

definitely exist for you out there for. Get involved in research early – evidence drives our clinical practice and is essential for our specialties development.

6. What are the greatest challenges involved in pre-hospital care?

Seeing patients who die in front of you despite everything that you do. It can be very hard to deal with exceptionally emotive situations in the uncontrolled environment outside the hospital. It can be difficult to control the frustration of not being able to do more for some patients. The skill is to channel this frustration constructively by training, reflecting and enhancing your skills for the next patient.

7. What is the most difficult case you have been involved with?

Having worked with numerous pre-hospital agencies I have been involved in many difficult and stressful cases. Undoubtedly the biggest test of a pre-hospital doctor is incidents where multiple patients are critically injured. Making strategic decisions about who to treat and how to triage large numbers of patients is a unique challenge.

8. Where do you see pre-hospital care developing in the next 10 years?

It is a truly exciting time in PHEM at present. With formal sub-specialist recognition and a UK network of pre-hospital critical care teams developing rapidly we are in a very strong position. I feel that we now need to collaborate on a national basis with some high quality pre-hospital research and trials to address questions that as yet remain unanswered: who benefits from pre-hospital anaesthesia? How should we treat patients in traumatic cardiac arrest?

9. Do you think there is a role for undergraduate teaching in pre-hospital care? And if so what would it be?

Undergraduate involvement in PHEM is essential! We need a generation of new doctors to become enthused and involved as our exciting new specialty evolves. PHEM needs to become a core part of the undergraduate and postgraduate curriculum like any other specialty.

Dr Colville Laird

General Practitioner
Director of Education for BASICS Scotland
Chair, Faculty of Pre-hospital Care

1. What was your career pathway?

I started off my career working in General Medicine and then went into General Practice. I always wanted to do rural practice and was offered a practice in Perthshire. I have been a GP there for 31 years. When I started in general practice most of pre-hospital care was provided by GPs. There were few paramedics. In the early 1990s this was still the case and there was a need for education. ALS and ATLS were becoming popular for our hospital colleagues and similar courses were needed for pre-hospital care. The demand for courses increased and by 2000 I was spending half of my working life arranging courses and BASICS Scotland was formed shortly after this. My work led to me being involved with The Faculty of Pre-Hospital Care at The Royal College of Surgeons Of Edinburgh. As a result of this involvement I am now Chairperson of The Faculty of Pre-Hospital Care.

3. How would you define pre-hospital care?

It's obviously about providing care to patients until they get to hospital but the key is good systems and good teamwork. It's not about individual professions or individuals it's about a huge range of individuals and professionals working together. This includes The Police, Fire Service, Mountain rescue and many other organisations. The role of the general public and the huge contribution of ambulance controls are generally underestimated.

4. What inspired you to become involved in pre-hospital care?

In my second year in general practice an 8year old girl was killed in a road traffic accident whilst getting on a bus to go to a Sunday School Picnic. Her airway was obstructed with sweets. One of my colleagues struggled, with no equipment, to clear her airway. He was severely affected by this experience and all the doctors in the town agreed we needed equipment and training.

5. What advice would you give to those looking to be involved in pre-hospital care?

A career in pre-hospital career will, in the future, require sub-speciality training, but there will still be a need for rural practitioners to play a part. There may still be a role to combine working in rural healthcare with pre-hospital care work.

6. What are the greatest challenges involved in pre-hospital care?

Where do I start! What we want to do is save lives, relieve suffering and improve outcomes for survivors of life threatening emergencies. To do this I think we need to train the general public to be more involved in providing early care to perform CPR, maintain airways etc. We

need to improve systems of care and for this I feel ambulance control centres need development.

8. Where do you see pre-hospital care developing in the next 10 years?

There are obvious answers to this question. In particular the new multi-professional sub-speciality of Pre-hospital Care will be a big part of this. Ideally we will see practitioners in pre-hospital care not profession specific but classified by the competencies they possess.

