

ABC of

Major Trauma

Rescue, Resuscitation with Imaging, and Rehabilitation

FIFTH EDITION

Edited by Peter A. Driscoll, David V. Skinner and Peter N. Goode



WILEY Blackwell

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Fifth Edition

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'This 5th Edition of the ABC of Major Trauma is dedicated to Maralyn Woodford.

As a key and pioneering member of UK TARN she has worked tirelessly to ensure that injury severity and survivability are accurately reported. This has been crucial to MTC's and TU's trauma care performance and has been pivotal in significantly improving the care of the injured patient population'

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Foreword

In his Foreword to the first edition of this book in December 1990, Professor Sir Miles Irving wrote of the enormous problem posed by injury in Western society. He regretted that although ‘Interested individuals have repeatedly pointed out the inadequacy of pre-hospital, hospital and rehabilitation services, calls for remedial action have, at best, elicited only partial responses’.

He went on to write, however, that with regard to trauma care, ‘Happily attitudes seem to be changing’.

This fifth edition of the *ABC of Major Trauma* reflects the tremendous advances in the care of the injured over the past 30 years, evidenced by the continuing reduction of avoidable deaths charted by the Trauma Audit and Research Network. New authors have both updated and enhanced existing chapters while additional chapters have been added, most notably on rehabilitation and trauma systems. Computed tomography (CT), rarely easily available 30 years ago, is now routine and integral to the trauma patient’s initial assessment in hospital. This increasing use of and dependence on CT is addressed with imaging appendices to many chapters, as well as there being access to teaching on the ‘CT primary and secondary survey,’ allowing readers to approach CT interpretation in a systematic fashion.

The text is fully referenced, reflecting the substantial research base that now exists. It is fully ‘up to date’ and aims, as far as is possible, to remain so with liberal use of hyperlinks to, for example, national guidelines, themselves updated on a regular basis.

While giving a perspective of worldwide trauma care, this edition, as with previous ones, describes UK practice, with a particular focus on early management in the pre-hospital and resuscitation-room phases. The many specialties contributing to the care of the injured patient are all represented within the 33 chapters, as the early involvement of inpatient specialists is key in the chain of trauma survival. All those involved in trauma care from the ‘roadside to effective rehabilitation’ should read this book and work to ensure that the next edition will again reflect further improvements in care.

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Preface

In 1991, the first edition of the *ABC of Major Trauma* was released early to help medical personnel dealing with casualties from the first Gulf War. Thirty years later, the fifth edition is being published with continuing conflicts in the Middle East, a pandemic and hostilities in the Ukraine. Though we may feel justified in thinking, "plus ça change, plus c'est la même chose", our responsibilities remain.

Over these three decades, many battles, fought to improve trauma care, have been won. It is opportune therefore with this edition to radically revise each chapter to reflect 'up to the minute' modern trauma management. In addition, there are new chapters describing the first-hand experience of authors and detailing impressive development in all areas. These include the trauma care system, pelvic trauma, ear, nose and throat trauma and non-technical skills factors in trauma management.

With this background of significant progress and development, two topics stand out. The first is imaging. The early use of whole-body, multiphase computed tomography (CT) has transformed trauma care. Furthermore, interventional radiology is increasingly available and is providing additional, less traumatic, options to managing the already-injured patient. This increased role is discussed in Section I within a series of imaging appendices to the chapters, including CT interpretation videos.

The second topic is rehabilitation. Taking a lead from military colleagues, civilian practice has seen the substantial beneficial

impact of focused comprehensive rehabilitation. This specialty represents a hugely important link in the chain of trauma care and rightly now has its own chapter.

In this new edition, we are keen to continue to address the varying educational needs of the readership. Like the trauma team itself, they come from a wide spectrum of specialities, professions and backgrounds. To meet this goal, we have developed a website, directly accessed by hyperlinks within each chapter, where topics are expanded and further information provided. This allows the text of the core book to focus on the resuscitation and initial management of the patient.

Looking back over 30 years, we can see that although battles have been won, the war against trauma continues. Until the day arrives when preventative care eliminates injury, we will need to ensure that the chain of trauma care continues to develop. It is therefore down to everyone involved to try to strengthen their link in the chain. In doing so, collectively, we can strive to continue to improve the outcomes for trauma patients who entrust us with their care at a difficult and stressful time in their lives.

