

Trauma Care in **Scotland**



A REPORT BY
THE TRAUMA WORKING GROUP
OF THE ROYAL COLLEGE
OF SURGEONS OF EDINBURGH

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FOREWORD

DAVID TOLLEY

PRESIDENT OF THE ROYAL COLLEGE OF SURGEONS OF EDINBURGH



EXECUTIVE SUMMARY

It is a stark truth that the management of complex trauma has moved on to the extent that the surgical community recognises the need to change the way that care of major injuries is delivered and managed. We cannot accept a lower standard of care in Scotland than in other parts of the “developed” world, and therefore we have an obligation to deal with that anomaly.

The management of trauma is a complex process and, like all emergency surgical care, requires a breadth and depth of experience to deal effectively and efficiently with major and challenging clinical problems. This also requires the acquisition of specific skills achieved through specialist training.

The key to improving standards and providing optimum training for future generations is to ensure that the patient receives care from a team of clinicians from several disciplines who are organised to provide best care.

Scotland’s geography presents challenges which contribute to the difficulties in providing optimal care for the patient with complex trauma. Similar issues have been faced by other countries: the detail of how these problems are ultimately solved is a task for politicians and Health Service managers, but we believe that there is now an imperative for change. The challenge is to devise a system which ensures the best treatment for this small group of patients with a potentially high mortality rate who have pathologies that are very difficult to treat.

The Royal College of Surgeons of Edinburgh has commissioned this report, which considers some of the evidence for the most effective trauma care systems for patients with complex injuries. It signals the need for a process to review current trauma care provision in Scotland, and it highlights some of the limitations of the current arrangements. The report makes recommendations about changes in trauma care that should be regarded as the starting point of the debate

which is needed in order to bring about an improvement in outcomes for patients with severe injuries, taking into consideration the particular challenges faced in Scotland with its unique geography and population distribution.

This is not a report about the local provision of emergency care within individual Health Boards: it focuses on the need to change the way in which a small group of patients with complex injuries is managed by establishing a more effective trauma system; inevitably, changes resulting from the debate may result in benefits for patients presenting with lesser degrees of trauma.

The authors have presented a cogent and compelling case for change in the way we currently deal with trauma patients in Scotland: I hope that the report will stimulate discussion at the highest level between providers, Health Service managers and Scottish Government in order to bring about an early change in the way we care for patients with major trauma.

David Tolley

President of the Royal College of Surgeons of Edinburgh
May 2012

“Patient safety” and “quality” have become central tenets of healthcare governance. Deviations from standards, including international comparators, are difficult to justify. The provision of trauma care in the UK has long lagged behind that of comparable health services, particularly in North America. Recognition of the poor quality of existing services in England has precipitated a paradigm shift in healthcare policy, resulting in the commissioning of a national network of regional trauma systems. This report examines the evidence for such systems in the Scottish setting.

The working group believes that the benefits of specialist, regionalised trauma care – including reduced mortality and improved functional outcomes – could also be attained in Scotland. Although the precise configuration of a trauma system for Scotland requires further research, the working group believes that the general principles of a holistic, inclusive, tiered system are equally applicable to Scotland as elsewhere. The focus of such a service should be on reducing disability as well as mortality, and providing a safe and high-quality service.



INTRODUCTION

1. It has been recognised for some time that the quality of trauma care in the United Kingdom lags behind that of countries with comparable health services. Deficiencies in trauma care were first identified in 1988, by the Royal College of Surgeons of England. Despite repeated reports, a further two decades passed before a reorganisation of trauma care in England was initiated. In 2008, Lord Darzi's NHS Next Stage Review reported that there were "compelling arguments for saving lives by creating specialised centres for major trauma", and strategic health authorities (SHAs) were asked to develop regional plans. In 2009, the Department of Health appointed the first National Clinical Director for Trauma Care, to lead the development of clinical policy, and in April 2010, the London Trauma System became the first regional trauma system in England.¹
2. Changes to the organisation of trauma care delivery in England have not been paralleled by similar developments in Scotland. Therefore, The Royal College of Surgeons of Edinburgh convened a working group to examine the evidence for the regionalisation of trauma care, and its applicability to the Scottish setting.
3. **REMIT OF THE TRAUMA WORKING GROUP**
 - 3.1 The working group on trauma in Scotland (Trauma Working Group, TWG) was asked to examine the current provision of trauma services in Scotland. In particular, the group was tasked:
 - To consider the case for a national trauma service in Scotland
 - If appropriate, to recommend a strategy for its establishment and implementation.
 - 3.2 *Inter alia*, this included consideration of:
 - The provision of trauma care elsewhere in the United Kingdom
 - The provision of trauma care outside the United Kingdom
 - Scotland's demographic challenges, with particular reference to population distribution, rural landscape and fragmentation of current trauma provision across multiple hospital sites.

4. THE CASE FOR CHANGE

- 4.1 Trauma is a serious public health problem. It is the leading cause of death in all groups under 45 years of age, and a significant cause of short- and long-term morbidity. In Scotland, trauma is responsible for approximately 1,300 deaths per year.² In England, for which more data are available, there are at least 20,000 cases of major trauma each year, resulting in 5,400 deaths.³ Many more result in permanent disabilities requiring long-term care.³ There are around a further 28,000 cases which, although not meeting the precise definition of major trauma, should be cared for in the same way. The National Audit Office (NAO) estimates that major trauma costs the NHS in England between £0.3 and £0.4 billion a year in immediate treatment.³ This figure does not include the cost of subsequent hospital treatments, rehabilitation, home care, or informal costs for carers.³ The NAO further estimates that the annual lost economic output as a result of major trauma in England is between £3.3 billion and £3.7 billion.³
- 4.2 Deficiencies in trauma care have been highlighted by a number of major reports. The 1992 UK Major Trauma Outcomes Study (MTOS), which involved nearly 15,000 patients, showed that patients were typically attended to by junior staff, their treatment was delayed and mortality was high compared with international comparators.⁴ An analysis performed by the Royal College of Surgeons of England, using Trauma Audit and Research Network (TARN) data, shows that there was no improvement in mortality rates between 1993 and 2004.⁵ Comparison with US National Trauma Data Bank (NTDB) data show that mortality for severely-injured trauma patients who are alive when reaching hospital is 40% higher in the UK than in North America.⁵
- 4.3 These results are, to a large extent, related to volume, experience and process issues. The most recent study, conducted by the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) reported that almost 60% of trauma patients had received a standard of care considered less than good practice.⁶ Major trauma patients comprise only 0.2% of the emergency medicine workload, rendering many hospitals and hospital staff unable to maintain optimal skills in trauma care.³
- 4.4 The studies discussed above were conducted in England, but it is unlikely that the situation in Scotland is materially different.

* The terms "trauma system" and "trauma network" are used interchangeably in this document

5. DEFINITIONS

- 5.1 An analysis of the structure of trauma care delivery, both in the UK and elsewhere, requires an understanding of its components. This section reviews the definitions of terms such as "major trauma", "trauma system", "trauma centre" and "trauma surgeon".

MAJOR TRAUMA

- 5.2 Much of the evidence relating to the effectiveness of regional trauma systems and tertiary trauma care relates to "major trauma", rather than all trauma. This distinction is therefore important. Major trauma is usually defined in terms of the injury severity score (ISS), an anatomical measure of injury. An ISS of more than 15 indicates a major degree of injury and identifies a cohort of patients who may benefit from management in a centre with the requisite facilities and expertise to manage a major trauma patient.
- 5.3 It is important, however, to recognise that the ISS is calculated retrospectively, once all injuries have been identified. Although a useful tool for quality assurance, performance improvement and research, it cannot be used to triage patients in the field. For the purposes of designing and administering a regional trauma system, "major trauma" should therefore include any injury that could result in permanent disability or death, or which is so complex that it exceeds the capabilities or expertise of the receiving unit, irrespective of the patient's final ISS.^{1,7}

Definition: Major trauma

"Major trauma" constitutes injuries which could result in permanent disability or death and/or combinations of injuries with an injury severity score exceeding 15.

TRAUMA SYSTEMS AND TRAUMA NETWORKS

- 5.4 A trauma system is defined as a public health model for the delivery of optimal trauma care to a defined population. This definition is somewhat cumbersome, and it is more practical to think of a trauma system as a managed clinical network for the delivery of trauma care. The recent NHS Clinical Advisory Group (CAG) report has therefore coined a related term, "trauma network", defined as the collaboration between the providers commissioned to deliver trauma care services in a geographical area.*

- 5.5 Trauma systems aim to reduce death and disability from injury, and must therefore consider all aspects of care, from pre-hospital care, through different types and aspects of hospital care, to rehabilitation. They must also consider aspects such as injury prevention, research, education and systems governance. A trauma system is therefore more than the designation of trauma-receiving hospitals, which then admit all trauma patients. While this model, known as an "exclusive trauma system", improves care for the severely injured, it worsens outcomes for those severely-injured patients who are treated in non-trauma centres. Major trauma makes up less than 15% of the entire injured patient population, and patients with mild or moderate injuries who end up in a major trauma centre (MTC) suffer as they are de-prioritised within an overloaded hospital. An inclusive trauma system describes a model in which all hospitals and providers in a geographical region collaborate to plan, provide and manage the treatment of people who have suffered trauma. Inclusive trauma systems have been shown to produce better outcomes than exclusive systems.⁷
- 5.6 A key element of a regional trauma system is selection, to facilitate admission to an appropriately resourced institution. This requires rapid and explicit pre-hospital triage as well as bypass and inter-hospital transfer protocols. These protocols already exist where trauma systems are in operation and are well-validated.⁸
- 5.7 Regional trauma systems operate within existing service delivery frameworks and should not compromise the care of other emergency or elective patients. In contrast, instituting a trauma system has been shown to improve the care of other non-trauma emergency patients, reducing emergency department waiting times, improving operating room access and reducing hospital stays.⁷

Definition: Trauma system/network

A "trauma system" (or "trauma network") is defined as a public health model for the delivery of optimal trauma care to a defined population.

MAJOR TRAUMA CENTRES

- 5.8 “Major trauma centre” (MTC) is the term chosen by the CAG to define the highest level of hospital trauma care available in England. It is broadly equivalent to “level 1” trauma centres, as defined by the American College of Surgeons. A MTC is a multi-specialty hospital, on a single site, optimised for the provision of trauma care. It is the focus of the trauma network and manages all types of injuries, providing consultant-led, and often consultant-delivered, care.¹ A MTC is responsible for the care of major trauma patients across the region covered by the trauma network. However, it may also act as a trauma unit (TU) for its local area.
- 5.9 The MTC has a clinical culture and management systems that reflect the importance of integrated trauma care. The centre has a regional leadership role with responsibility for optimising the pathways and care of major trauma patients wherever they are injured in the region. It has senior clinical and executive commitment to the care of major trauma patients, and an integrated trauma service responsible for the ongoing care of all major trauma patients in the hospital.
- 5.10 The MTC includes all surgical specialties and support services to provide care for major trauma patients regardless of their pattern of injury. It supports the other TUs, pre-hospital care and rehabilitation providers in the region. The centre has its own trauma clinical governance and performance-improvement programmes, and assists in delivering quality assurance and quality improvement across the network. The MTC has active research, education and injury-prevention programmes that support trauma care across the region.
- 5.11 It is recognised that there is a volume–outcome relationship in major trauma care, and it is recommended that a MTC should see at least 400 major trauma patients each year. MTCs with a sufficient volume of work to gain experience in managing these patients have demonstrated a 15–20% improvement in mortality.^{7,9} Conversely, low-volume MTCs have little impact on patient outcomes. Each MTC should serve, therefore, a minimum population of approximately 2–3 million people.
- 5.12 MTCs will also manage a certain proportion of trauma patients who have not suffered major trauma. These patients come from their local catchment area and from over-triage of trauma patients to the centre.⁷ A degree of over-triage is necessary to ensure that the vast majority of

patients who should receive MTC care are taken to such a centre.