9. Do you think there is a role for undergraduate teaching in pre-hospital care? And if so what would it be?

Definitely, BASICS Scotland already provides regular teaching at two of the five medical schools in Scotland. I would like to provide this at every medical school but financial restrictions mean this is not possible. We are an independent charity and have to ensure our financial viability. I did try to get this added to the Scottish undergraduate curriculum but this was rejected. Now that we have a GMC recognised sub-speciality of Pre-hospital Care we should try again. I do not think the teaching needs to be extensive but reality suggests that once qualified many doctors will be asked to provide pre-hospital care, either as a " good Samaritan " act or to provide cover for events that they or members of their family may be involved in. Without teaching many will think that the training and qualifications they have will equip them for this. Undergraduate teaching in pre-hospital care should alert them to the fact that this is not the case, the safety risks and basic skills of CPR, airway management and spinal immobilisation.

Dr. Stefan Mazur

Chief medical officer South Australia ambulance service, MEDstar, HEMS physician

How has pre-hospital care fitted into the rest of your medical career?

It's helped define who I am, has improved my Emergency medicine, has made me more resilient.

How would you define pre-hospital care?

Decreasing the therapeutic vacuum by delivering quality value adding medical assessment and interventions in the out of hospital environment.

What inspired you to become involved in pre-hospital care?

I don't actually know? The challenge of doing more with less maybe.

What advice would you give to those looking to be involved in pre-hospital care?

This isn't something you do as a hobby or side interest, this is true critical care in difficult environments. Your patient and pre-hospital colleagues deserve more than you doing this as a hobby.

What challenges would you highlight in the delivery of pre-hospital care?

Ensuring that politicians and future funders appreciate the clinical value that physicians provide to critical patients in the pre-hospital environment.

What difficult pre-hospital cases stick with you?

Children, and patients who talk to you and then die. And the funny ones – intubating a patient in a posh club and then draining the contents of his NGT into a crystal vase that was provided.

Where do you see pre-hospital care developing in the next 10 years?

Better, faster transport frames. Higher levels of portable critical care with trained credentialed pre-hospital physicians providing it.

Appendix

- Pre-Hospital Care Organisations
- Resources
- Basic Life Support – Adult and Paediatric CPR algorithm
- Student Fact Sheets

PRE-HOSPITAL CARE ORGANISATIONS

BASICS

Basics is the British Association for Immediate care, an organisation which emerged in 1977 serving to provide immediate care with the provision of skilled medical help at the site of an accident. They provide training in immediate care for various healthcare professionals, or as they put it themselves:

'BASICS is a strong and vibrant professional association that brings together a wide range of individuals and maintains the driving force behind many of today's leading developments in pre-hospital care.'

For more information see the BASICS website at www.basics.org.uk

BASICS Scotland

Basics Scotland is the British Association for Immediate Care specifically for Scotland. It is similar to BASICS in its aims and delivery.

For more information see the BASICS Scotland website www.basics-scotland.org.uk

Faculty of Pre-Hospital Care

The Faculty of Pre-Hospital Care is part of The Royal College of Surgeons of Edinburgh. The faculty was setup in 1996 it runs a number of courses and seminars for education, research and professional development in Pre-Hospital care.

For more information visit the faculty website at www.fphc.co.uk

Pre-Hospital Emergency Medicine

This is now a recognised subspecialty and is open to trainees in Emergency Medicine, Anaesthesia, Intensive Care Medicine or Acute Medicine.

For more information visit the faculty website at http://www.ibtphem.org.uk

Community First Responders

A community first responder is a volunteer trained to attend emergency calls received by ambulance services to provide care until the ambulance arrives. They are trained in basic first aid including basic life support (BLS), automated external defibrillator usage and are trained to provide oxygen therapy. All medical students are eligible to become one.