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Abbreviations

AAAM	association for the advancement of automotive medicine	CPR	cardiopulmonary resuscitation
AAST	american association for the surgery of trauma	CRCE	centre for radiation, chemical and environmental hazards
ABG	arterial blood gas	CRM	crew resource management
ABPI	ankle brachial pressure index	CRT	capillary refill time
ACVPU	alert, confusion, voice, pain, unresponsive	CSCATTT	command, safety, communication, assessment, triage, treatment
ADP	adenosine diphosphate	CSF	cerebrospinal fluid
AE	angioembolisation	CT	computed tomography
AGP	aerosol generating procedure	CTG	cardiotocograph
AIS	abbreviated injury scale	CT TAP	computed tomography of the thorax, abdomen and pelvis
AKI	acute kidney injury	CVP	central venous pressure
ALS	advanced life support	CVVH	continuous venovenous hemofiltration
AMP(L)E	allergies, medications, past medical history, (last meal or other intake) and events leading to presentation	DAI	diffuse axonal injury
APLS	advanced paediatric life support	DAS	difficult airway society
ARDS	acute respiratory distress syndrome	DCS	damage control surgery
ASD	acute stress disorder	DIC	disseminated intravascular coagulation
ATLS	advanced trauma life support	DICOM	digital imaging and communications in medicine
ATMIST	age, time, mechanism, injury, signs, treatment	DOB	date of birth
ATNC	advanced trauma nursing course	DVT	deep venous thrombosis
ATP	adenosine triphosphate	DWI	diffusion weighted image
AVF	arteriovenous fistula	e-FAST	extended focused assessment with sonography in trauma
BASICS	british association for immediate care	EAC	external auditory canal
BATLS	battlefield advanced trauma life support	ECG	electrocardiogram
BA	behavioural activation	ECMO	extracorporeal membrane oxygenation
BP	blood pressure	ED	emergency department
BPM	beats per minute	EEG	electroencephalogram
BSA	body surface area	EFGHI	elderly fallers get head injuries
BVM	bag-valve-mask	EMDR	eye movement desensitization and reprocessing
<C>ABCDE	catastrophic haemorrhage, airway, breathing, circulation, disability, exposure	EMS	emergency medical services
CBF	cerebral blood flow	ENT	ear, nose and throat
CBT	cognitive behavioural therapy	ERC	european resuscitation council
CCA	civil contingencies act	EtCO ₂	end-tidal carbon dioxide
CCP	casualty collection point	ETT	endotracheal tube
CCS	casualty clearing station	ETA	expected time of arrival
CLP	casualty loading point	ETC	european trauma course
COPD	chronic obstructive pulmonary disease	FAST	focused assessment with sonography in trauma
COVID-19	coronavirus disease - 2019	FBC	full blood count
CPB	cardiopulmonary bypass	FCP	forward command point
CPP	cerebral perfusion pressure	FFP	fresh frozen plasma