Definition: Major trauma centre (MTC)

A “major trauma centre” is a multi-specialty hospital, on a single site, optimised for the provision of trauma care. It is broadly equivalent to an American “level 1” trauma centre.

TRAUMA UNITS

- 5.13 A TU manages injured patients from its local catchment area, and is broadly equivalent to a “level 2” or “level 3” trauma centre (as defined by the American College of Surgeons). It is responsible for the management of trauma patients who are not triaged to MTC care by pre-hospital providers. Patients with such injuries (usually indicated by an ISS \leq 15) do no better, and may do worse, if managed in a MTC. This is in part because they may be de-prioritised compared with the major trauma patients.^{1,7}
- 5.14 TUs may, however, also receive major trauma patients, either due to under-triage errors, because patients are delivered by relatives, or because patients require immediate life-saving interventions prior to continued care at a MTC. TUs must maintain, therefore, the capability and readiness to deal with such emergencies. TUs should have close links with MTCs, through the network, to facilitate rapid transfer of major trauma patients received at a TU. TUs have a responsibility to engage in trauma system activities, including data collection, governance and performance improvement, research, education and injury prevention.^{1,7}

Definition: Trauma unit (TU)

A “trauma unit” is a hospital responsible for the management of trauma patients. These patients are from the local catchment area and do not require a major trauma centre care.

LOCAL EMERGENCY HOSPITALS

- 5.15 A local emergency hospital (LEH) is a hospital that does not receive routinely acute trauma patients (except those with minor injuries). It has processes in place to ensure that should this occur – for example, because a patient was delivered by a relative – patients are transferred appropriately to a MTC or TU. Local hospitals also have a role in the rehabilitation of trauma patients.¹

Definition: Local emergency hospital (LEH)

A “local emergency hospital” is a hospital that does not receive routinely acute trauma patients (except those with minor injuries).

TRAUMA SURGEONS

- 5.16 A trauma surgeon is a surgeon who has the training, knowledge and skill to treat patients who have suffered trauma. In North America, the term is used to refer to a general surgeon, whereas in the United Kingdom, the term is applied to orthopaedic surgeons. This is a source of confusion, and it would be useful for surgeons from the two sub-specialties to be referred to as “general trauma surgeons” and “orthopaedic trauma surgeons”. Both specialties have a central role in providing trauma care. Orthopaedic trauma is much more common, and the surgical workload in particular exceeds the torso trauma workload. However, orthopaedic injuries are rarely life-threatening, whereas torso trauma often is.
- 5.17 The management of patients with major trauma (in the setting of a MTC) requires a lead specialty, or service. This is particularly important in patients with polytrauma (injuries to more than one body region), where many specialties (such as general surgery, orthopaedic surgery, intensive care medicine, interventional radiology and neurosurgery) may be involved. In this situation, it is essential for one consultant to maintain “the bigger picture”, and act as the liaison between specialties. In North America, this service is provided by general trauma surgeons. There is no inherent reason why it could not be provided by another specialty, such as orthopaedic trauma surgery or critical care medicine, as long as the care provided is holistic.
6. EVIDENCE FOR THE REGIONALISATION OF TRAUMA CARE
- 6.1 Proving the effectiveness of trauma systems in improving outcome is not straightforward. A trauma system is the implementation of a public health strategy, consisting of numerous and diverse components, rather than the testing of a single intervention. Effectiveness should furthermore not only be appraised in terms of mortality, but also the functional outcome of survivors. This recognition is reflected in the dual aims of preventing death and disability.

- 6.2 Despite these difficulties, there is strong evidence that trauma systems and trauma centres improve both mortality and functional outcome.
- 6.3 The American College of Surgeons first recognised the need for a systematic approach to trauma in 1922, by forming the Committee on Treatment of Fractures, which subsequently became the Committee on Trauma.¹⁰ National attention to trauma system development commenced in 1966, stimulated by a major report into accidental death and disability.¹¹ It is not surprising, therefore, that much of the evidence for trauma systems originated from the North America.

7. MORTALITY REDUCTION

- 7.1 Early studies from the 1980s from Orange County, California, reported a 19% absolute reduction in the preventable death rate.^{12–14} Analysis of severely-injured patients in Los Angeles, before and after the implementation of the Los Angeles County regional trauma system, showed a statistically significant improvement in the adjusted odds of survival for victims of motor vehicle collisions who sustained multiple serious injuries. The odds of survival for the study population as a whole were improved, but not significantly.¹⁵ A similar before-and-after study of trauma patients in Oregon showed no difference in mortality following the initial implementation of a state trauma system.¹⁶ Three subsequent studies compared the performance of the Oregon trauma system with non-trauma hospitals, and found a significant reduction in mortality following the implementation of the trauma system.^{17–19} When the Oregon trauma system was compared with the adjacent state of Washington, which did not have a trauma system, the Oregon trauma system showed reduced mortality.¹⁹ Several before-and-after studies, from the states of New York, Washington and Alabama, as well as the province of Quebec, have shown statistically significant improvements in mortality following the implementation of a trauma system.^{20–24} An examination of the trauma system in upstate New York revealed a significant reduction in the mortality rate for the region following implementation of the system. A comparison of mortality rates among 22 US states with an existing trauma system and those without a trauma system has shown a 9% mortality reduction.²² A meta-analysis of six of the above studies,^{15,17–20,24} selected according to methodological quality, has revealed a 15% reduction in mortality in favour of the presence of a trauma system.¹⁰

7.2 Several recent and methodologically-superior studies provide higher level evidence for the effectiveness of regional trauma care. A study of road traffic accident victims in Florida has shown a significant reduction in case fatality rate for patients treated at a trauma centre compared with patients treated at a non-trauma centre. The mean case fatality rate was 2.8% (95% confidence interval (CI), 2.4 to 3.3%). Patients treated at a trauma centre had a case fatality rate of 1.4% (95% CI, 1.1 to 1.7%), whereas those treated at a non-trauma centre had a rate of 3.2% (95% CI, 2.7 to 3.7%). The association was independent of age, alcohol use, speed, rural/urban location, and pre-hospital resources.²⁵ A further evaluation of the Florida trauma system revealed that triage to a trauma centre decreased the risk of mortality by 18%.²⁶ An accompanying health economic analysis showed that, for each patient returned to work, there is a five to 15-fold return of the investment.²⁶ This compares favourably with the cost of treating other public healthcare problems.²⁷

7.3 The highest level of evidence for the effectiveness of trauma centres in reducing mortality comes from a propensity-score weighted comparison of 5,191 patients treated in 18 level 1 trauma centres and 51 non-trauma hospitals across 14 US states.²⁸ After adjustment for differences in the case mix, the in-hospital mortality rate was significantly lower at trauma centres than at non-trauma centres (7.6% vs 9.5%; relative risk (RR), 0.80; 95% CI, 0.66 to 0.98), as was the one-year mortality rate (10.4% vs 13.8%; RR, 0.75; 95% CI, 0.60 to 0.95).²⁸ The effects of treatment at a trauma centre varied according to the severity of injury, with evidence to suggest that differences in mortality rates were confined primarily to patients with more severe injuries. The authors concluded that the risk of death is significantly lower when care is provided in trauma centres rather than in non-trauma centres, and argue for continued efforts at regionalisation.²⁸

7.4 Studies from Australia also point towards a beneficial effect of trauma systems. A case-mix adjusted before-and-after study from Southern Australia, following the implementation of a trauma system, using pre-implementation data as the reference, has shown a year-on-year decrease in the odds of death.²⁹ A comparison of outcomes from traumatic brain injury between the state of Victoria, which has a trauma system, and England (using TARN data) has revealed significantly greater odds of dying in England (odds ratio (OR), 2.15; 95% CI, 1.95 to 2.37), even after adjusting for age, gender, cause of injury, head injury

severity, Glasgow Coma Scale (GCS) score, and ISS (odds of death, 3.22; 95% CI, 2.84 to 3.65).³⁰

8. IMPROVED FUNCTIONAL OUTCOMES

8.1 It is important to recognise that mortality is not the only measure of the effectiveness of a trauma system. Other outcomes, such as limb salvage, functional outcomes and quality of life are equally important.^{31,32} These aspects of performance are, however, much harder to measure than mortality, and therefore not as well researched. There is, however, evidence that patients who sustain high-energy lower-limb trauma have higher levels of physical functioning and better mobility.³³ A very large retrospective study has shown that the complex care delivered by advanced level trauma centres is associated with improved functional outcomes, as measured by functional independence measure (FIM).³⁴ A study of severe injuries (defined as aortic, caval, iliac vessel, cardiac, or grade IV/V liver injuries, quadriplegia, or complex pelvic fractures) from the North America has shown significantly better functional outcomes in level I compared with level II centres.³⁵ Similar differences have been noted after trauma in children.³⁶

9. COST-EFFECTIVENESS

9.1 The cost of trauma centre care often raises questions about the value of a regionalised approach to trauma care. Health economic evaluations have confirmed that regionalising trauma care is not only effective, but also cost-effective: the cost per life saved and per life year saved is low compared with other medical interventions.³⁷⁻³⁹

10. THE STAFFORDSHIRE STUDY

10.1 Nicholl and Turner's before-and-after study of the "effectiveness of a regional trauma system in reducing mortality from major trauma" in Staffordshire, which is still quoted frequently, showed no difference in mortality.⁴⁰ However, this study was marred by numerous conceptual and methodological issues: despite the title, the "trauma system" described was rudimentary, and the "trauma centre" would not have met the current minimum requirements for a MTC, or a level 1 trauma centre. The developments put in place as part of the study included: the appointment of a small number of additional emergency medicine consultants "to provide 24h cover" (suggesting that major trauma patients were previously not received

by consultant staff); twelve additional emergency department staff nurses; some changes to the structure of the ambulance services in the region; and training in Advanced Trauma Life Support. Many other important facets of trauma care, such as surgical services, critical care provision, diagnostic and interventional radiology facilities, rehabilitation, but also certain aspects of pre-hospital care, received no attention. Furthermore, the catchment population of the study region was small (1.8m) and there were issues with regards to the control areas. In summary, this study was poorly designed and executed, and should not be used as an argument against the regionalisation of trauma care in the UK.

Summary Statement: Evidence for the Regionalisation of Trauma Care

There is good evidence that regionalised trauma care improves mortality and disability from major trauma, and is cost-effective.

