



**Royal College of Surgeons in Ireland**  
123 St Stephen's Green  
Dublin 2  
[www.iaem.ie](http://www.iaem.ie)  
[www.emergencymedicine.ie](http://www.emergencymedicine.ie)

# **An Integrated Trauma System for Ireland**

**Irish Association for Emergency Medicine**

**December 2014**

# Contents

Executive Summary .....	3
Background .....	3
International Experience .....	3
The Irish Context .....	4
Pre-Hospital Care .....	4
Trauma Units .....	5
Major Trauma Centres .....	5
Key Trauma Specialties .....	5
Overview .....	5
1. Introduction .....	7
1.1 Background .....	7
1.2 Financial Incentives .....	7
1.3 The Burden of Trauma .....	8
1.4 A Trauma System, not just Major Trauma Centres .....	8
1.5 Trauma Epidemiology .....	9
1.6 The Reorganisation of Trauma Services .....	9
2. The US Model .....	10
2.1. The American Model of Major Trauma Centres <sup>9</sup> .....	12
3. The UK and Australian Models .....	12
3.1 Major Trauma Centre .....	13
3.2 Hybrid facilities .....	13
3.3 Diagnostics and Radiology: .....	14
3.4 On-going Care: .....	14
3.5 Acute/Early Phase Rehabilitation: .....	14
3.6 Network Delivery: .....	14
3.7 Co-located Services: .....	15
3.8 Trauma Unit .....	16
4. Trauma Triage .....	16
4.1 London Ambulance Service Triage Rule .....	17
4.2 US Guidelines for field triage of injured patients – CDC .....	18
4.3 Over-triage and Under-triage .....	19
5. Pre-Hospital Care .....	19
5.1 National Ambulance Service .....	19
5.2 Air Transportation .....	19
6. The Trauma Reception and Resuscitation Team .....	21
7. Clinical Functions of Services Contributing to Trauma Care .....	22
7.1 Emergency Medicine .....	22
7.2 General Surgery .....	22
7.3 Neurosurgery .....	22
7.4 Orthopaedic Surgery .....	23
7.5 ICU Organization and Responsibility .....	23
7.6 Pain Management .....	24
7.7 Care of Injured Children .....	24
7.8 Geriatric Trauma .....	24
7.9 Rehabilitation .....	25
7.10 Psychiatry, Psychology, and Posttraumatic Stress Disorder Intervention .....	25
7.11 Support Groups .....	25
7.12 Brain Injury .....	25
7.13 Spinal Cord Injury .....	25
7.14 Social Work .....	25
7.15 Operating Theatre of the Major Trauma Centre .....	26
7.16 Radiology .....	26
7.17 Clinical Laboratory .....	26
7.18 Burn Centre Referral Criteria .....	26
7.19 Paediatric Patients with Burns .....	27
8. Rural Trauma Care .....	27
9. Required Trauma Centre Performance .....	28
10. Trauma Audit, Research and Scholarship .....	30
10.1 Trauma audit .....	30
10.2 Trauma Research .....	30
11. Disaster Planning and Management .....	31
12. Organ Donation .....	31
13. Emergency Medicine Facilities in Ireland .....	32
14. Consultant in Emergency Medicine Staffing in Ireland .....	32
15. Conclusions .....	33
Appendix 1: Hospital Inpatient Enquiry 2012 - Patients eligible for TARN inclusion in Irish Hospitals and on-site clinical services .....	34

## Executive Summary

### Background

In Ireland, improvements in infrastructure, social policy, preventative strategies and better medical treatments in recent years have led to the reversal, disappearance or a greatly improved prognosis for many medical conditions. The successful rollout of the National Cancer Control Programme, with associated improvement in the prognosis of many cancers and the Acute Coronary Syndrome Programme, whereby patients with heart attack are brought directly to a centre capable of performing immediate angioplasty are examples of what can be done. It is essential that the networked management of trauma now be given the same priority.

One of Ireland's great strengths has been its citizens' pride in their parish and county. There are general hospitals in many counties in Ireland, historically based around the dedicated services of the "two surgeons and two physicians" model, whereby local citizens receive most of their health care needs locally from very dedicated medical and nursing staff who live amongst them but who recognise when the patient's needs are best met by transfer to a regional or national centre. The practice of victims of trauma being brought to the nearest hospital in the first instance is therefore well embedded in Irish culture.