FiO ₂	fraction of inspired oxygen	NPIS	national poisons information service
FONA	front of neck access	NSAID	non-steroidal anti-inflammatory drug
FRC	functional residual capacity	OM	occipitontal
GACI	global alliance for the care of the injured	OPA	oropharyngeal airway
GCS	glasgow coma scale	OPG	orthopantomogram
GP	general practitioner	ORIF	open reduction internal fixation
HART	hazardous area response team	OSS	orthopaedic scoop stretchers
HSA	health security agency	PaCO ₂	partial pressure of carbon dioxide in arterial blood
HCT	hospital co-ordination team	PACS	picture archiving and communication system
HDU	high dependency unit	PAINAD	pain assessment in advanced dementia scale
HECTOR	heartlands' elderly care trauma and ongoing recovery	PaO ₂	partial pressure of oxygen in arterial blood
HEMS	helicopter emergency medical services	PCA	patient-controlled analgesia
HR	heart rate	PCC	prothrombin complex concentrates
HU	hounsfield units	PEEP	positive end-expiratory pressure
IC	infection control	PHC	pre-hospital care
ICF	international classification of functioning, disability and health	PHEA	pre-hospital emergency anaesthesia
ICP	intracranial pressure	PICS	post-intensive care syndrome
ICU	intensive care unit	PICT	pre-hospital immediate care and trauma
ID	identification	pO ₂	partial pressure of oxygen
IED	improvised explosive device	POC	point of care
IM	intramuscular	PPE	personal protective equipment
INR	international normalised ratio	PPH	postpartum haemorrhage
IO	intraosseous	PPID	positive patient identification
IPE	individual protective equipment	PRC	packed red cells
IPT	interpersonal therapies	PROM	patient reported outcome measures
ISS	injury severity score	PT	prothrombin time
IV	intravenous	Ps	probability of survival
IVR	interventional radiology	PTSD	post-traumatic stress disorder
JESIP	joint emergency services interoperability principles	RAPD	relative afferent papillary defect
KE	kinetic energy	RCR	royal college of radiologists
LMA	laryngeal mask airway	REBOA	resuscitative endovascular balloon occlusion of the aorta
LMICs	low and middle-income countries	RM	rehabilitation medicine
LMWH	low molecular weight heparin	ROSC	return of spontaneous circulation
MAP	mean arterial pressure	RPM	respiration per minute
MERIT	medical emergency incident response team	ROSIER	recognition of stroke in the emergency room
MEWS	modified early-warning score	RSI	rapid sequence induction
MHP	major haemorrhage protocol	RTC	road traffic collision
MILS	manual in-line stabilisation	RTS	revised trauma score
MIP	maximum intensity projection	SAD	supraglottic airway device
MODS	multi-organ dysfunction syndrome	SaO ₂	arterial oxygen saturation
MRI	magnetic resonance imaging	SBP	systolic blood pressure
MTA	marauding terrorist attacks	SCI	spinal cord injury
MTC	major trauma centre	SCIWORA	spinal cord injury without radiological abnormality
NAI	non-accidental injury	SEMP	senior emergency medicine physician
NARU	national ambulance resilience unit	SGA	supraglottic airway
NASMeD	national ambulance services medical directors	SIGN	scottish intercollegiate guidelines network
NCEPOD	national confidential enquiry into patient outcome and death	SpO ₂	peripheral capillary oxygen saturation
NEWS2	national early warning score 2	SPOC	single point of contact
NET	narrative exposure therapy	STAG	scottish trauma audit group
NGT	nasogastric tube	STIR	short tau inversion recovery
NICE	national institute of health and care excellence	SVC	superior vena cava
NMTNG	national major trauma nursing group	SWI	susceptibility weighted imaging
NPA	nasopharyngeal airway	TARN	trauma audit and research network
		TCG	tactical coordinating group

TBI	traumatic brain injury	TRALI	transfusion-related acute lung injury
TBSA	total body surface area	TXA	tranexamic acid
TEG	thromboelastogram	U&Es	urea and electrolytes
TIC	trauma induced coagulopathy	UK ROC	uk rehabilitation outcome collaborative
TM	tympanic membrane	URT	upper urinary tract
TN	trauma network	US	ultrasound
TNCC	trauma nursing core course	VEM	visco-elastic method
TRiM	trauma risk management	VBG	venous blood gas
TRISS	trauma and injury severity score	V/Q	ventilation/ perfusion ratio
TTL	trauma team leader	WBCT	whole-body ct
TTM	trauma team member	WHO	world health organization
TU	trauma unit	Ws	standardised W statistic

About the companion website

This book is accompanied by a companion website.

<https://www.wiley.com/go/driscoll/trauma>



This website includes:

- Additional text, videos and images to complement the chapters in the print book
- Links to useful on-line resources.
- Trauma in pregnancy (PowerPoint presentation with audio & video)
- Ultrasound resource
 - Normal thoracic and heart ultrasound examples
 - Thoracic and heart ultrasound examples following trauma
 - Normal abdominal and pelvic ultrasound examples
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SECTION I

General circumstances

The development and organisation of trauma services

David Bramley, Peter N. Goode, Michael Hüpfel and Brian Burns

OVERVIEW

This chapter aims to:

- define major trauma
- highlight that major trauma is a common cause of death and disability worldwide
- discuss the evidence-based strategies that exist to improve outcomes following trauma
- identify each aspect of trauma care from prevention through to rehabilitation that must be developed to achieve optimal outcomes
- provide an overview of the development of major trauma systems in the UK and abroad.