DEVELOPMENTS IN ENGLAND

1. The organisation of trauma services in England is undergoing major and dramatic changes. This process was prompted by the publication of the "Trauma: Who Cares?" NCEPOD report in 2007. In 2008, the Department of Health appointed Professor Keith Willett as the first National Clinical Director for Trauma Care, with responsibility for the commissioning of regional trauma systems, and SHAs declared their intentions to support the establishment of improved regional services for major trauma. Following extensive consultation and planning, the London Trauma System came into existence in spring 2010. Since then, other regions, including the East of England, the East Midlands, the North East, and the South West have undergone extensive reorganisation of trauma services, with establishment of trauma systems and designated trauma centres. The Revised Operating Framework of June 2010 confirmed that these commitments would be fulfilled, despite the recent change of Government.¹ Much of the work which has been done in England and London is transferable.

2. THE TRAUMA CARE PATHWAY

2.1 In order to assist SHAs in establishing regional services for major trauma, the NHS in England has established a CAG for Trauma. Members were drawn from medical, nursing, and other health professionals, as well as managers, from a range of SHAs. The CAG has reviewed much of the evidence relating to trauma system design, and its applicability to the English setting. It is the opinion of the TWG that the resulting guidance is, however, as applicable to Scotland as it is to England, and therefore reproduced here. The CAG report is structured to follow the patient pathway, dividing trauma care into four stages, which usefully define the organisational and administrative aspects of a trauma system.¹ The recommendations also give a useful indication of the expected standard of care, and the required scale of change.

PRE-HOSPITAL CARE

2.2 Pre-hospital care encompasses the response from the call alerting the emergency services, to on-scene care, triage, primary transfer and (if required) inter-hospital transfer. The CAG recommendations include:

- A Trauma Triage Tool (such as the Field Triage Decision Scheme/National Trauma Triage Protocol of the American College of Surgeons/

Centre for Disease Control) should be used to identify patients with major trauma.

- A paramedic should be present in the Ambulance Control room 24 hours a day. His/her role is to identify potential major trauma patients and coordinate the response.

2.3 Pathways of care

- All patients identified as having major trauma should be taken to a MTC. Those who are within 45 minutes travelling time from the MTC should be taken there directly, bypassing other units.
- Patients who are further away or who are critically unstable should be subject to further guidance on an individual basis.
- Patients with major trauma who are taken to a local TU should be transferred to a MTC after initial assessment and optimisation in the Emergency Department.

2.4 Enhanced care of the severely injured in the pre-hospital phase

- Enhanced Care teams should be available 24/7 to provide care to the major trauma patient.
- Major trauma patients should be transferred to an appropriate MTC when indicated.

2.5 Hospital pre-alert and handover

- A structured pre-alert should be given to the receiving hospital as early as possible.
- On arrival at the hospital, a structured handover should be given to the receiving team.

2.6 Secondary Emergency Department inter-hospital transfers

- Secondary Emergency Department transfer to a MTC could be provided by an appropriately trained team.
- For time-critical conditions, the transfer should be performed without delay.
- A structured checklist and standardised documentation should be used and included in the patient's clinical record.

2.7 Audit & feedback

- All components of the Trauma Network (including pre-hospital services) should submit data for all major trauma patients to a National Trauma Dataset (currently TARN).
- Regular audit of the pre-hospital phase of trauma care is essential. Pre-hospital care providers should be given feedback on the patients they manage, and should attend audit and other meetings in the MTC and network as part of good clinical governance.

ACUTE CARE

2.8 Acute care extends from the hospital reception of the patient through the initial assessment and acute stabilisation of physiology and injuries. This includes all immediate trauma care and urgent surgical interventions provided within an acute setting. The CAG recommendations include those described below.

2.9 Reception and staffing

- There should be a pre-alert system with effective communication between pre-hospital and in-hospital teams as part of a region-wide network as well as documented criteria for trauma team activation and patient handover.
- There should be a trained trauma team present 24 hours a day for the immediate reception of the patient. The trauma team leader should be a consultant in the MTC and, in the TU, should be at least ST4 or equivalent competency who will attend immediately, and be supported within 30 minutes by a consultant.
- There should be surgical and resuscitative thoracotomy capability within the receiving trauma team.
- For the acute management of injuries, consultants should attend within 30 minutes.

2.10 Radiology

- Emergency radiology facilities, including CT, should be co-located in the Emergency Department.
- Whole-body CT is the diagnostic modality of choice where patients are stable enough for transfer to CT.
- MRI should be available 24 hours a day at MTCs.
- There are agreed timelines and competencies for reporting and documentation.
- There are teleradiology facilities between all TUs and the MTC within the network.
- At MTCs, interventional radiology capability will attend within 60 minutes, 24 hours a day. Ideally, interventional suites should be co-located with operating rooms and/or resuscitation areas.

2.11 Emergency trauma surgery

- Emergency trauma surgery should be performed by a consultant surgeon with appropriate skills and experience.
- All emergency trauma surgeons should understand the principles and techniques of damage control surgery.

2.12 General, orthopaedic, vascular and thoracic surgery

- There should be 24-hour access to a fully-staffed and equipped emergency theatre.
- General surgery and orthopaedic surgery senior trainees should be on site 24 hours a day. Consultants should attend within 30 minutes for the acute management of injuries.
- Vascular and cardiothoracic consultants should be available for consultation to the Trauma Network 24 hours a day, and must attend within 30 minutes to the MTC.

2.13 Neurosurgery, neurosciences and spinal cord injury

- Neurosurgery consultants should be available for consultation by the Trauma Network 24 hours a day. At the MTC, there should be a senior trainee on-site and a neurosurgery consultant available within 30 minutes.
- Patients with severe head or spinal cord injury should be managed in a neurosciences centre, irrespective of the need for surgical intervention.
- A consultant should be involved in all decisions to operate for traumatic brain injury. Patients requiring acute neurosurgical intervention for isolated brain injury should receive this within 4 hours of injury and within 1 hour of arriving in the MTC. The patient should be appropriately resuscitated to prevent hypoxia and hypotension.
- Network protocols should ensure the safe and rapid transfer of patients to specialist care. The effective referral for transfer is the responsibility of the neurosciences centre. The key point here is to ensure responsibility and ownership, which is imprecise currently, leading to inconsistency.
- There should be a network protocol in place for assessing the whole spine in patients with major trauma. Spinal imaging and assessment should be completed and reviewed by an appropriate consultant within 24 hours of admission.

2.14 Critical care

- Intensive care units (ICUs) should be on-site and comply with minimum generic standards of the Intensive Care Society and Department of Health.
- Transfers should be appropriately staffed and undertaken in a timely and safe manner.

2.15 Blood transfusion and haemorrhage control

- Appropriate major haemorrhage protocols must be in place across the network TUs; activations of the protocols must be audited regularly.
- In the MTC, there should be clinical transfusion leadership and a transfusion specialist should be available for advice 24 hours a day.

- All patients requiring acute intervention for haemorrhage control should be in a definitive management area (operating room or intervention suite) within 60 minutes.

ONGOING CARE AND RECONSTRUCTION

2.16 The ongoing care and reconstruction phase of the trauma patient's pathway starts immediately after any resuscitation and urgent surgery, and continues until discharge from the acute setting.

2.17 Delivering patient-centred services

- Across networks, there should be a focus on delivery of patient-centred services which consider all of the health and well-being needs of people who have sustained traumatic injuries. The important role of family and friends should be acknowledged and actively supported.
- Coordination of medical, nursing and rehabilitation packages of care is crucial in both MTCs and TUs.

2.18 Coordinating care

- Within MTCs, patient care should be overseen and coordinated by a Trauma Service. All major trauma patients should be admitted under the primary care of one of the Trauma Service consultants. The Trauma Service should include a care and rehabilitation coordinator (Major Trauma Coordinator) who is responsible for coordination and communication regarding the patient's current and future care and rehabilitation.
- Within TUs, patient care should be overseen by speciality teams with a designated responsible consultant for each patient.

2.19 Cross-specialty supporting services

- **Nursing**
 - Co-locate patients with multiple injuries in dedicated trauma wards.
 - Establish critical mass of experienced, trained staff with an appropriate skill-mix.
- **Radiology**
 - Provide 24-hour access to CT, MRI, ultrasound, interventional radiology and angiography in MTCs.
 - Provide universal access to Picture Archiving and Communication System (PACS) across networks, using compatible systems.
- **Anaesthesia and theatres**
 - Ensure access to dedicated, separate, fully-resourced daytime operating theatres for trauma and reconstructive surgery in MTCs,

and appropriate access to theatres during normal working hours in TUs.

- **Critical care**
 - Provide 24-hour care from dedicated intensive care consultants, supported by multi-disciplinary staff.
 - Critical care units should be part of critical care network and audited nationally.
- **Rehabilitation**
 - Establish patients' rehabilitation needs.
 - MTCs to provide enhanced rehabilitation services to meet the needs of complex trauma patients.
 - TUs to have skills and capacity to deliver rehabilitation.
- **Pain management**
 - Initiate analgesia early in the pre-hospital phase, and on an ongoing basis throughout the trauma management process.
 - All hospitals taking trauma patients to have a specialist acute pain service.
- **Neuropsychology and neuropsychiatry**
 - Post-traumatic amnesia screening and monitoring to be routine in all major trauma patients.
 - Psychosocial and mental healthcare.
 - Psychosocial resilience of all patients should be sustained.
 - There should be more substantial interventions for selected patients who suffer more significant and/or persistent distress.
 - Mental healthcare should be provided for those patients who have a pre-existing mental disorder, or who have developed a mental disorder.
- **Equipment**
 - Appropriate equipment to be available routinely.
 - Care teams to be skilled in using and maintaining equipment.

2.20 Injury-specific care

- Individual specialities required to manage injuries will exist in some TUs. Where they do not, or where there are multiple injuries, clear referral pathways to MTCs must be defined.
- Facilities should exist that allow early definitive fixation of pelvic and long-bone injuries.
- Treatment planning and surgery for complex intra-articular injuries should both be performed by an orthopaedic trauma specialist.
- Compliance with published standards for the management of open fractures relies on daily access to appropriate theatres that can be staffed simultaneously with both senior orthopaedic and plastic surgeons with the requisite skills to treat these challenging cases.

- Definitive planned surgery for amputations should be performed in consultation with rehabilitation and prosthetic services.
- The prevention of complications arising from spinal instability or neurological compromise involves all members of the multi-disciplinary team and must begin immediately. If there is significant spinal cord injury, early contact should be made with a spinal cord injury centre for advice and to plan strategy.
- Burn care should be managed through the designation of specialist centres, supporting burns units and some local burns' services. Multi-professional outpatient burns services are essential to ensure optimum ongoing management and outcomes after discharge.
- For hand injuries, there must be expertise in microvascular surgery and the management of tissue loss. MTCs should have a combination of plastic surgeons and orthopaedic surgeons in the hand surgery team. A hand therapy unit, manned by specialist therapists, is fundamental to achieving a good result following hand trauma.
- For maxillofacial injuries, there is a requirement for both TUs and MTCs to provide round-the-clock consultant-led care with immediate specialist maxillofacial technical support.
- Craniofacial trauma should be concentrated in MTCs, usually co-located with neurosurgical units.
- Traumatic brain injuries should be managed as per published recommendations. Opinions should be sought from neurology and neuroradiology departments, with a clear definition of areas of clinical responsibility among the various neurological specialities.
- Complex peripheral nerve, such as brachial plexus injuries, should be managed in specialist units.
- Facilities should be in place in MTCs to provide major vascular and endovascular surgery.
- Pneumothoraces, chest drains and tracheostomies should be managed in line with published guidelines. There should be 24-hour access to respiratory physiotherapy, including an out-of-hours on-call service.
- Injuries to the kidney and urinary tract are often complex, and should be identified early and managed in conjunction with urologists, as per published recommendations.