RESOURCES

For more information about pre-hospital care, below is a list of resources that you may find useful:

www.fphc.co.uk

www.**basics**-**scotland**.org.uk

www.**sandpipertrust**.org

www.**basics**.org.**uk**

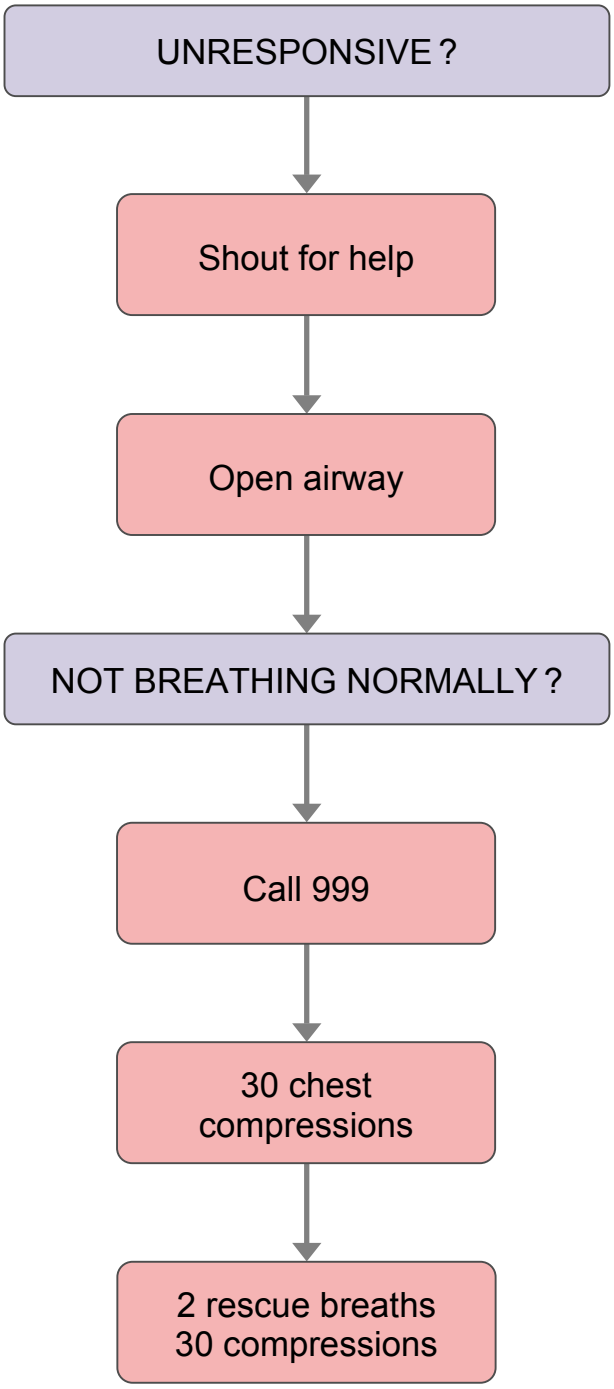
www.londonsairambulance.co.uk

www.sydneyhems.com

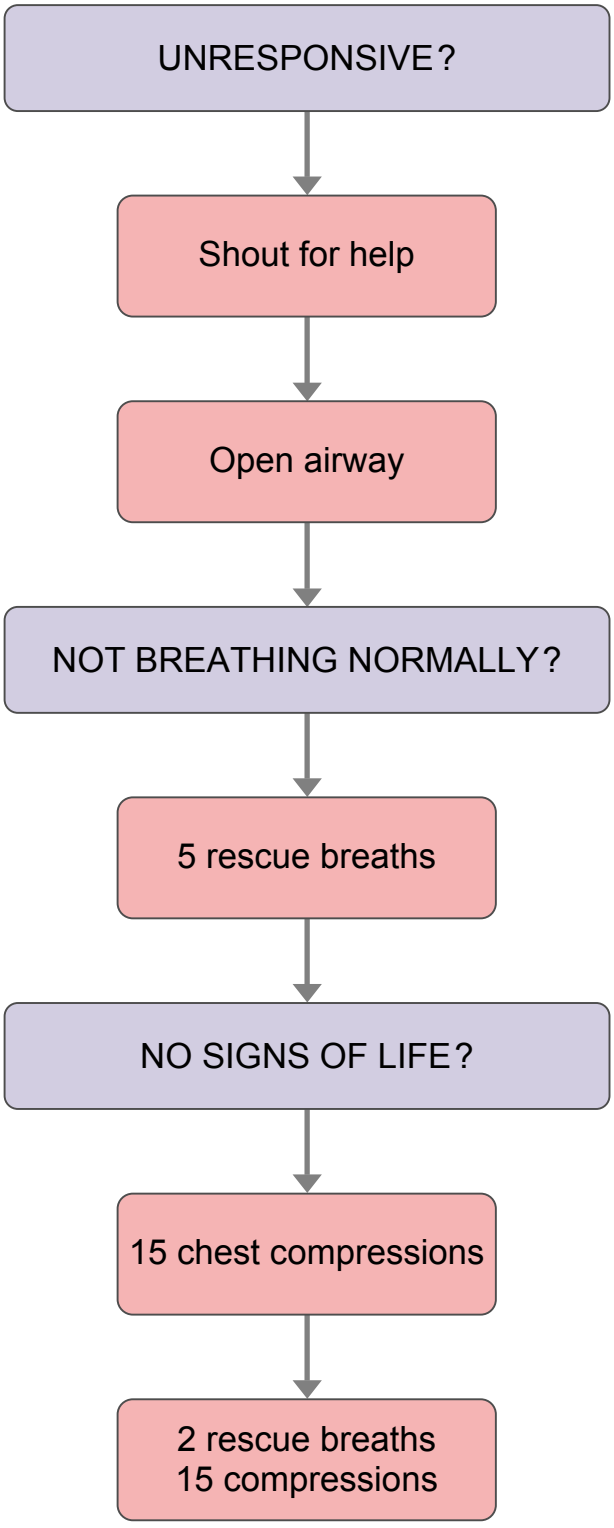
http://careers.bmj.com/careers/advice/view-article.html?id=20011662