However for more than 30 years the concept of the centralisation of the care of victims of major trauma in units that are properly staffed and equipped to deal with the large number of immediately life-threatening complex conditions that may exist in the one patient has gained ground internationally. Significant financial and staffing commitment to the formation of such an integrated trauma systems model has led to pockets of excellence around the world that have consistently shown significant improvements in the mortality and morbidity rates for victims of trauma, citizens who are very often amongst the most economically productive members of society at the time of the trauma.

### International Experience

In the last decade, many First World countries, including most recently our nearest neighbour, the United Kingdom, have taken the bold steps necessary to reorganise trauma management. Following the formation of trauma networks in the United Kingdom in recent years, a consistent 30% reduction in the mortality rate for victims of trauma has been seen and a significant improvement in quality of life outcomes also achieved. Furthermore, it has been the experience in the UK that health system costs can be redistributed, rather than the overall cost of the system increased<sup>1</sup>.

---

<sup>1</sup> Personal communication

Pre-hospital triage of trauma is challenging. Some over-triage is desirable to ensure that patients who should be brought to the Major Trauma Centre (MTC) are identified. However as trauma systems mature, efforts are increasingly being successful in minimising this over-triage. This ensures that the MTC does not become overloaded with patients who could be successfully treated elsewhere which would compromise its ability to deliver optimal management to the small number of the most seriously injured patients. Such an approach also ensures that other networked trauma units (*vide infra*) maintain expertise in the assessment and management of patients with lesser degrees of trauma.

#### The Irish Context

The National Emergency Medicine Programme (EMP)<sup>2</sup>, in which the Irish Association for Emergency Medicine is a key stakeholder, has described a model of care based around Emergency Care Networks and a National Emergency Care System under the governance of a National Emergency Care Steering Group. An effective integrated trauma system requires that the breadth of trauma from minor injury to major life-threatening / life-altering injury be dealt with safely, effectively and seamlessly. Local Injury Units (LIUs), as described in the EMP, have the potential to see a significant volume of minor trauma but must be integrated seamlessly with the 24/7 Consultant-led hub Emergency Department within the Network and associated Major Trauma Centre to avoid disadvantaging self-presenting patients whose requirements exceed the expertise of the LIU.

#### Pre-Hospital Care

The model proposed recommends on-going close collaboration with the National Ambulance Service (NAS); consideration of aero-medical transport and access to 24/7 tele-medical support as needed, to ensure the appropriate identification of patients who are best transported directly to a Major Trauma Centre (MTC) provided this can be achieved within a timeframe of 45 minutes. Assessment of the patient's mechanism of injury (a clue to the likelihood of concealed injury); the presence of obvious serious injuries; physiological derangement (such as low blood pressure or altered conscious state) will help this identification. This development has training and resource implications for the NAS as transport times will be lengthened and there will be a greater requirement to safely treat and manage the trauma patient for longer when the nearest hospital is bypassed. IAEM acknowledges the significant achievements of recent years with the close collaboration between the Health Service Executive (HSE), the Air Corps and Department of Defence in establishing a Helicopter Emergency Medical Service (HEMS) and the mapping of designated landing sites at Gaelic Athletic Association (GAA) grounds throughout the country. These unique synergies favourably change the costing model of HEMS operations as existing resources are utilised.

---

<sup>2</sup> National Emergency Medicine Report 2012. <http://www.hse.ie/eng/about/clinicalprogrammes/emp/empreport2012.pdf>

## Trauma Units

In the re-organisation of Trauma Services in the UK, a Trauma Unit is a hospital responsible for the management of trauma patients that have not been classified / triaged as having suffered major trauma or where transfer of a Major Trauma victim to the MTC cannot be achieved within the 45 minute window. It is becoming apparent that patients who do not meet the criteria for Major Trauma do no better if managed in an MTC than in a Trauma Unit<sup>3</sup>. IAEM contends that the 24/7 Type A ED as defined in the EMP Report is ideally placed to function as a Trauma Unit, provided the hospital has on-site Orthopaedic Surgery.

## Major Trauma Centres

The setup of a Major Trauma Centre requires initial capital investment and on-going revenue costs. A method of recognising this and allocating costs appropriately must be found - this has been key to the success of the Australian (Victoria) and the UK trauma systems. The designation of a hospital as a Major Trauma Centre without appropriate infrastructural and staffing investment will defeat the entire purpose of trauma networks, leading to patients bypassing hospitals but without improvement and indeed with potential for deterioration in their outcomes.

International experience would suggest that a population the size of Ireland, with its geographical spread, is best served by two or three Major Trauma Centres (depending on whether or not there is a separate Major Trauma Centre developed for children). In advancing this plan, consideration should be given as to whether a Major Trauma Centre in Belfast might be more easily accessible within 45 minutes from parts of the Republic than other options.