2.21 Other considerations

- In addition to the treatment of injuries, children and older people require specific age-related considerations. Joint care with paediatric or ortho-geriatric support is important.
- Pre-existing medical conditions should be considered, and other specialists involved in care as appropriate.

- Organisations and network structures should facilitate follow-up appointments to take place in the most appropriate setting, be this in the MTC, TU or community.

2.22 Policies, protocols and standards

- Discharge summary and rehabilitation prescription: a discharge summary describing the patient's injuries, care received and ongoing needs and plans should be provided at the time of discharge or transfer from a MTC or TU. This should include a rehabilitation prescription.
- Patient transfer: There should be cross-network agreements and adequate resources to ensure that once specialist medical care has been completed, patients can be transferred to the care of a service which is able to meet their ongoing care and rehabilitation needs.
- Nutritional management: Effective nutritional management is crucial to recovery and rehabilitation following traumatic injury. Policies for nutritional management should be in place in MTCs and TUs.

2.23 Governance

- Any hospital receiving trauma patients should have associated governance structures in place.

REHABILITATION

2.24 Rehabilitation is "a process aiming to restore personal autonomy to those aspects of daily life considered most relevant by patients" (The Kings Fund).

2.25 Rehabilitation is an essential component of trauma care which addresses both physical and psycho-social needs. Without such input, patients are unlikely to return to their maximum levels of function, which has significant implications for them, their carers, and society as a whole.

2.26 The principle of a patient receiving specialist care appropriate for his/her injuries is fundamental. To abandon this principle at the point at which rehabilitation is required, is illogical and compromises patient outcomes. It is wrong to assume that specialist rehabilitation techniques will be carried out on a general orthopaedic or surgical ward in a district general hospital.

2.27 The CAG recommendations are shown below.

- Rehabilitation should start as soon as is appropriate after admission, typically in the critical care setting, and continue at the intensity required, and for as long as is necessary, to enable patients to achieve their functional potential.

2.28 Principles

- Patients who have not been admitted to a MTC should not be disadvantaged in accessing the level of rehabilitation they require.
- Trauma patients should receive appropriate levels of care and rehabilitation at all points along their care pathway.
- There should be coordinated development of rehabilitation services and long-term support in the community which can deliver comprehensive and effective rehabilitation to meet the needs of traumatically-injured patients irrespective of their age.

2.29 Rehabilitation pathway structures

- All stages of care, including the rehabilitation and transfer aspects of the patient's pathway, should be the responsibility of the network.
- There should be an appointment of a Trauma Network Director of Rehabilitation Services.
- There should be an appointment of a Clinical Lead for Acute Trauma Rehabilitation Services in every MTC (Consultant in Rehabilitation Medicine).
- There should be adequately skilled and resourced multi-disciplinary rehabilitation teams in all of a network's services.
- There should be rehabilitation and care coordinator posts throughout the network. Patients should have an identified key worker to be a point of contact for them, their carers or family doctor, and to ensure delivery of their personal prescription for rehabilitation.

2.30 Identifying the needs of the rehabilitation patient

- Every patient should receive routine screening of rehabilitation needs.

2.31 Rehabilitation prescription

- A rehabilitation prescription should be provided to all trauma patients with identified needs.

2.32 Vocational/educational rehabilitation

- Many trauma patients are of working age, so vocational rehabilitation should therefore be a key component of rehabilitation.

2.33 Implementing change: a country-wide review

- There should be a country-wide review of all services providing rehabilitation to patients who have sustained traumatic injuries.

2.34 Funding structures

- Appropriate funding structures should be developed to ensure timely and comprehensive rehabilitation.

2.35 Data management and outcome measures

- There should be a review of the applicability of the UK National Dataset for Specialist Rehabilitation Services to all major trauma patients.

2.36 National directory of services

- A directory of services and resources should be developed relating to rehabilitation and ongoing care to facilitate referral and access to these services.

Summary Statement: Developments in England

The reorganisation of trauma services in England is proceeding apace. NHS England has created a useful framework for the delivery of trauma care in the UK setting.

THE CURRENT SITUATION IN SCOTLAND

1. The geography and population distribution of Scotland present challenges for the provision of trauma care. However, Scotland's circumstances are not unique: parts of Australia and North America face similar issues.

2. DEMOGRAPHICS

- 2.1 In 2001, at the time of the last census, Scotland had a population of just over 5 million. The majority were living in the central belt, with the largest urban conurbation at the western end. The Greater Glasgow Health Board area contains an estimated population of 1.2 million. Outside the central belt, there are two large urban centres on the east coast (Dundee and Aberdeen). However, in the Highlands there is a population estimated at just fewer than 222,000, dispersed in an area the size of Wales. The 2011 census data is not yet available but it is unlikely that there has been major change.

3. INCIDENCE OF MAJOR TRAUMA

- 3.1 The current incidence of major trauma in Scotland is not known. Trauma, as well as outcomes from trauma, has been intermittently audited by the Scottish Trauma Audit Group (STAG). The first STAG audit, which ran 1992–2002 – and is therefore somewhat historical – estimated that there were approximately 900–1,000 major trauma patients in Scotland per year (Table 1). These data do not include pre-hospital deaths or children (<13 years). Furthermore, not all Scottish hospitals participated in the audit, although the number increased over its duration, and was high at the time of its conclusion (Table 2). The true incidence may thus be somewhat higher.
- 3.2 Estimates from England suggest an incidence rate of approximately 4 major trauma cases per million population per week. It seems reasonable to extrapolate this figure to the Scottish population, yielding an incidence of around 1,000 major trauma cases per year.
- 3.3 Data from the Institute of Advanced Motoring in 2009 indicated the annual rate of road fatalities in Scotland is 4.2/100,000 population. This compares to a fatality rate of 3.6/100,000 in England. Moreover, the rate of serious injuries in Scotland as a consequence of motor vehicle accidents is higher than in England and Wales (12% vs 8%). Motor vehicle accidents are one of the main sources of

multiple trauma patients, so these data suggest the incidence in the Scottish population may be higher than in England.^{41,42}

- 3.4 The new STAG audit, which commenced in January 2011, will provide more precise estimates. However, it is likely that the volume of major trauma in Scotland is sufficient to justify the establishment of at least one MTC.

Table 1: Number of patients with ISS >15 in Scotland 1998–2002 (from first STAG audit)

| Year | Number of hospitals participating in audit | Number of patients with ISS >15 |
|------|--|---------------------------------|
| 1998 | 25 | 848 |
| 1999 | 25 | 1,035 |
| 2000 | 24 | 984 |
| 2001 | 25 | 895 |
| 2002 | 24 | 854 |

Table 2: Hospitals which participated in the STAG trauma audit in 2002

| |
|-------------------------------------|
| Aberdeen Royal Infirmary |
| Ayr Hospital |
| Belford Hospital |
| Borders General Hospital |
| Caithness General Hospital |
| Crosshouse Hospital |
| Dr Gray's Hospital |
| Dumfries & Galloway Royal Infirmary |
| Falkirk & District Royal Infirmary |
| Glasgow Royal Infirmary |
| Hairmyres Hospital |
| Inverclyde Royal Hospital |
| Monklands Hospital |
| Ninewells Hospital |
| Perth Royal Infirmary |
| Raigmore Hospital |
| Royal Alexandra Hospital |
| Southern General Hospital |
| St. John's Hospital |
| Stirling Royal Infirmary |
| Vale of Leven Hospital |
| Victoria Infirmary, Glasgow |
| Western Infirmary, Glasgow |
| Wishaw General Hospital |

Summary Statement: Demographics

The population size and incidence of major trauma in Scotland indicates the need for one, or at the most two, major trauma centres.

4. DISPERSION

4.1 Data from the first STAG audit (1992–2002) shows a wide dispersion of major trauma cases across a large number of hospitals, with varying capabilities. Given the relatively small numbers of cases seen in even the largest hospitals, it is improbable that any of these institutions – or the individuals working within them – can accumulate sufficient experience to optimally manage patients with major trauma.



Figure 1. Dispersion of severely injured patients by hospital (from STAG data, 1997–2002)

- Glasgow Royal Infirmary
- Royal Infirmary, Edinburgh
- Aberdeen Royal Infirmary
- Western Infirmary, Glasgow
- Ninewells Hospital
- Southern General Hospital
- Crosshouse Hospital
- Victoria Infirmary, Glasgow
- Wishaw General Hospital
- Raigmore Hospital
- Monklands Hospital
- Royal Alexandra Hospital
- Hairmyres Hospital
- Stirling Royal Infirmary
- Ayr Hospital
- Dumfries & Galloway Royal Infirmary
- St John's Hospital
- Falkirk & District Royal Infirmary
- Borders General Hospital
- Vale of Leven Hospital
- Inverclyde Royal Hospital
- Belford Hospital
- Queen Margaret's Hospital
- Perth Royal Infirmary
- Caithness General Hospital
- Dr Gray's Hospital

Summary Statement: Dispersion of Major Trauma Workload

The volume of major trauma in Scotland, and the number of receiving hospitals, indicate that the institutional experiences of any of the centres falls short of recognised thresholds for a service capable of improving survival from major trauma.

5. QUALITY OF CARE

MORTALITY

5.1 The data collected by the STAG includes the ISS (as described above) and the Revised Trauma Score (RTS), which incorporates systolic blood pressure, respiratory rate and GCS score, and provides a composite measure of physiological derangement. In combination, using Trauma Score - Injury Severity Score (TRISS) methodology, the ISS and RTS can be used to predict survival.⁴³

5.2 Despite 10 years' of data collection, there is only one published analysis of mortality data from the first STAG audit.⁴⁴ The article concluded that, over the first six years of the audit, the survival of seriously injured patients had improved from 65.3% to 75.6%, and that the management of injured patients in Scotland was significantly better than that of the rest of the UK.⁴⁴ The latter conclusion was based on a comparison with data from the TARN.

5.3 Although at first sight reassuring, this analysis has methodological limitations, particularly with regards to the use of TRISS methodology.⁴⁵ The coefficients used to calculate the probability of survival were derived from the MTOS,⁴³ performed over 20 years ago, and may not have been reflective of practice even ten years ago, and are almost certainly no longer reflective of current practice.⁴⁶ TRISS methodology has also been shown to be unreliable when comparing outcomes between trauma centres, and has an unacceptably high misclassification rate in patients with severe trauma.⁴⁷ A more contemporary method of analysis, such as the risk-adjusted mortality analysis now used as part of the American College of Surgeons' Trauma Quality Improvement Program, might show outcomes worse than those indicated by the above analysis.⁴⁸ These criticisms pertain equally to the planned analysis of current STAG audit data.