http://www.ibtphem.org.uk/IBTPHEM/Welcome.html

Adult Basic Life Support

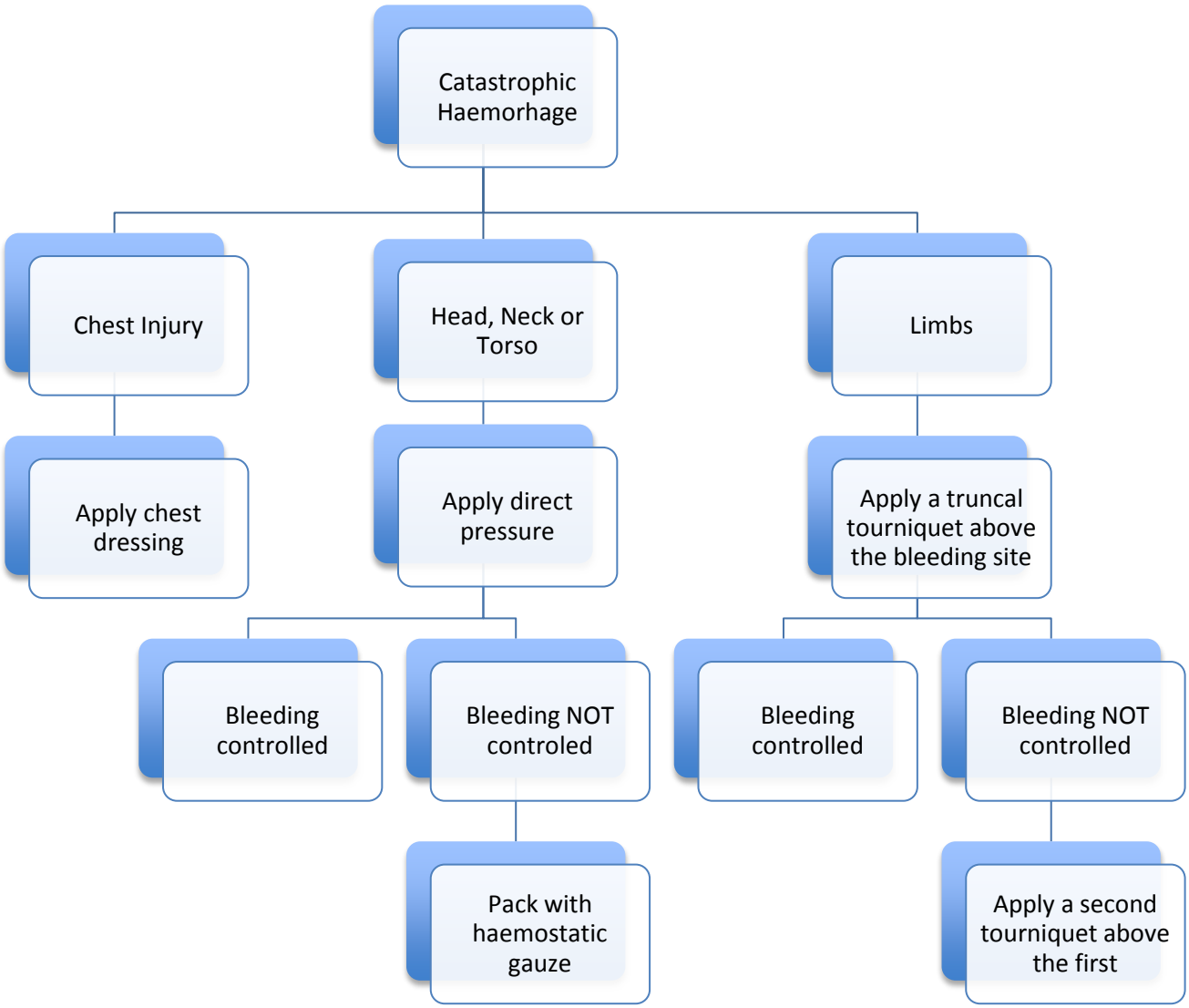


Paediatric Basic Life Support
(Healthcare professionals with a duty to respond)



Call resuscitation team

Catastrophic Haemorrhage



Airway

The Airway Ladder

airway not maintained
- Head tilt-chin lift
- OR
- Jaw Thrust (if c-spine injury is suspected)

airway not maintained
- Insert oropharyngeal OR nasopharyngeal airway

airway not maintained
- Supraglottic Device

airway not maintained
- Intubation

Intubation
- Surgical airway (needle or surgical cricothyroidotomy)

ASSESMENT

Look Chest movement- *Symmetrical? Increased work of breathing? Any signs of obstruction?*

Listen *Talking? Breathing? Choking? Sounds? Wheeze, stridor, stertor, gurgle*

Feel *for air movement*

Manual Inline Stabilization

Head tilt Chin Lift

Jaw Thrust

Breathing

- *Respiratory Rate*
- *Inspection*
- *Palpation*
- *Percussion*
- *Auscultation*
- *Oxygen saturation probe*

Oxygen therapy

Mouth to mouth

↓

Pocket Mask

↓