## Key Trauma Specialties

Certain key specialists need to be rapidly available at senior level to ensure optimal outcomes in a Major Trauma Centre. These include Emergency Medicine, General or Trauma Surgery (effectively a surgeon capable of stopping life-threatening haemorrhage in a patient's chest, abdomen or pelvis), Interventional Radiology, Neurosurgery and Critical Care. A Major Trauma Centre also requires access to Orthopaedic and Plastic/Burns Surgery on site to obviate the need for transfer of critically injured patients out of the hospital. Augmentation of Ireland's rehabilitation services to ensure maximum recovery of patients is also essential; otherwise any benefits that might accrue from better initial care will be negated.

## Overview

This paper relates to the initial management of the victim of major trauma and the networked management of victims of lower level trauma. It describes in detail the justification for the formal establishment of trauma networks, how trauma care is delivered internationally, the known benefits and the crucial need for on-going audit of outcomes from the entire network as well as individual units. Whilst some initial investment will be necessary, it is likely that once a steady state of service delivery is achieved, the introduction of trauma networks will be shown to reduce the total cost of

---

<sup>3</sup> Regional trauma systems - Interim guidance for Commissioners. The Intercollegiate Group on Trauma Standards. December 2009  
[https://www.rcseng.ac.uk/news/docs/Regional\\_trauma\\_systems.pdf](https://www.rcseng.ac.uk/news/docs/Regional_trauma_systems.pdf)

the management of trauma in Ireland. Suboptimal management of trauma results in greater on-going costs to the health system and society at large, as patients require health services for longer and may fail to return to work. Good care can cost less. Our patients deserve optimal care, society deserves that this is provided as efficiently as possible.

**Note on nomenclature**

*By convention and to avoid confusion, this paper will use equivalent Irish nomenclature to describe the components of and contributors to international trauma systems.*

# 1. Introduction

## 1.1 Background

The development of Trauma Networks in England and the associated 30% increase in odds of survival suggest that the development of Trauma Networks in a population such as ours could prevent one avoidable death per fortnight and that two patients per week could be saved from severe disability. Their Trauma Network aims to provide a comprehensive system of specialist care for people who have suffered serious injury (major trauma) through the delivery of a regional trauma network. In so doing they have seen a dramatic reduction in preventable deaths and improved functional outcome as well as better health and psychological wellbeing in those who survive. The components of their approach are:

- A system of initial triage to enable conveyance by the local ambulance service to the most appropriate destination according to agreed criteria;
- Networked Trauma Units (TUs); linked into
- Major Trauma Centres (MTCs), working with Acute Hospitals, local general rehabilitation services and specialist rehabilitation providers:
- Services for children provided at a children's MTC or in a combined adult/children's MTC;
- Monitoring of the system through robust major trauma audit to ensure quality and continuous quality improvement.

The Irish Association for Emergency Medicine and others have advocated for the re-organisation of trauma services for many years. As frontline providers, Consultants in Emergency Medicine recognise the inadequacies of current trauma service arrangements where, all too often, major trauma patients are brought to hospitals with inadequate resources and expertise to deliver safe, high quality trauma care. In the current situation, even large university hospitals have systems of managing the multiply injured patient that compare poorly with contemporary international standards in trauma care and access to definitive care does not compare well with 'gold standard' trauma systems<sup>4</sup>.

International research and education, including initiatives such as the Advanced Trauma Life Support (ATLS) programme, have resulted in improved outcomes for injured patients and have transformed the delivery of modern trauma care<sup>5,6</sup>.

## 1.2 Financial Incentives

We currently have a unique opportunity to ensure that funding for trauma care in Ireland is included in the development of future health system funding models. Hospitals should not incur a financial

---

<sup>4</sup> Scallan E, Staines A, Fitzpatrick P, Laffoy M, Kelly A. Unintentional injury in Ireland: a comparison of mortality and morbidity data. *Journal of Public Health* 2004;26:6-7.

<sup>5</sup> Towards Trauma 2014: Review and future directions of the Victorian State Trauma System, Australia, February 2009. Available at: [http://www.health.vic.gov.au/trauma/publications/trauma\\_towards\\_2014.pdf](http://www.health.vic.gov.au/trauma/publications/trauma_towards_2014.pdf).