5.4 In addition to the statistical limitations, there are conceptual issues with the above study: a comparison of outcomes in Scotland with other countries in the UK, particularly in 2000, is unhelpful. As described in the previous chapters, the quality of trauma care in England was, for many decades, demonstrably inferior to, for example, North America. Using England as a reference standard is therefore flawed. It would be more useful to conduct a comparison with a reference population served by a regionalised trauma system, but such analysis has not been performed.

5.5 STAG is not the only group to collect health services data. The Information Services Division (ISD) of NHS National Services Scotland collects information on every hospital episode in Scotland, and could thus be a useful resource for analysing trauma outcomes. However, the data sets used currently do not include trauma-specific data. In particular, ISS are not recorded, which makes comparisons difficult. ISS could be derived from International Classification of Diseases codes (ICISS),⁴⁹ but such methods rely on accurate primary coding. Data abstraction by staff without training in coding – and, in particular, injury coding – may also be suboptimal.⁵⁰

Summary Statement: Mortality from Major Trauma in Scotland

There is only limited information on survival from major trauma in Scotland. There are no comparisons with populations served by a trauma system.

TEMPORAL DISTRIBUTION OF TRAUMA DEATHS

5.6 The first STAG audit also examined the temporal distribution of trauma deaths in Lothian and the Borders.^{44,51} The pattern of these deaths differed from that previously described in North America, in that there was no evidence of a trimodal distribution, comprising immediate deaths at the scene (typically due to severe neurological injury or torrential haemorrhage, which can be addressed only with primary prevention); death from slower haemorrhage (within 4 hours of injury, potentially preventable); and late deaths (after days or weeks), typically due to infectious complications (which may also be preventable).⁵²

5.7 The authors of the study from South-East Scotland hypothesised that the temporal distribution could be due to expert treatment, but was more likely due to differences in mechanisms of injury, and in particular the lower incidence of penetrating trauma. The authors concluded that the “potential for ‘saving lives’ from trauma in South-East Scotland by improving treatment is significantly less currently, than suggested by previous work.”

5.8 The findings of this study are important, but they are historical, and as such should not be over-extrapolated. Similar trends have been observed elsewhere,⁵³ however the results were derived from one area of Scotland only, and may not be applicable to other regions, or the whole of Scotland. Furthermore, mortality – and, particularly, early mortality – is not the only measure of the quality of trauma care, and using the findings to argue against specialist or regionalised trauma may deprive others of optimal care.

Summary statement: Temporal Distribution of Trauma Deaths

The temporal distribution of trauma deaths in Scotland may differ from other regions.

OUTCOMES OTHER THAN MORTALITY

5.9 There are no published data on outcomes other than mortality after major trauma in Scotland. Although mortality is important, it is not the only indicator of a high-quality service. Other measures – such as limb salvage rates, functional outcomes and quality of life – are equally important, but not currently recorded.

Summary statement: Outcomes Other Than Mortality

There are no published data on outcomes other than mortality after major trauma in Scotland.

RURALITY

5.10 There remains a perception among both the general public and medical and nursing staff that patients with injuries are best served by being taken to the nearest hospital. This is incorrect. The key times are the time from injury to arrival of pre-hospital teams, and the time from injury to definitive care. This is particularly important in an area such as Scotland.

5.11 Major trauma patients managed initially in local hospitals are 1.5–5 times more likely to die than patients transported directly to trauma centres, and the average delay in transferring patients from a local hospital to a major centre in the UK is 6 hours.^{54,55} In contrast, longer pre-hospital times have a minimal effect on trauma mortality or morbidity, even in rural areas such as the west of Scotland.⁵⁵ It is probable that there is a critical time after which some hospital care may be better than no hospital care, but this time is not known, and almost certainly varies from patient to patient. Many trauma systems use a cut-off of 45 minutes. If a casualty cannot be delivered to the desired level of care within this timeframe, he/she is taken to the nearest facility capable of receiving trauma patients.

Summary Statement: Rurality

There is evidence, from Scotland, that travel times – within reason – are less important than once thought. Direct transfer to a centre capable of providing definitive trauma care is associated with better outcomes than care in a local hospital.

INTER-HOSPITAL COMPARISONS

5.12 There are no published data comparing the quality of trauma care provided by different Scottish hospitals. Such data might be useful in identifying outliers.

Summary Statement: Variations in Trauma Outcomes

There is insufficient information on variations in outcomes from trauma care in different hospitals.

CONSULTANT INVOLVEMENT

5.13 Trauma management requires good decision making, and thus experience. Trainees – regardless of specialty – do not have this experience, and therefore cannot, and should not, be expected to manage major trauma cases on their own. Data from the original STAG audit, published in 1999, showed that involvement of emergency medicine consultants, as compared with junior staff, was associated with a significant increase in the number of expected survivors.⁵⁶ It is probable that the same applies to other specialties involved in trauma care.

Summary Statement: Consultant Involvement

There is evidence that consultants are not involved at a sufficiently early stage.

6 ORGANISATION

6.1 The current organisation of trauma care in Scotland is best examined in terms of the four stages of the trauma care pathway coined by the CAG.¹

PRE-HOSPITAL CARE

6.2 Scottish Ambulance Service

Retrieval of injured patients from the scene of the accident is the responsibility of the Scottish Ambulance Service (SAS). Unusually – compared with the remainder of the UK – the SAS is a national asset, which provides care to casualties anywhere in Scotland.

6.3 Organisation

The service is delivered by five Regional Operational Divisions:

- North Division; comprising the Highlands, Grampian, the Western and Northern Isles
- East Central Division; comprising Tayside, Forth Valley and Fife
- South East Division; comprising Lothian and the Borders
- West Central Division; comprising Lanarkshire, Greater Glasgow and Dunbartonshire
- South West Division; comprising Ayrshire, Argyll & Clyde, Dumfries and Galloway.

6.4 All operations are co-ordinated through three Emergency Medical Dispatch Centres (EMDCs). These centres direct responses to 999 calls, arrange patient transport services to hospitals as requested by other medical professionals, and manage the air ambulance response. EMDCs are located in:

- Inverness; responsible for operations in Highlands & Islands and Grampian
- South Queensferry; responsible for operations in Lothian, Borders, Tayside, Fife and Forth Valley
- Cardonal; responsible for operations in Glasgow, Lanarkshire, Ayrshire, Argyll & Clyde and Dumfriesshire.

6.5 Ground fleet

The SAS has a range of vehicles available to respond to emergency and urgent calls. The traditional ambulance, double-crewed with a paramedic/technician skill-mix, is the most

common configuration. Paramedic response units are available and will, in the main, comprise a single paramedic in a response car, or on a motorcycle or pedal cycle.

6.6 Ambulance officers are available on both a shift and on-call basis. Officers carry either first response or paramedic equipment depending on their skill level. Ambulance officers' vehicles are fitted with emergency warning systems and radio systems.

6.7 Air assets

The ground fleet is supplemented by the air ambulance service which operates from Inverness, Aberdeen and Glasgow. In contrast to other parts of the UK, where air ambulance services are funded by charitable donations, the service in Scotland is fully funded by the NHS. The air ambulance fleet comprises two EC-135 helicopters, based in Glasgow and Inverness, and two King Air 200c planes, based in Aberdeen and Glasgow. The helicopters respond primarily to emergency calls and requests from remote and rural locations, and provide medical care and transport to mainland healthcare facilities. The two fixed-wing assets are used primarily for inter-hospital transfers. The aircraft operate with paramedics on board and fly over 4,000 missions every year. The air ambulance service works closely with the Emergency Medical Retrieval Service (EMRS) (see below).

6.8 Tasking and operational policy

Emergency calls to the SAS are triaged using the Medical Priority Dispatch System (MPDS). Clinical supervision is provided by paramedics, who can advise on the appropriate mobilisation of assets such as pre-hospital teams, helicopter services, and British Association for Immediate Care, Scotland (BASICS) responders. There is also an on-call paramedic (consultant grade) available for senior clinical advice.

6.9 Current health service (and therefore ambulance service) policy is for injured patients to be taken to the nearest hospital with an Emergency Department. This strategy does not take into account either the severity of the injuries (triage) or the facilities and staffing of the receiving unit, and often leads to a mismatch between patients' needs and hospitals' capabilities.

6.10 There are two regions where this policy has been overridden by locally agreed de facto bypass protocols. In Tayside, patients with serious injuries are taken directly to Ninewells Hospital, rather than – for example – Perth Royal Infirmary. Similarly, in Lothian, trauma services have to some extent been regionalised at the Royal Infirmary of Edinburgh.

Other accident and emergency departments in the region no longer accept SAS-delivered trauma cases. It should be noted, however, that neurosurgical services are still located at the Western General Hospital.

- 6.11 Secondary transfers of trauma patients taken initially to the nearest hospital are common and can involve long journeys, which can impact on the service's ability to respond to further emergency calls.

Summary Statement: Pre-Hospital Triage

There is no triage to ensure that patients are taken to a hospital capable of dealing with their injuries.

6.12 Emergency Medical Retrieval Service

The EMRS was set up to improve the care of adults with life-threatening illness or injury, particularly in rural areas, when advanced medical intervention is required to facilitate safe retrieval. Initially limited to the West Coast, the service has now been extended to the whole of Scotland, and is funded by the Scottish Government. It is staffed by doctors, nurses and paramedics, and is able to provide two retrieval teams at any one time. The EMRS relies on SAS airframes (see above) or – when weather conditions do not permit the use of civilian aircraft – Royal Navy Search and Rescue helicopters. Although capable of performing primary retrievals, most of the work of the EMRS comprises secondary transfers. EMRS assistance may be requested directly (by doctors), by telephoning the duty consultant, or through the SAS.

PRE-HOSPITAL TEAMS

- 6.13 Some hospitals have medical teams which will provide pre-hospital care to trauma patients if requested to do so by the SAS EMDCs. Typically these teams are staffed by emergency medicine departments, and availability and stand-to time may depend on staffing levels in these departments.

VOLUNTARY SECTOR

- 6.14 In many rural parts of Scotland, doctors, nurses and paramedics make themselves available voluntarily to attend trauma and medical emergencies if requested to do so by EMDCs. In some areas, particularly the smaller Islands, these practitioners may be the only providers of pre-hospital care. The location and availability of these individuals is indicated by vehicle locator systems,

which have been purchased through charitable donations. Training is provided by BASICS, accredited by The Royal College of Surgeons of Edinburgh and funded by NHS Education for Scotland.

Summary Statement: Pre-Hospital Trauma Care

The provision of pre-hospital trauma care is fragmented.