Bag-valve-mask

↓

supraglottic airway

↓

ET Tube

Airway obstruction
Tension pneumothorax
Open pneumothorax
Massive haemothorax

Flail chest
Cardiac tamponade

- Suspect Pneumothorax?
  +
- Circulatory compromise?
  =
- TENSION PNEUMOTHORAX
- Needle thoracostomy 2nd intercostal space mid-clavicular line

Circulation

- Chest
- Abdomen
- Pelvis
- Long bones
- Floor

Catastrophic Haemorrhage?

Inspection – *Fractures, obvious bleed, patient colour,*

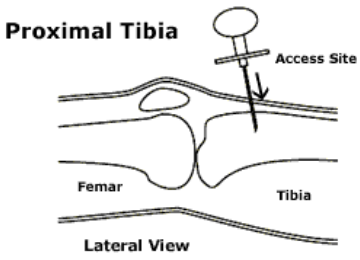
Palpation – Capillary refill >2, *Respiratory rate, pulse rate <40 or >120*

Auscultation - *Heart and chest*

Blood Pressure – *Carotid 60, femoral 70-80, radial 80<*

AVPU

Gain access – IV or IO



Simple positioning placing the patient supine with legs raised and follow external haemorrhage steps

Gain intravenous access as soon as possibly, if not available consider Intraosseous access

Fluid resuscitation

No radial pulse? Give 250ml bolus of crystalloid

Disability

- Alert
- Verbal
- Pain
- Unresponsive

Pupils- Equal? Responsive?