<sup>6</sup> NHS Clinical Advisory Groups Report: Regional Networks for Major Trauma, September 2010:371-378. Available at: [http://www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Dearcolleagueletters/DH\\_120048\\_Accessed\\_20\\_Oct\\_2014](http://www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Dearcolleagueletters/DH_120048_Accessed_20_Oct_2014)

loss in attempting to provide excellence in trauma care. The funding of trauma care should promote best practice across the entire spectrum from high-complexity, high-acuity major trauma through to rehabilitative and community care. Funding models also need to include pre-hospital care and retrieval systems. High volume, low-acuity, ambulatory trauma care also needs a fit-for-purpose funding model to incentivise the management of as many patients as possible without in-patient admission. The effectiveness of the system must be measured through a trauma registry/audit that measures not just processes of care and mortality but also functional and quality of life outcomes. Good trauma care giving the best functional outcomes results in a cost benefit to society with more productive life years saved than for any other medical condition <sup>7</sup>.

### 1.3 The Burden of Trauma

Globally, trauma is the leading cause of death for individuals aged between 5 and 44 years<sup>8</sup>. In the European Union, injury represents the fourth<sup>6</sup> and in Ireland the third leading cause of death<sup>9</sup> and account for at least 8.5% of admissions to hospitals<sup>10</sup>. Injuries are the leading cause of death among young people in Ireland, causing 44.3% of deaths in 5-14 year olds and 70.0% of deaths in 15-24 year olds<sup>11</sup>.

### 1.4 A Trauma System, not just Major Trauma Centres

A trauma system includes all components of trauma care from injury to recovery, including prevention; access; pre-hospital care and transportation; emergency and acute hospital care; rehabilitation and research activities. The planning of systems for trauma management includes regional designation of those hospitals able to fulfil the roles of trauma centres at varying levels of complexity; ranging from large urban trauma centres to smaller rural hospitals and local injury units. It also implies the planning of mobile emergency medical services, pre-hospital triage (to determine which patients should go to which types of designated facilities), transfer criteria and transfer arrangements between hospitals<sup>12,13</sup>. This all-encompassing approach is referred to as an inclusive trauma system. It is imperative that the various levels of trauma centres/units cooperate in the care of injured patients to ensure that precious healthcare resources are used as effectively as possible. The treatment of critically ill patients with multiple injuries requires expert, multidisciplinary, high-cost, coordinated and timely interventions<sup>14,15,16</sup>.

---

<sup>7</sup> Faul M, Wald MM, Rutland-Brown W, Sullivent EE, Sattin RW. Using a cost-benefit analysis to estimate outcomes of a clinical treatment guideline: testing the Brain Trauma Foundation guidelines for the treatment of severe traumatic brain injury. *J Trauma*. 2007 Dec; 63(6):1271-8. doi: 10.1097/TA.0b013e3181493080.

<sup>8</sup> Sethi D, Racioppi F, Frerick B, Frempong N. Progress in Preventing Injuries in the WHO Region: Implementing the WHO Regional Committee for Europe resolution EUR/RC55/R9 on prevention of injuries in the WHO European Region and Recommendation of the Council of the European Union on the prevention of injury and promotion of safety. Rome: World Health Organization, 2008.

<sup>9</sup> Scallan E, Staines A, Fitzpatrick P, Laffoy M, Kelly A. Injury in Ireland. Dept. of Public Health Medicine and Epidemiology. Dublin: University College Dublin, 2001

<sup>10</sup> Scallan E, Staines A, Fitzpatrick P, Laffoy M, Kelly A. Unintentional injury in Ireland: a comparison of mortality and morbidity data. *Journal of Public Health*. 2004;26:6-7

<sup>11</sup> Boland M, Staines A, Fitzpatrick P, Scallan E. Urban-rural variation in mortality and hospital admission rates for unintentional injury in Ireland. *Inj Prev*. 2005;11:38-42.

<sup>12</sup> Nathens AB, Jurkovich GJ, Maler RV et al. Relationship between trauma centre volume and outcomes. *JAMA* 2001; 285: 1164-71

<sup>13</sup> MacKenzie EJ et al. A national evaluation of the effect of trauma centre care on mortality. *NEJM* 2006; 354: 366- 378.

<sup>14</sup> Towards Trauma 2014: Review and future directions of the Victorian State Trauma System, Australia, February 2009. Available at:

[http://www.health.vic.gov.au/trauma/publications/trauma\\_towards\\_2014.pdf](http://www.health.vic.gov.au/trauma/publications/trauma_towards_2014.pdf)

<sup>15</sup> NHS Clinical Advisory Groups Report: Regional Networks for Major Trauma, September

2010:371-378. Available at: [http://www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Dearcolleagueletters/DH\\_120048](http://www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Dearcolleagueletters/DH_120048). Accessed 20 Oct 2014

<sup>16</sup> Resources for the Optimal Management of the Injured Patient 2014. Committee on Trauma, American College of Surgeons.