Introduction

Definitions

Depending on the context, the term, ‘major trauma’ has various meanings. Academically, it is defined by an injury severity score (ISS) of greater than 15 (see Chapter 33 – Evaluating the effectiveness of trauma care – Anatomical scoring system). However, the ISS is a retrospective calculation based on the anatomical nature of the injuries, so it cannot be used at the time of the patient’s initial presentation to medical care. It should also be appreciated that ‘moderate trauma’ (i.e. ISS 9–15) can be associated with significant mortality and morbidity, especially at the extremes of age. Some complex isolated limb injuries may have a relatively low ISS yet result in significant morbidity and require specialist management.

As the focus of this book is on the clinical care of the injured patient, we follow UK NHS major trauma networks guidance (NHS Clinical Advisory Group on Trauma, 2010) and describe major trauma as a serious injury, or injuries, which may result in death or disability.

The impact of major trauma

Major trauma represents a significant burden to global health. The World Health Organization (WHO) reports that, every day, 16,000 people die of injuries, with many thousands more suffering

The importance of injury prevention cannot be overstated. It is the most cost-effective way of dealing with trauma.

significant morbidity and permanent disability (Mock et al., 2004). In the United States, trauma is the leading cause of death in those under 45 years of age (American Association for the Surgery of Trauma, 2019). A similar impact is seen in England where the National Audit Office data (2010) identified 5400 deaths annually due to injury and at least 20,000 cases of permanent disability. The immediate treatment costs to the NHS in England were assessed to be around £400 million, excluding any continuing rehabilitation or support. There is also an estimated additional loss to the economy of £3.7 billion due to the inability to work because of injury (National Audit Office, 2010).

Worldwide, there is significant discrepancy in the outcomes from major trauma when comparing high- and low-income settings. The mortality from moderate severity trauma ranges from 6% in high-income countries to 36% in low-income settings. The WHO (2004) concluded that, ‘Much of the improvement inpatient outcome in higher-income countries has come from improvements in the organisation of trauma care services.’ When considering how to establish and develop these services, it is essential to start at the right place. ‘How should a severely injured patient be resuscitated?’ is only one aspect of what is needed. Asking the broader question of ‘How can the impact of major trauma be reduced?’ is more inclusive but requires a macro view of the system. To do this, it is necessary to identify and address:

- How can serious injury be prevented?
- If trauma does occur, how can the severity be reduced at the time of injury?
- What trauma system should be in place to ensure optimal care is delivered in the right place and at the right time?
- How should the injured patient be managed both acutely and definitively?
- How can effective rehabilitation be used to ensure the optimal level of recovery is achieved?

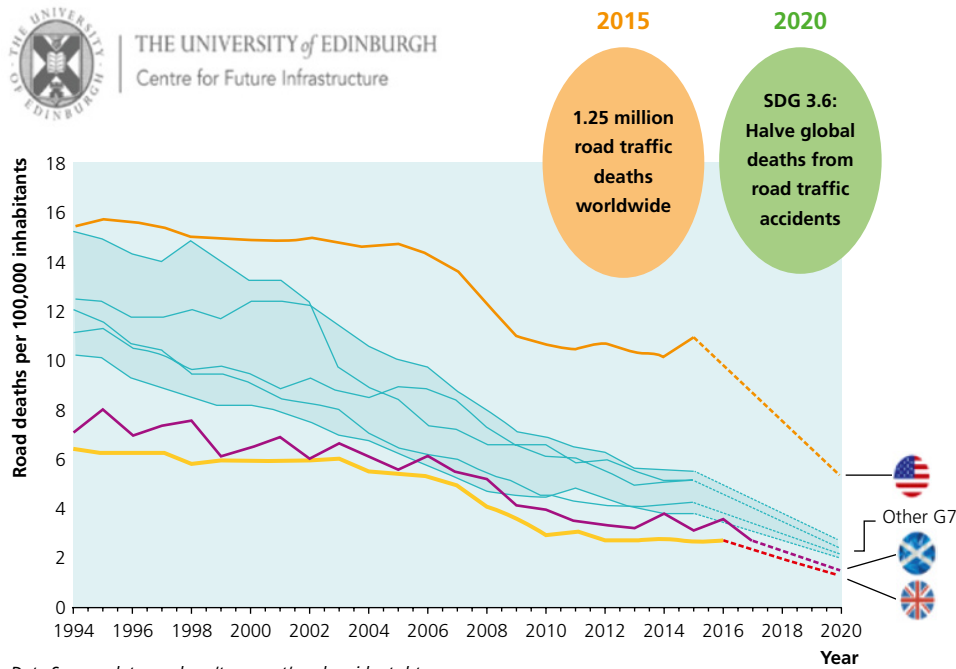
Each of these points is considered in this chapter.