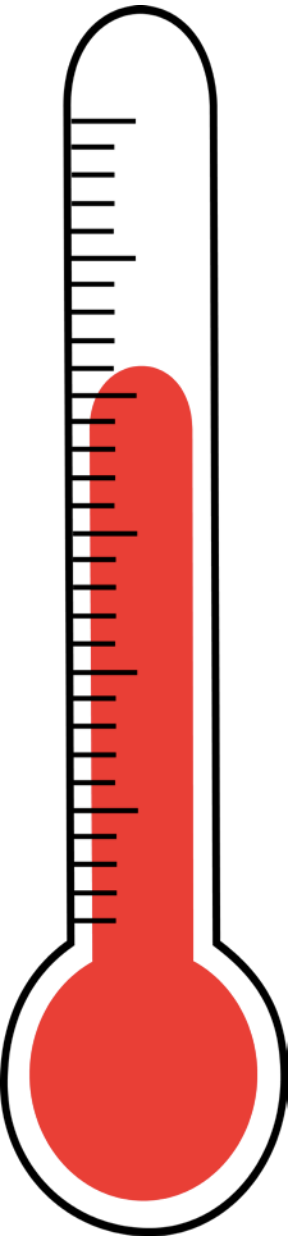
Analgesia

- Paracetamol
- Entonox
- Morphine
- Ketamine

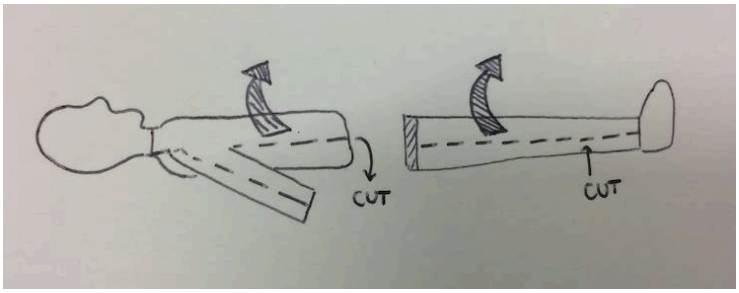
IMMEDIATE MANAGEMENT
Stop any external haemorrhage Immobilise the affected area Give adequate analgesia If pelvic or long bone fracture get IV access (both these are cause of major blood loss and so IV access can be a life-saving intervention)

ABC – Don't Ever Forget Glucose

Exposure



36°C
Feel cold
35°C
Shivering
34°C
Acting bizarre
33°C
Confused
32°C
Stuff limbs
31°C
Unresponsive
30°C
Fixed pupils
29°C
Irregular pulse and cardiac arrest



Cold (>35°C)

Encourage activity, put on more clothes

Mild Hypothermia (35-32°C)

- Insulation
- Shelter
- Warm sweet drinks
- Remove wet clothing if other clothing is available
- If uninjured and alert then there is no need for hospitalization

Moderate Hypothermia (32-28°C)

- Active warming- heat packs, forced-air
- IV/IO access
- Fluid replacement – saline heated to 40-42°C
- Transfer to hospital, if haemodynamically unstable then ensure an ICU and cardiopulmonary bypass if available.

Severe Hypothermia (<28°C)

- Treat as per above
- Intubation or use a supraglottic device followed by ventilation
- CPR if no signs of life
- Transfer to hospital preferably with cardiopulmonary bypass

Look – deformity, asymmetry, colour, function
Feel – warmth, pain, capillary refill, neurovascular status
Move – reduced range of movement, reduced function

Secondary survey

- Reassessment of vital signs
- Focussed history
- Physical examination - Head to toe examination

A*llergies*
M*edication*
P*ast medical history*
L*ast meal*
E*vent leading up to the injury/ environment related to injury*

'Are you in any pain?'
'Where is the pain?'
'What else is bothering you?