<https://www.facs.org/~media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.aspx>



## 1.5 Trauma Epidemiology

Demonstrating a survival advantage attributable to treatment at a Major Trauma Centre (MTC) may be difficult because in a mature trauma system with adequate triage, delivery of seriously injured patients to MTCs means that the patients with the greatest risk of dying will be clustered in these centres<sup>17</sup>. It would not be unexpected to observe an increased or unchanged mortality risk in MTCs in a mature system<sup>18,19,20,21</sup>. In addition, a halo effect may be seen with the maturation of a trauma system; this effect results in improved survival of injured patients system-wide regardless of whether they are treated at a MTC or not<sup>22</sup>. It is key therefore that the audit outcomes for the whole system are measured and compared, as distinct from the audit outcomes for individual MTCs and units alone. This phenomenon notwithstanding, it has been shown that high volume trauma centres provide better care than other centres<sup>23,24,25</sup> and that severely injured patients are 15-20% less likely to die if admitted to such an MTC than if admitted to other hospitals<sup>26</sup>. The evidence in favour of high volume trauma centres is growing though research data should be interpreted with caution, as noted earlier. Few individual facilities however can provide all care to all patients in all situations – over-reliance on a small number of MTCs might result in these centres being overburdened with large numbers of patients who do not need high complexity care and lead to unnecessarily prolonged travel times for patients. This reality mandates the development of a trauma system of care as well as developing trauma centres.

## 1.6 The Reorganisation of Trauma Services

The regional reconfiguration of trauma services allows the concentration of the most seriously injured patients who account for a small proportion of all trauma patients to a limited number of centres, facilitating the development of expertise by the centres. This ensures that all the staff, facilities, equipment and expertise to manage patients with challenging injuries are immediately available. Sustainable rotas that ensure better availability of Consultants and other expert staff at all times are more easily deliverable in such centres. The concentration of major trauma in fewer designated centres gives an opportunity to increase audit activity, quality control, quality improvement and also facilitates research. This is a more efficient use of limited resources and the societal cost of such a system is favourable<sup>27</sup>.

---

<sup>17</sup> Flint L, Orban B, Durham R, et al. A comprehensive assessment of the Florida trauma system. Accessed on October 27, 2005.

<sup>18</sup> Clark D, Anderson K, Hahn D. Evaluating an inclusive trauma system using linked population-based data. *J Trauma*. 2004;57:501–509.

<sup>19</sup> Reilly J, Chin B, Berkowitz J. Use of a state-wide administrative database in assessing a regional trauma system: the New York City experience. *J Am Coll Surg*. 2004;198:509–518.

<sup>20</sup> Clark D. Trauma system evaluation using the fatality analysis reporting system. *J Trauma*. 2003;54:1199–1204.

<sup>21</sup> Rogers F, Osler T, Shackford S, et al. Population-based study of hospital trauma care in a rural state without a formal trauma system. *J Trauma*. 2001;50:409–414.

<sup>22</sup> Barquist E, Prizzutiello M, Tian L, et al. Effect of trauma system maturation on mortality rates in patients with blunt injuries in the Finger Lakes region of New York State. *J Trauma*. 2000;49:63–70.

<sup>23</sup> Cooper G, Laskowski-Jones L. Development of trauma care systems. *Prehosp Emerg Care* 2006; 10: 328-331.

<sup>24</sup> Liberman M, Mulder D, Jurkovich G, Sampalis J. The association between trauma system and trauma centre components and outcome in a mature regionalized trauma system. *Surgery* 2005; 137: 647-658.

<sup>25</sup> Mullins R. A historical perspective of trauma system development in the United States. *J Trauma* 1999; 47 (3 Suppl): S8-S14.

<sup>26</sup> Celso B et al. A systematic review and meta-analysis comparing outcome of severely injured patients treated in trauma centres following the establishment of trauma systems. *J Trauma* 2006;60:371-378.

<sup>27</sup> Durham R, Pracht E, Orban B, Lottenburg L, Tepas J, Flint L. Evaluation of a mature trauma system. *Ann Surg*. 2006; 243(6):775-83.

## International Trauma Systems

An overview of leading international trauma systems offers models of care that might be adapted for the Irish health system.