Injury prevention and reduction of severity

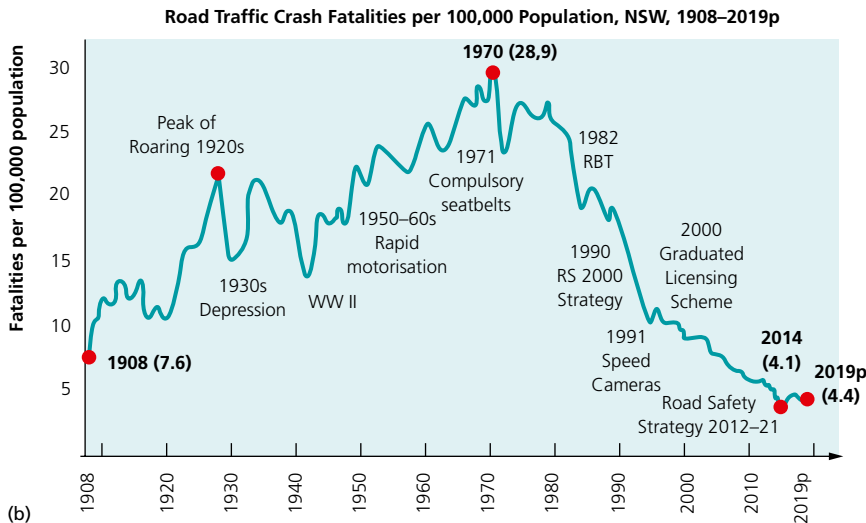
There are numerous initiatives that have reduced the incidence of trauma, incorporating many legislative procedures, particularly in high-income countries. Examples include a broad range of measures such as health and safety legislation in the workplace, mandatory vehicle safety standards, drink-driving laws, speed restriction measures, firearms licensing and targeted knife crime initiatives.

Strategies to minimise the severity of injury should a traumatic event occur can be best illustrated by the efforts of the

automotive industry. The US National Highway Traffic Safety Administration (2021) identified that, in 2009, there were nearly 15,000 lives saved in America simply by wearing a seat belt. The continuing development of vehicle safety features, from airbags to automatic assisted braking, also continues to reduce death and morbidity from injury. Similar effects are seen in the UK and other countries (Figure 1.1). This trend has led to more people surviving what would otherwise have been a fatal traumatic event. The challenge in these patients is to optimise their initial management and definitive care. Although often overlooked,



(a)



(b)

Figure 1.1 (a) G8 road traffic deaths since 1994 and projection to the UN sustainable development goals. SDG = Sustainable Development Goal. Source: Edinburgh Futures Institute; Masterton (2018) Reproduced with permission from The University of Edinburgh. (b) Road traffic collision fatalities per 100,000 population, New South Wales, Australia. RBT = Random Breath Test. Source: Transport for NSW (2020).

experience shows that the latter must include a continuing process of rehabilitation to maximise their return to as near their pre-accident state as possible.

The trauma system

History

In 1966, the US National Research Council published *Accidental Death and Disability: The neglected disease of modern society* (National Academy of Sciences (US) and National Research Council, 1966). This seminal work concluded with key recommendations, which included the need for optimal care starting in the prehospital phase and the accreditation of hospitals based on their abilities to deliver different levels of care. About this time, a state-wide trauma system was launched in Illinois, using Cook County Hospital in Chicago as the major receiving centre. It had five key components (Box 1.1). Since that time, this framework has evolved and spread throughout the United States (Mullins, 1999), with many countries worldwide also adopting similar processes.