ACUTE CARE, ONGOING CARE AND RECONSTRUCTION

- 6.15 Scotland does not have designated trauma receiving hospitals. All hospitals with Emergency Departments – regardless of other capabilities – receive trauma patients, irrespective of the severity of their injuries. There are currently 26 hospitals (Table 3) with Emergency Departments accepting SAS-delivered adult trauma patients in Scotland. Seven of the hospitals are larger, city centre, university-affiliated teaching hospitals (Table 4). Four have neurosurgical services. The remainder are district general hospitals of variable size, facilities and medical personnel. None of these hospitals meet the requirements for a MTC or even a TU (as defined by CAG), or a level 1 or 2 trauma centre (as defined by the American College of Surgeons).¹ 9 Aberdeen Royal Infirmary is the only hospital with all the required specialties on site. The Royal Infirmary of Edinburgh does not have neurosurgical services. Ninewells Hospital does not have a cardiothoracic service. Services in Glasgow are fragmented across several hospitals and sites, although some of these will be consolidated at the redeveloped Southern General Hospital over the next few years.

- 6.16 All 26 hospitals lack the organisational framework to function as a MTC. Both the acute and ongoing care and reconstruction phase of patient care are often characterised by competing clinical interests, which may threaten the effective progress of patients as they move from the initial resuscitation and surgery phase to early rehabilitation and surgery to restore function.¹ This applies particularly to multiply injured patients, who will have many different specialist teams contributing to their care, creating communication, logistic and prioritisation problems.¹ The effective management of this phase of care is crucial, and best handled by a dedicated trauma service.

- 6.17 Ongoing care and rehabilitation should reflect the patient's needs. In some cases, that will be in a specialist facility; if there is repatriation to a local hospital from the specialist centre this must be capable, with the Trauma Network, of satisfying those care and reablement needs.¹

Table 3. Hospitals accepting adult trauma patients

| |
|---------------------------------------|
| Aberdeen Royal Infirmary |
| Ayr Hospital |
| Balfour Hospital (Orkney) |
| Belford Hospital |
| Borders General Hospital |
| Caithness General Hospital |
| Crosshouse Hospital |
| Dr Gray's Hospital |
| Dumfries and Galloway Royal Infirmary |
| Forth Valley Royal Hospital |
| Gilbert Bain Hospital (Shetland) |
| Glasgow Royal Infirmary |
| Hairmyres Hospital |
| Inverclyde Royal Hospital |
| Monklands Hospital |
| Ninewells Hospital |
| Perth Royal Infirmary |
| Queen Margaret Hospital |
| Raigmore Hospital |
| Royal Alexandra Hospital |
| Royal Infirmary of Edinburgh |
| Southern General Hospital |
| Victoria Infirmary – Glasgow |
| Western Infirmary Glasgow |
| Western Isles Hospital |
| Wishaw General Hospital |

Table 4. University-affiliated teaching hospitals accepting adult trauma patients

| |
|------------------------------|
| Aberdeen Royal Infirmary |
| Glasgow Royal Infirmary |
| Southern General Hospital |
| Victoria Infirmary – Glasgow |
| Western Infirmary Glasgow |
| Royal Infirmary of Edinburgh |
| Ninewells Hospital |

Summary Statement: Acute Care, Ongoing Care and Reconstruction

There are no hospitals in Scotland which fulfil the criteria for an English Major Trauma Centre or American level 1 trauma centre.

REHABILITATION

- 6.18 Many hospitals have facilities for patients with general, rather than specialist, rehabilitation needs. The Queen Elizabeth National Spinal Injuries Unit, based at the Southern General Hospital in Glasgow, provides acute care and rehabilitation for patients with spinal cord injuries (traumatic and non-traumatic). For patients with traumatic brain injury there is a nationally managed clinical care network (NMCN). This has been arranged by the National Services Division (NSD). The proposal for establishing the network was agreed in 2006 and a service-level agreement was arranged by NSD with NHS Lothian to provide the co-ordination and facilitation of the NMCN. The network includes several regional centres dedicated to neurorehabilitation, including the Astley Ainslie Hospital in Edinburgh, the Maidencraig Unit in Aberdeen, and the Central Scottish Brain Injury Centre in Lanarkshire. These are supplemented by small specialist units within some district general hospitals or affiliated institutions. Examples include the rehabilitation ward in Raigmore Hospital or the Sir George Sharp Unit at the Cameron Hospital in Fife. For patients with behavioural difficulties following acquired brain injury, a Scottish Neurobehavioural Rehabilitation Service is provided by the Royal Edinburgh Psychiatric Hospital, which accepts referrals from throughout Scotland.

- 6.19 For patients with neurological rehabilitation needs there is therefore a NMCN. All hospitals with orthopaedic departments will have a physiotherapy and occupational therapy service available, but the staff will not necessarily have the sub-specialist skills required to provide comprehensive rehabilitation for trauma cases. There are insufficient facilities for patients with other specialist (e.g. complex musculoskeletal) or multifaceted rehabilitation needs.

Summary Statement: Rehabilitation

Specialised trauma rehabilitation services are an essential component of the trauma system to enable injured people to achieve their optimal functional potential. The current provision of specialist and general rehabilitation facilities is insufficient.

7. PERFORMANCE EVALUATION

- 7.1 The resumption of trauma audit by the STAG, after almost a decade without data collection, is a welcome development, and will provide new insights into the quality of trauma care in Scotland. However, the audit requires better support, particularly at local level, and should be extended to capture more patients, and additional data. With appropriate safeguards in place, it could be usefully linked to other information, such as pre-hospital data collected by the SAS and EMRS, and general data collected by the ISD of the NHS in Scotland. This would create a more powerful tool for audit, research, and performance improvement.
- 7.2 There is also a need for a broader performance evaluation framework to monitor all elements of trauma care and track changes. The data already collected by the STAG should form part of this, but should be augmented by additional, continuously collected, process and outcome data.

Summary Statement: Performance Evaluation

The resumption of trauma audit, by the Scottish Trauma Audit Group, is a welcome development, but requires extension.

8. IMPACT OF THE EUROPEAN WORKING TIME REGULATIONS, NEW DEAL AND CHANGES IN TRAINING PROGRAMMES

- 8.1 The provision of trauma services at multiple sites has been rendered progressively more difficult as a consequence of the restrictions imposed by the European Working Time Regulations (EWTR) and New Deal, as well as changes in trainee numbers and training programmes. So far, many of the regulations have been applied stringently only to trainees, but it is likely that the working conditions of consultants will also come under closer scrutiny. The provision of on-call trauma services continues to rely heavily on junior staff resident in the hospital with consultants on-call from home. Many emergency and orthopaedic departments are heavily dependent on surgical trainees for provision of acute trauma services. EWTR and New Deal regulations have had a significant effect on the number of hours trainees have available for rotas, and the planned reduction in trainee numbers proposed by the Scottish Government Health Department (SGHD) will have a dramatic

effect on the number of compliant on-call rotas that can be supported in a number of relevant specialities.

- 8.2 The current trainee establishment in Scotland is 2,564 but the projected SGHD trainee establishment by 2015 is anticipated to be 1,953, a reduction of 611 trainees, or 24%. However, some of the projected reductions will be borne disproportionately by some of the sub-specialty areas particularly involved in provision of trauma care, including general surgery (29% reduction), orthopaedic surgery (26% reduction) and accident and emergency (82% reduction) training programmes.
- 8.3 The impact of this reduction is difficult to quantify. However it is accepted that, for any given rota, a minimum cell size of 10 trainees is necessary to maintain EWTR-compliant rotas. The surgical service most closely associated with a large trauma workload is orthopaedic surgery. Data from the Scottish Orthopaedic Training Programme indicates that 12 on-call rotas will be possible for low-intensity work but only 8 if the posts are high-intensity, once the training programmes are fully staffed by run-through trainees. It will thus be impossible to maintain the number of units currently taking trauma on-call if the present model of staffing rotas with trainees persists. Consolidation of services into a smaller group of hospitals will be necessary, even from a staffing perspective.

Summary Statement: Working Time Regulations

The provision of trauma services at multiple sites has been rendered progressively more difficult as a consequence of the restrictions imposed by the EWTR and New Deal, as well as projected changes in trainee numbers.

MODELS FOR TRAUMA CARE DELIVERY IN SCOTLAND

- This section describes different models of how trauma care in Scotland could be delivered in the future. The TWG has identified three possible options:
 - Establishment of a national trauma system
 - Establishment of a smaller number of trauma-receiving hospitals (which are not part of a trauma system)
 - Maintenance of the status quo (no change from present situation).

2. A NATIONAL TRAUMA SYSTEM

RATIONALE

- There is an abundance of evidence to support the role of a trauma system in providing excellence in trauma care, lowering mortality, reducing morbidity, and optimising functional recovery.

PROPOSED STRUCTURE

- A national trauma system for Scotland would require an uplift of pre-hospital care delivery, the designation of MTCs and TUs, enhancement of rehabilitation facilities, and the creation of a performance evaluation framework.

Pre-hospital Care

- It is likely that primary (from the scene) as well as secondary (inter-hospital transfer) aeromedical evacuation capabilities would need to be increased. Pre-hospital triage would need to be introduced. All organisations (SAS, EMRS, BASICS) involved in providing pre-hospital care would require coordination and integration, ideally through joint control.

Acute Care, Ongoing Care & Reconstruction

- The size of the Scottish population, and the current estimates of the volume of major trauma cases, would justify one or perhaps two MTCs, with a supporting network of designated TUs. If a single MTC configuration is chosen, it is likely that this centre would need to be located in the central belt. If a configuration based on two MTCs is chosen, it is probable that one of these should be located in the central belt. The exact configuration requires further study, which is under way (see Appendix 3).
- Decisions about the number and location of MTC(s) should not be made in isolation. TUs would

form an integral part of the system, particularly so in the context of a geographically-dispersed population, as in the North or West of Scotland, and the population density characteristics of the central belt. These units would deal with lesser trauma from their own areas, but would also act as fall-backs when primary transport of major trauma patients to the MTC(s) is not possible; whether due to the nature of the injuries (e.g. airway obstruction) or simply time (due to remoteness of the incident location). The number and location of such units must be taken into account. Again, mathematical modelling based on incident location and triage data would facilitate this process (see Appendix 3).

- MTCs and TUs will require a lead service, and MTCs should have a dedicated trauma service to take charge of major trauma patients. This role could be fulfilled by general surgeons, as in North America, or by another specialty, as is the case in some English MTCs. If the lead clinicians are not from general surgery, general surgeons must nevertheless be readily available, and trained, to deal with torso trauma. If the lead clinicians are general trauma surgeons, they may wish to maintain another interest to maintain their technical skills, because the torso trauma operative workload will be low. This is due to the effects of injury prevention, the low incidence of penetrating trauma, and the increasing use of non-operative management. In North America, the concept of "acute care surgery" (comprising both trauma and non-trauma emergency general surgery) as a dedicated specialty has emerged, and is showing promise. At the Royal London Hospital, the trauma service is provided by vascular surgeons.

- Other specialties (e.g. neurosurgery) must be adequately resourced to be able to cope with the additional trauma workload; and supporting services (such as intensive care, anaesthesia, theatres, and interventional radiology) must be available. This may require some reorganisation of services, particularly in the MTC(s). However, the establishment of such centres must take into account existing facilities. Building new, large hospitals, with all supporting facilities, in a geographically "ideal" location is neither feasible nor desirable. MTC(s) – and TUs – should be established in existing hospitals, ideally those that already have the majority of essential services, such as general surgery, orthopaedic surgery, vascular surgery and neurosurgery. This will reduce costs, and build on existing experience. Some compromises between ideal and feasible locations would have to be made.