### 2. The US Model

While the American model is the oldest of such models, it is the least likely to be applicable to Ireland. The American College of Surgeons Committee on Trauma (ACS-COT) provide a template description of 4 levels of trauma receiving units from level I, designed to deal with the most complex multiply injured patients through level IV, designed to deal with minor injury but being seamlessly integrated so the expertise in the level I centre can be accessed.

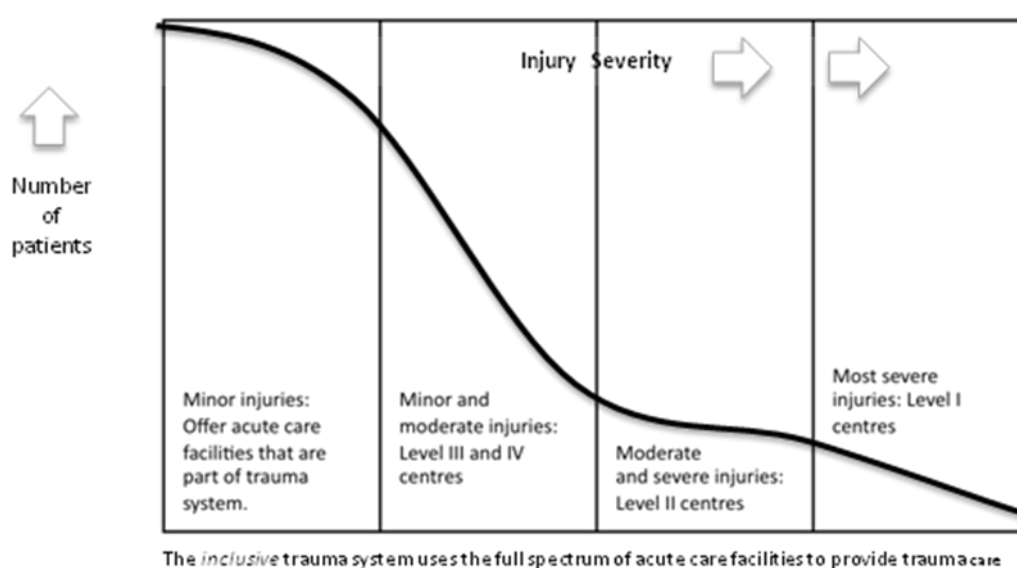


Figure 1: A diagrammatic representation of an inclusive trauma system

To ensure adequate experience and expertise, the Level I centre requires a certain volume of injured patients to be admitted each year, including the most severely injured. In addition, certain injuries that occur infrequently are concentrated there to ensure that these patients are properly treated; that high quality trauma research can be undertaken to drive further improvement and to support the required training programmes for future trauma care providers<sup>28,29</sup>. ACS-COT requires that a Level I trauma centre admit at least 1,200 trauma patients annually or have 240 admissions with an Injury Severity Score of more than 15 (i.e. major trauma patients). All patients who require the resources of the Level I centre should have access to it, either directly or through efficient transfer processes. This facility must have the capability of providing leadership and total care for every aspect of injury. The hospital should provide medical education programmes including

<sup>28</sup> Bennett KM, Vaslef S, Pappas TN, Scarborough JE. The volume-outcomes relationship for United States Level I trauma centres. *J Surg Res*. 2011;167(1):19-23.

<sup>29</sup> Marx WH, Simon R, O'Neill P, et al. The relationship between annual hospital volume of trauma patients and in-hospital mortality in New York State. *J Trauma*. 2011;71(2):339-345.

training programmes, post-graduate fellowships, exchange programmes, joint appointments and other approaches appropriate to the local situation. It should serve as a comprehensive resource for all healthcare organisations dealing with injured patients in the system's catchment area<sup>30</sup>.

The Level II trauma centre provides initial definitive trauma care, regardless of the severity of injury. Level I and Level II trauma centres are clinically equivalent except that Level I centres have the capacity to manage more complex, specialised injuries such as complex pelvic injuries, replantations etc. Level II trauma centres may be the most prevalent facility in a community and manage the majority of trauma patients. Level II trauma centres should not interfere with the flow of patients to Level I centres and patients meeting major trauma triage criteria should be transported to the highest available level of care that is within 45 minutes transport time by road or air. For a centre to achieve level II status, ACS-COT dictates that Neurosurgical care must be continuously available and must be present within 30 minutes. In Ireland neurosurgical care is available in – Beaumont Hospital, Dublin; Cork University Hospital and the Children's University Hospital, Temple St, Dublin. The Royal Victoria Hospital, Belfast provides neurosurgical services for Northern Ireland.