Box 1.1 Key components of the Illinois trauma system (Mullins, 1999)

- An appropriate ambulance service.
- Designation of hospitals as trauma centres.
- Specific training for health professionals.
- Improved communication within the system.
- A trauma registry.

In the late 1980s, there was a resurgent interest in trauma care following a Royal College of Surgeons of England report on the management of patients with major injuries (Saleh, 1989). Fledgling trauma care systems began to emerge, paralleled by the development of emergency medicine and pre-hospital care as recognised specialties in the UK. There has also been a huge increase in trauma training including courses, such as Advanced Trauma Life Support (ATLS), the Anaesthesia Trauma and Critical Care Course, the European Trauma Course, the Trauma Nursing Core Course, the Advanced Trauma Nursing Course and the Trauma Immediate Life Support Course.

In England, there had been several publications and recommendations highlighting the need for a more integrated system with some regions attempting to develop specific pathways for major trauma (Nicholl and Turner, 1997). However, concerns continued to be raised regarding trauma care. The publication of the NCEPOD report, *Trauma: Who Cares?* (NCEPOD, 2007), highlighted that 60% of patients studied received suboptimal care. Trauma care subsequently became the focus of a national strategy, with the first national clinical director for trauma being appointed in 2008. By 2012, following the mandatory development of regional major trauma networks, every area in England had established a system of major trauma centres (MTCs), trauma units and a directory of pathways to optimise trauma care (Figure 1.2). These pathways emphasised the need for timely and definitive care. To achieve this,

ambulance and helicopter services were empowered to take patients directly to MTCs when appropriate. To help further with rapid access to specialist care, it also mandated direct transfer of patients from trauma units to MTCs if required. The aim was to get the patient to the most appropriate facility as safely as possible in a timely fashion.

The components

The separate parts of a trauma system are complex and wide-ranging (Box 1.2). To be inclusive, all the potential stakeholders need to be recognised and represented. In this way, the whole patient journey can be considered from pre-hospital providers through to rehabilitation. It is therefore essential that there is coordination and clinical leadership in both the establishment of a system and its continuing management. The latter, in particular, requires a process of active engagement with representatives from the whole system so that consistent, best practice is delivered, and areas for improvement are identified and actioned.

National Institute for Health and Care Excellence guidance

The National Institute for Health and Care Excellence (NICE) has produced several key documents dealing with the management of injured patients in the trauma care system. *Major Trauma: Service delivery* (NG40) was published in 2016 and includes recommendations on pre-hospital triage, the destination of patients with major trauma and the organisation of trauma services (National Institute for Health and Care Excellence, 2016a). In addition, it provides guidance on documentation, audit and provision of information and support for patients, their relatives and carers.

In the same year, NICE produced the supporting guideline, *Major Trauma: Assessment and initial management* (NICE, 2016b). This document's aims are to reduce deaths and disabilities in people with serious injuries by improving the quality of their immediate care. In so doing, it covers the rapid identification and early management of major trauma (excluding burns) in pre-hospital and hospital settings, including ambulance services, emergency departments, major trauma centres and trauma units.

These two documents are referred to on numerous occasions throughout this book, as they provide the basis for the management of several trauma conditions encountered in the prehospital and hospital settings.

The major trauma care pathway

The major trauma care pathway can be divided into four stages: pre-hospital care, reception, definitive care and rehabilitation (Figure 1.3). Each of the links in this pathway, from roadside to rehabilitation, and the flow between them, must be as strong and efficient as possible.

Community training

A holistic approach, where every aspect of trauma management is optimised and all stakeholders are involved is what makes an effective trauma system. A false assumption is that this process