- 2.8 Establishment of a trauma system with a MTC(s) and supporting TUs would not result in the closure of existing hospitals or their Emergency Departments. The volume of major trauma patients as a proportion of the trauma workload is less than 1%. The vast majority of trauma cases are therefore isolated injuries which would continue to be managed within local regions. Designation of TUs might entail some consolidation of trauma services into a smaller number of bigger hospitals within regions. This has already occurred in Lothian, Forth Valley, and Tayside.

Rehabilitation

- 2.9 An effective rehabilitation service is essential for maximising functional recovery and restoring casualties back to productive roles in society. There are rehabilitation facilities in many areas of Scotland at present, and these could be incorporated into a trauma system. The National Spinal Injuries Unit is based in Glasgow and will move to the new Southern General Site in due course. It would be an important consideration when evaluating the designation of a MTC. Similarly, there are established neurological rehabilitation units in the Astley Ainslie Hospital in Edinburgh, and the Maidencraig Unit in Aberdeen, which might fulfil an extended role to support rehabilitation of neurologically-impaired patients recovering from trauma. General rehabilitation services, in local hospitals would have an important part to play, both for patients treated locally, and the small number of patients who received their initial treatment in a MTC.

Performance Evaluation

- 2.10 A national trauma service would require a comprehensive performance evaluation framework to evaluate clinical outcomes, the health of the network, and drive change and improvement.

POTENTIAL DIFFICULTIES

- 2.11 Potential difficulties in implementing this model of trauma care include the eccentric distribution of the Scottish population, and costs. In terms of the size of Scotland's population, and estimates of the incidence of major trauma (around 1,000 cases per year), a single, national MTC is an attractive option. Such a centre would have the necessary case volume (>400 major trauma cases per year) to ensure improvements in outcome. Furthermore, a single centre would facilitate staffing, and limit associated costs. Such an approach could be likened to Maryland's trauma system, which is centred on Baltimore's Shock Trauma Centre. However, Scotland's geography and demography is different from those of Maryland, and must be

taken into consideration. The majority of Scotland's population is based in the central belt and, if a single centre were to be designated, it should be based in this area. However, even in the central belt, population density is uneven, with large concentrations at each end. Furthermore, much of Scotland's North is remote, and some distance from where such a centre would be located in the central belt. This situation is not unique, and could be likened to the Northwest of the United States (served by Harborview Trauma Centre) and much of Canada. There is good evidence supporting the viewpoint that transfer times are less important than time to definitive care, but there is obviously also a critical time after which the benefits of specialist care are outweighed by the time it takes to get there. This time probably varies, depending on the injuries, and the patient. In many trauma systems, 45 minutes is regarded as the "cut-off": if patients cannot be delivered to the centre to which they should go (on account of their injuries or injury severity) within this time, they are taken to another facility first (usually a TU) and then transferred secondarily. In any case, such a system requires good transport, both primary and secondary, and often helicopters, as well as agreed protocols which facilitate rapid transfer (again, Maryland's trauma system is a good example). If travel times for patients from more remote areas of Scotland would be excessive (even if taken by air), a second MTC in the North of Scotland should be considered. This is an area requiring further research, both in terms of the predicted volume of such a centre, and whether it would meet the required threshold, and patients' travel times. Mathematical modelling of different combinations is very feasible, but requires accurate data on triage decision and incident location, which is not currently available. Further research is underway (see Appendix 3).

ADVANTAGES

- 2.12 If this model of care were implemented, it would have the advantage that seriously-injured patients would be treated in institutions with appropriate personnel and equipped with the necessary facilities for dealing with complex injuries in the most effective fashion. Based on published evidence, a reduction in the number of deaths and improvements in other outcomes could be expected.

- 2.13 The reorganisation which would be necessary to implement such a system would also lead to improvements in the care provided at the TUs: it would release expensive medical time for managing the bulk of trauma which is ISS <15 and which is disrupted by the arrival of an unusual major case.

- 2.14 Current concerns about training within 48 hours would be addressed by ensuring concentrated experience in relatively short periods of time for trainee surgeons of many specialties. This would not translate into an excess of 'level 1 trauma surgeons' but would ensure that all surgeons are exposed to adequate experience in managing these challenging cases. This can only raise the quality of care delivered by a surgeon dealing with the occasional, unexpected trauma patient presented at their hospital.

DISADVANTAGES

- 2.15 The cost of implementing a national trauma service in Scotland is not known.
- 2.16 Some patients (and therefore their friends and relatives) would receive treatment further from home than is currently the case, depending on the final configuration of the system chosen.
- 2.17 Instituting such a system is bound to attract public concern and political disquiet. However, the undoubted advantages for patients and their families in terms of survival and better functional outcomes should not be underestimated.

3. ESTABLISHMENT OF A SMALLER NUMBER OF TRAUMA-RECEIVING HOSPITALS

RATIONALE

- 3.1 Cost. Providing trauma care in regional centres, on a smaller number of sites, may improve outcomes, and would be cheaper than instituting a national service delivery framework.

PROPOSED STRUCTURE

- 3.2 Trauma care could be provided in a smaller number of regional units, without the other elements of a trauma system. There are some examples already in Scotland where this has been implemented on a limited scale. The management of seriously-injured patients, and indeed all trauma patients requiring inpatient care, has been centralised in the Lothian region at the Royal Infirmary since 2003. Similarly, in Tayside, the SAS has a bypass protocol to take seriously injured patients directly to Ninewells Hospital in Dundee rather than bringing them the Perth Royal Infirmary.
- 3.3 Such a strategy could be likened to a trauma system comprising TUs only, without an "apex" MTC, and a local/regional approach to aspects such as pre-hospital care, secondary transfers and governance.

ADVANTAGES

- 3.4 Reduced implementation costs, although it is uncertain whether such a strategy would be as cost-effective as a national trauma service in the longer term.

DISADVANTAGES

- 3.5 Integration of services, both within and outside of hospitals and leadership (by MTCs and individuals) are thought to be major drivers of the success of trauma systems. It has long been recognised that trauma centres in isolation do not improve outcomes, and must be part of a trauma system. This reflects the need to consider trauma as a public health issue, rather than as a disease treated in a hospital. It is unlikely, therefore, that the benefits of establishing a trauma system could be realised through simply enhancing the capability of a few hospitals, which would never approach the capability of a MTC. The evidence supporting these observations is strong. Given that the primary aim of trauma care is to reduce death and disability, it is difficult to support a model which is unlikely to achieve these aims.

3.6 Maintaining a larger number of such units is likely to be expensive in terms of staffing. The implications for training are that the experience of trainee surgeons of all types would be diluted because the likelihood of regularly dealing with major trauma cases over a relatively short period of time is reduced.

3.7 The effects of the New Deal and EWTR, combined with the training requirements of competence-based curricula, mean that the current reliance on trainees to provide service will become more difficult to sustain. If the service for patients with major trauma is going to rely on a trained workforce, then there will have to be a rationalisation of the institutions that will provide that service.

4. MAINTAINING THE PRESENT SYSTEM RATIONALE

4.1 Cost.

ADVANTAGES

4.2 Maintaining the present system of delivering trauma care in Scotland has little to commend it.

DISADVANTAGES

4.3 It will be apparent from the contents of this report that there are many disadvantages of persisting with the current trauma service. Changes in on-call rotas to comply with legislation mean that the present method of staffing the trauma service is not sustainable.

RECOMMENDATIONS AND CONCLUSIONS

1. This section reiterates the summary statements from previous chapters, and presents the working group's recommendations and conclusions.

2. SUMMARY AND RECOMMENDATIONS

2.1 There is good evidence that regionalised trauma care improves mortality and disability from major trauma, and is cost-effective.

The working group recommends the development of a coherent, integrated and inclusive national trauma service in Scotland.

2.2 The reorganisation of trauma services in England is proceeding apace. NHS England has created a useful framework for the delivery of trauma care in the UK setting.

The working group believes that much of the service delivery framework which has been developed in England is transferable to Scotland.

2.3 There are only limited data regarding survival from major trauma in Scotland. There are no comparisons with populations served by a trauma system.

The working group recommends further study of mortality from trauma in Scotland.

2.4 The temporal distribution of trauma deaths in Scotland may differ from that in other regions.

The working group believes that the temporal distribution of trauma deaths should not be used to argue against improvements in trauma care because mortality is not the only indicator of effective trauma care.

2.5 There are no published data on outcomes other than mortality after major trauma in Scotland.

The working group recommends further study of functional outcomes from trauma in Scotland.

2.6 There is insufficient information on variations in outcomes from trauma care in different hospitals.

The working group recommends further study of variations in outcomes from trauma in Scotland.

2.7 The resumption of trauma audit, by the STAG, is a welcome development, but requires extension.

The working group recommends the continuous collection of process and outcome data, as part of a comprehensive performance improvement strategy, to facilitate the evaluation of trauma care in Scotland.

2.8 Pre-hospital trauma care is fragmented.

The working group recommends the integration of all organisations providing pre-hospital care, to facilitate rapid retrieval from the scene of the accident and – if necessary – secondary transfer.

2.9 There is no triage to ensure that patients are taken to a hospital capable of dealing with their injuries.

The working group recommends the introduction of pre-hospital triage to ensure that patients are taken to appropriately staffed and resourced trauma centres, which form part of an inclusive trauma system.

2.10 There is evidence, from Scotland, that travel times – within reason – are less important than once thought. Direct transfer to a centre capable of providing definitive trauma care is associated with better outcomes than care in a local hospital.

The working group recommends that the delivery of pre-hospital care should focus on rapid transfer to definitive care.

2.11 The volume of major trauma in Scotland, and the number of receiving hospitals, indicates that the institutional experiences of any of the centres falls short of recognised thresholds for a service capable of improving survival from major trauma.

The working group recommends that the care of trauma patients, and particularly patients with major trauma, should be concentrated in designated centres.

2.12 The population size and incidence of major trauma in Scotland indicate the need for one, or at the most two, MTCs.

- 2.13 There are no hospitals in Scotland which fulfil the criteria for an English MTC or American level 1 trauma centre.

The working group recommends further study to determine the optimal configuration of a trauma system for Scotland, including the number of MTCs, TUs and changes to pre-hospital services.

- 2.14 There is evidence that consultants are not involved at a sufficiently early stage.

The working group recommends that trauma care should be delivered by consultants, while instructing doctors in training.

- 2.15 The provision of trauma services at multiple sites has been rendered progressively more difficult as a consequence of the restrictions imposed by the European Working Time Regulations and New Deal, as well as changes in trainee numbers and training programmes.

The need to comply with the EWTR and changes to the structure of postgraduate training programmes will require consolidation of emergency services to a smaller group of centres.

- 2.16 Specialised trauma rehabilitation services are an essential component of a trauma system to enable injured people to return to achieve their optimal functional potential. The current provision of specialist and general rehabilitation facilities is insufficient.