Level III trauma centre serves communities that do not have immediate access to a Level I or II institution. Level III centres can provide prompt assessment, resuscitation, emergency operative intervention and stabilisation and arrange for transfer to a facility that can provide definitive trauma care when needed. Trained Emergency Medicine specialists and general surgeons are required in a Level III facility. Care of injured patients in these hospitals requires transfer agreements and standardized treatment protocols and participation in the larger regional trauma system is essential. Given the large distances between urban centres in the USA, level IV trauma facilities provide advanced trauma life support before patient transfer in remote areas where no higher level of care is available. A well-trained doctor must be continually available. Level IV trauma facilities should be an integral part of the inclusive trauma care system.

---

<sup>30</sup> Resources for the Optimal Management of the Injured Patient 2014. Committee on Trauma, American College of Surgeons.  
<https://www.facs.org/-/media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.ashx>

## 2.1. The American Model of Major Trauma Centres<sup>9</sup>

### **Level I Trauma Centre Requirements:**

- On site trauma surgeon;
- On site Emergency Medicine specialist;
- On site Radiologist;
- On site Anaesthetist;
- Trauma Medical Director (Trauma Surgeon);
- Emergency Medicine Medical Director;
- Trauma Programme Manager (Senior Nurse);
- 24 hour CT availability;
- 24 hour equipped and staffed Operating Suite with immediate availability of a second operating theatre;
- Trauma intensive care facilities for adult and paediatric patients;
- Trained trauma team
  - At least 1 Trauma Surgeon (as team leader)
  - At least 1 Emergency Medicine Specialist;
  - At least 2 trained trauma nurses.
- A dedicated resuscitation suite capable of managing two simultaneously multi-system injured patients;
- 24 hour laboratory facilities;
- Protocol for on-site burn care;
- Rehabilitation facilities;
- Helicopter landing pad on site close to the Emergency Department;
- Paediatric resuscitation facilities, personnel and intensive care unit;
- Administrative facilities;
- Research facilities;
- Ambulance Service facilities.

### **Level II Trauma Centre Requirements:**

Requirements are the same as for Level I, except that the requirements for on-site and on-call specialists vary. Level II facilities are not required to have neurosurgeons/trauma surgeons on-site but must have them able to attend within 30 minutes.

## **3. The UK and Australian Models**

The UK trauma system has adapted a more straightforward approach defining two levels of care, namely Major Trauma Centres and Trauma Units and integrating such centres into Trauma Networks. Eighty percent of major trauma care in Victoria, Australia is delivered in two adult and

one paediatric MTC Patients meeting trauma triage criteria are brought preferentially to these centres if they can be reached within a 45-minute transport time. If the transport time is likely to be longer than this, the patient is brought to a Metropolitan Trauma Services (MeTS) unit where trauma patients will be stabilised with early transfer to the MTC and definitive treatment is provided for a very limited number of major trauma cases under defined conditions. Metropolitan Trauma Services (MeTS) are primarily responsible for trauma patient care that does not meet major trauma criteria.

### 3.1 Major Trauma Centre

A MTC (adult, child or combined) has all the facilities and specialties required to be able to treat patients with any type of injury in any combination. In the UK, elements of the service considered necessary to manage these patients include:

#### *Emergency Care and Surgery*

- 24/7 Consultant availability on-site to lead the trauma team;
- Appropriately trained trauma team present 24 hours a day for immediate reception of the patient;
- Ability to undertake resuscitative thoracotomy in the Emergency Department;
- A massive haemorrhage protocol in place for patients with severe blood loss and transfusion specialist advice available 24 hours a day;
- 24/7 immediate availability of fully staffed operating theatres;
- Consultant delivered surgical decision making with emergency trauma surgery undertaken or directly supervised by Consultants;
- Consultants are available within 30 minutes in the following specialties: Neurosurgery; Spinal Surgery; Vascular surgery; General surgery (adult or paediatric); Trauma and Orthopaedic surgery; Cardiothoracic surgery; Plastic surgery; Maxillofacial surgery; Ear, Nose and Throat surgery; Anaesthetics; Interventional Radiology and Critical care.

### 3.2 Hybrid facilities

Many Major Trauma Centres around the world are now building 'hybrid facilities.' This describes an area where the unstable patient can be brought directly from the scene of the trauma that allows assessment, resuscitation, CT angiography, interventional radiology and operative resuscitation, be that a thoracotomy or a laparotomy or C clamp of the pelvis to be performed without moving the patient further<sup>31</sup>.