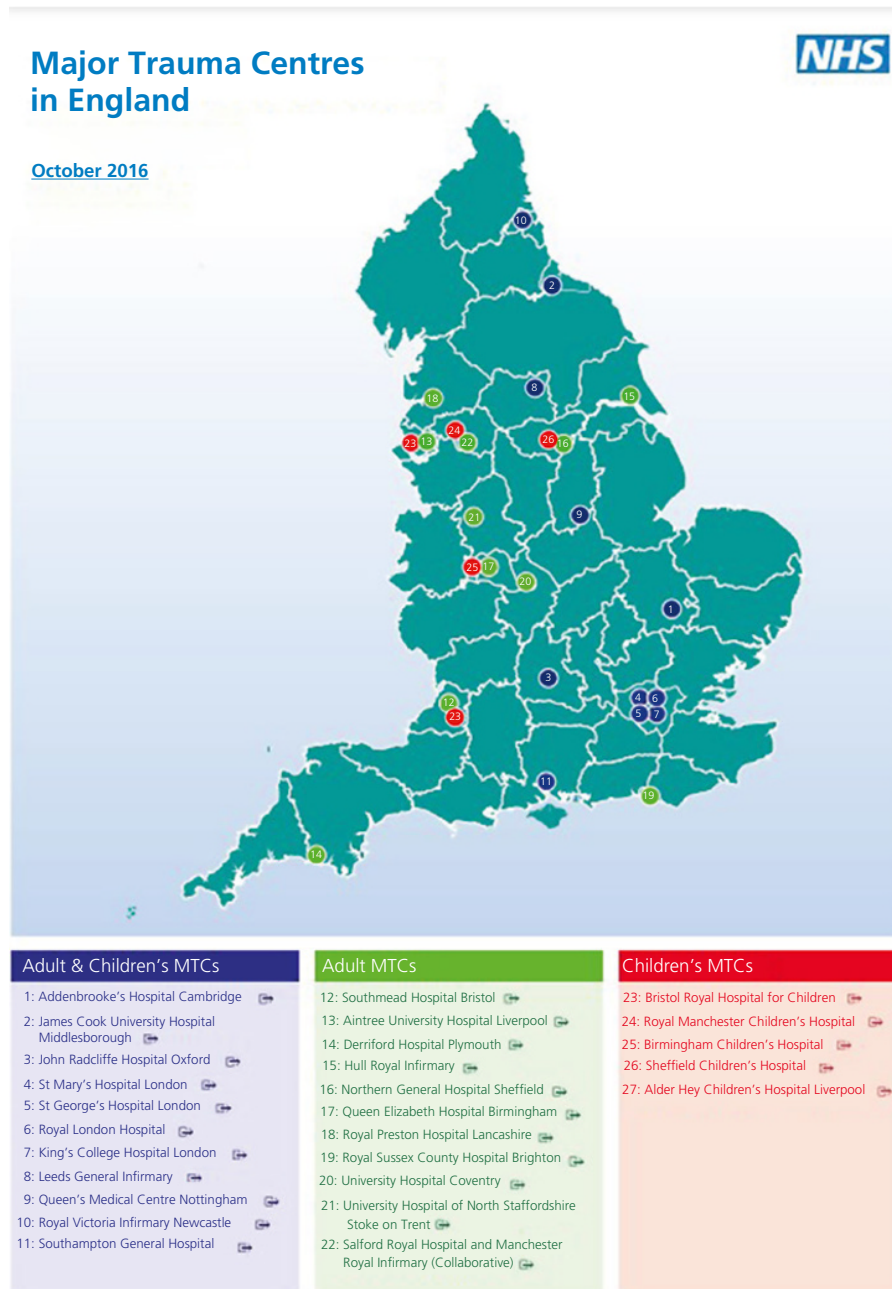


Figure 1.2 Major trauma centres in England. Source: NHS England.

commences with the arrival of the first medical personnel. In fact, the actions of 'zero responders' (i.e. those people who happen to be there at the time of the incident) can be critical. In addition to calling the emergency services, basic actions by passing members of the public, including haemorrhage control and simple airway management, can be lifesaving. Consideration should therefore be given to further public initiatives to improve the chances of the severely injured patient receiving good-quality immediate first aid. This can be enhanced by the inclusion of first aid training in the workplace or within the school curriculum (Frederick et al., 2000).

Pre-hospital

The aim of the major trauma care pathway is to ensure that the patient receives the appropriate treatment at the correct time with resources that are accessible. Typically, this will mean identifying cases requiring the specialist interventions available only at an MTC and transferring them there with appropriate pre-hospital care. Inevitably, there will be some patients who will be too unwell to survive the potentially extended transfer directly to an MTC. To cover this possibility, the network must provide rapid transfer to the closest trauma unit for urgent stabilisation and then secondary transfer to the MTC if appropriate. For