Existing rehabilitation services require reorganisation and enhancement to ensure that complex and multifaceted needs are met and delivered in a seamless fashion in all stages of the patient's journey from the trauma centre to the community.

3. CONCLUSIONS

- 3.1 The working group believes that the benefits of specialist, regionalised trauma care, which have been realised elsewhere – including reduced mortality and improved functional outcomes – could also be attained in Scotland.

- 3.2 Although the precise configuration of a trauma system for Scotland requires further research, the working group believes that the general principles of a holistic, inclusive, tiered system are equally applicable to Scotland as elsewhere. Such a service should make use of existing facilities wherever possible, but may require expansion of the infrastructure.

PAEDIATRIC TRAUMA CARE

1. DEMOGRAPHICS

- 1.1 Trauma is the most common cause of death in children, and is responsible for more deaths in children and adolescents than all other causes combined.^{57,58} In the UK, trauma is the cause of death in 16% of children aged 1–4 years and in 40% of teenagers aged 15–19 years.⁵⁹ Boys are more commonly involved than girls (66% vs 34%).⁶⁰ Major trauma is uncommon but one population-based study estimated that just over 4% of paediatric trauma admissions could be classified as seriously injured based on the paediatric trauma score.⁶¹ This is not dissimilar to the proportion of major trauma in the adult population.

- 1.2 Data from the TARN indicates that motor vehicle accidents account for 41% of multiple trauma in children, followed by falls (37%).⁶² Cranial and limb injuries predominate, being present in 25% and 65% of paediatric multiple trauma cases, respectively.⁶² Mortality is most commonly associated with severe head injury or spinal injury.^{63–65} However, severe head injuries are almost always associated with other significant trauma, mainly long-bone fractures.⁶⁴ Improvements in hospital care have been associated with better outcomes.^{62,66} Mortality rates vary with age. The highest mortality is seen in patients aged 0–5 years (23%), but is still appreciable in adolescents (15–20%).⁶⁷

- 1.3 Chest trauma results from blunt injury in 96% of cases and is most often sustained in motor vehicle accidents. Serious chest trauma is associated with other injuries in 99% of cases. Only 7% of patients require surgical intervention.⁶⁸

- 1.4 Scottish data on paediatric trauma are sparse. However, an analysis of 185 paediatric trauma cases presenting to the paediatric hospital in Glasgow revealed that 131 were seriously injured, 99 (50%) required ICU treatment and 32 (17%) were transferred to the neurosurgical unit. Road traffic accidents were responsible for most of the serious injuries and eight of the eleven trauma deaths.⁶⁹

- 1.5 There are fewer outcome studies devoted to the management of paediatric trauma. However, one North American study evaluated over 13,000 paediatric trauma admissions with survival as the main outcome measurement. Mortality rates were lowest when patients were treated in a

paediatric MTC or an adult trauma centre staffed and equipped to deal with paediatric trauma.⁷⁰ This larger study confirmed the findings of an earlier study with smaller numbers which also showed improved survival of paediatric trauma victims when management was carried out in a designated paediatric trauma centre compared with non-specialist centres.⁷¹ Studies on the cost-effectiveness of various trauma systems for the paediatric population are lacking but one economic analysis indicated that management in a paediatric TU was more cost-effective than initial treatment elsewhere and subsequent transfer.⁷² This suggests that, as in adults, time-to-definitive-treatment is a key determinant of outcome.

2. CURRENT SITUATION IN SCOTLAND

- 2.1 Scotland has four centres for paediatric treatment in Edinburgh, Glasgow, Dundee and Aberdeen. In Dundee and Aberdeen, these are on the same site as the main adult teaching hospital (Foresterhill, Aberdeen; Ninewells, Dundee). In Glasgow and Edinburgh there are separate paediatric hospitals (Yorkhill and Royal Hospital for Sick Children, respectively). There are plans to move the paediatric hospital in Edinburgh, the Royal Hospital for Sick Children in Edinburgh (RHSC) onto the same site as the Royal Infirmary, but it is not envisaged this will occur before 2015. For each of these four centres the provision of major areas of specialist expertise varies. In each institution there are staff in the Emergency Departments trained in paediatric resuscitation and assessment.

- 2.2 However, only two centres (RHSC, Edinburgh; Yorkhill Hospital, Glasgow) have a paediatric ICU. There is no paediatric ICU on the other two university sites. Although neurosurgery is available in Aberdeen and Dundee, there is no subspecialist paediatric neurosurgical expertise. Adult neurosurgeons may undertake paediatric neurosurgery in these centres but children requiring postoperative intensive care require transfer to Edinburgh or Glasgow. Paediatric cardiothoracic surgery is available only on the Yorkhill Hospital site. Some thoracic surgery is undertaken by general paediatric surgeons at the RHSC and at Royal Aberdeen Children's Hospital. All four university centres have general and orthopaedic surgeons with paediatric expertise. In addition, the Glasgow and Edinburgh centres have paediatric maxillofacial surgical services and a broad range of medical paediatric expertise.

- 2.3 Paediatric trauma outwith the four university centres is variably managed depending on local

expertise. In general, children with major trauma are usually taken to the nearest local hospital with an Emergency Department for initial assessment and surgical stabilisation. Subsequent transfer to Edinburgh or Glasgow is required for those patients requiring paediatric ICU treatment.

- 2.4 Children identified with significant head injuries are, in general, transferred directly to either the Edinburgh or Glasgow paediatric hospitals for definitive treatment. Children with skeletal trauma not requiring other surgery may be managed in the district general hospital setting if a surgeon with expertise in paediatric orthopaedics is available to undertake or supervise treatment.
- 2.5 Most of these institutions will have consultant staff with sub-specialist expertise in paediatric surgical problems, but none of the general hospitals will have all of the relevant areas of expertise. In addition, the consultants with paediatric expertise mainly provide elective paediatric services and the array of expertise out of hours may be well short of what is required for effective management of complex paediatric trauma emergencies.

3. CONCLUSIONS AND RECOMMENDATIONS

- 3.1 There is conclusive evidence indicating major trauma is an important cause of morbidity and the single most common cause of mortality in the paediatric population. The literature on the management of complex paediatric trauma is less abundant than for adult trauma. Despite this, it is clear that the published studies reach broadly similar conclusions. The mortality rates after paediatric trauma are lower when patients are treated in specialised centres where staff are trained and equipped to assess and manage paediatric trauma patients. Transfer directly to these centres results in better outcomes and is less costly than initial treatment in a hospital where paediatric specialist expertise is not available.
- 3.2 In the UK population, the cause of serious paediatric trauma is identical to the adult population – motor vehicle accidents and falls account for most cases. The patterns of injury are therefore similar, with skeletal trauma predominating. Head injury is the most common cause of mortality. Although chest and abdominal injury do occur, the requirement for surgical intervention is lower than that for the adult population.
- 3.3 Taking these facts into consideration, the main requirements of a system of trauma care for the paediatric population would be as shown below.

3.4 Pre-hospital Care

There may be variability in paediatric training and experience among the staff in the SAS. Ideally all paediatric trauma emergencies would be attended by SAS staff trained in paediatric life support and resuscitation. District general hospitals currently provide a satisfactory service for non-complex isolated injuries, and in any system of trauma care this would not change greatly. However, for the same considerations that apply to provision of out-of-hours care for adult trauma, it would be preferable to reduce the number of sites providing emergency paediatric trauma care for isolated injuries. This would entail bypass protocols both for major trauma and isolated injuries in a paediatric population. It would also require effective triage of paediatric cases so patients reached the most appropriate designated centre for the injury sustained.

3.5 Designated Paediatric Trauma Centres

Most district general hospitals are not staffed or equipped to deal with complex paediatric trauma. Seriously-injured paediatric victims should be taken, therefore, to a designated paediatric trauma centre. As the situation stands, there are only two existing centres in the main cities that approach the range of surgical expertise and facilities to be equipped for this role. It is possible that the volume of paediatric trauma to develop the necessary sub-specialist expertise in complex trauma management to optimise outcome might not be adequate to justify two paediatric trauma centres. Depending on decisions about reorganisation of the adult major trauma service, it would be logical to designate one, or at most two, centres as the preferred destination for management of complex paediatric trauma. Head injury is the main cause of mortality in the paediatric trauma population, so the presence of neurosurgery and a paediatric ICU would be mandatory. This would make Glasgow and Edinburgh the logical choices to designate as paediatric TUs because they have majority of the relevant specialities and facilities already on-site. There are currently plans for both of the paediatric units to move to the same site as a major adult hospital. In the case of Glasgow, Yorkhill Hospital is scheduled to relocate to the site of the new Southern General Hospital in 2013/14. The Royal Hospital for Sick Children in Edinburgh is scheduled to move to the Royal Infirmary site by 2015. This relocation to a site with major adult trauma facilities on-site would strengthen the case for designating one or both of these paediatric units as paediatric MTCs.

appendix 2-3

APPENDIX 2

1. MAJOR INCIDENT PREPAREDNESS

A mass casualty incident is defined as “a disastrous single event, or simultaneous events, or other circumstances where the normal major incident response of several NHS organisations must be augmented by extraordinary measures in order to maintain an effective, suitable and sustainable response.”⁷³ Such events have the potential to overwhelm the local capacity available to respond, even with the implementation of major incident plans. To date, the NHS in Scotland has not experienced events resulting in mass casualties, but the terrorist attacks in the United States on 11 September 2001 and subsequent attacks in Bali, Spain and London underscore the need for preparedness. The terrorist attack at Glasgow Airport on 30 June 2006, while not resulting in a mass casualty incident, also demonstrates that Scotland cannot consider itself immune from the threat of such events.⁷³ The Scottish Government has issued comprehensive guidance for NHS boards in Scotland on how to plan for incidents involving mass casualties.⁷³ While it is important to recognise that not all such events involve traumatic injuries, many do. The development of a national trauma service, provided it is aligned with major incident plans, would strengthen the ability and capacity of the health service in Scotland to deal with such incidents.⁷⁴

APPENDIX 3

1. FUTURE RESEARCH OUTCOMES

- 1.1 The new STAG audit will provide valuable data, but these will not be available for some time. Similarly, at present there are no plans for a comparison of mortality with a population served by a mature trauma system. Such a comparison would be worthwhile, and relatively easy to perform once the 2011 STAG audit has been completed. There is also a need for research into outcomes other than mortality.

DESIGNING A TRAUMA SYSTEM

- 1.2 The need to design a trauma system that takes into account centre volumes as well as travel times has already been alluded to. Such an analysis is relatively straightforward – similar modelling exercises have been performed for police and fire services. However, before such an analysis can be commenced for trauma services, reliable data on incident locations and injury severity (in the form of triage decisions) are required. Although the incident location data recorded by the SAS are excellent, the clinical information is not sufficient to conduct a retrospective triage. One of the authors of this report, in conjunction with the SAS, is planning a prospective study which aims to determine the optimal configuration of a trauma system (number and location of MTCs, number and location of TUs, number of additional helicopters required), based on actual incident locations, and the type of facility which patients would be triaged to, if such a system were in place.

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