---

<sup>31</sup> Kirkpatrick AW, Vis C, Dubé M, Biesbroek S, Ball CG, Laberge J, Shultz J, Rea K, Sadler D, Holcomb JB, Kortbeek J. The evolution of a purpose designed hybrid trauma operating room from the trauma service perspective: The RAPTOR (resuscitation with angiography percutaneous treatments and operative resuscitations). *Injury*. 2014 Sep;45(9):1413-21

### 3.3 Diagnostics and Radiology:

Immediate (ideally within 30 and no later than 60 minutes) access to CT scanning and appropriate reporting within 60 minutes of scan. The closer the CT is located to the trauma room, the better the probability of survival. Distances of more than 50m had a significant negative effect on the outcome. If new emergency departments are planned or rebuilt, the CT scanner should be placed less than 50m away from or preferably in the trauma room<sup>32</sup>. There should be availability of interventional radiology within 60 minutes of referral.

### 3.4 On-going Care:

Requirements for on-going care include:

- Immediate access to critical care or high dependency care (adult or paediatric) when required;
- A defined team that takes responsibility for ensuring the complex medical needs of the polytrauma patient are addressed efficiently in a co-ordinated manner<sup>25,26,27</sup>;
- Specialist nursing and allied health professionals;
- Access to supporting services including Pain Management, Rehabilitation Medicine Neuropsychology and Neuropsychiatry (including management of disturbed behaviour);
- A defined ward for major trauma patients for with disability<sup>26,27</sup>;
- A nursing team able to facilitate patient independence in functional activities, as advised by the rehabilitation team.

### 3.5 Acute/Early Phase Rehabilitation:

- Assessment within 72 hours by a Consultant in Rehabilitation Medicine or specialist with equivalent competencies;
- A multi-disciplinary team including rehabilitation nurses, Allied Health Professionals and a Consultant in Rehabilitation Medicine under whose care all patients needing rehabilitation are managed.

### 3.6 Network Delivery:

- Provision of clinical advice to other providers within the network;
- Prompt transfer of major trauma patients admitted to a Trauma Unit but require definitive care at the MTC. Complex injuries that require MTC intervention such as complex pelvic fractures etc should be transferred within 48 hours.

---

<sup>32</sup> Huber-Wagner S, Mand C, Ruchholtz S, Kühne CA, Holzapfel K, Kanz KG, van Griensven M, Biberthaler P, Lefering R; TraumaRegister DGU. Effect of the localisation of the CT scanner during trauma resuscitation on survival-Aretrospective, multicentre study. *Injury*. 2014 Oct;45 Suppl 3:S76-82. doi: 10.1016/j.injury.2014.08.022.

### 3.7 Co-located Services:

<b>SPECIALTY SERVICES FOR MAJOR TRAUMA CENTRES</b>
Emergency Medicine
Radiology
Interventional Radiology
Neurosurgery
Anaesthetics
Intensive Care
Theatres
General Surgery
Vascular Surgery
Trauma and Orthopaedic Surgery
Cardiothoracic Surgery
Spinal Cord Injury Services (acute)
Plastic Surgery
Maxillofacial Surgery
Ear nose and throat surgery
Transfusion Services
Pathology services
Acute/Early Phase Rehabilitation Services
Clinical Psychology
Organ Donation

*Table 1: Co-located services for Major Trauma Centres*

### 3.8 Trauma Unit

In the UK model, the role of a Trauma Unit (TU) in each region is to accept and manage, at any time, arrival of patients from the following groups:

- Those considered to have injuries not requiring expertise of the MTC;
- Those critically injured for whom direct transfer to MTC could adversely affect outcome (with subsequent plans to transfer);
- Those who cannot reach a MTC within 45 minutes.

A TU may be the primary receiving unit for seriously injured patients too unstable to cope with a 45-minute transfer to the MTC. These patients are resuscitated prior to transfer to the MTC. A TU may also receive local trauma patients with less serious injuries including simple fractures of one limb, lacerations and minor head injuries.

#### *Key elements of a Trauma Unit:*

- A trauma team which includes:
  - A trauma team leader of an agreed level of seniority and training;
  - An airway competent doctor;
  - A doctor capable of recognising patients who require damage control surgery and can deliver this in line with network protocols;
  - Senior nursing staff.
- Network secondary transfer protocols agreed with the MTC and Ambulance Service;
- Consultant in Emergency Medicine and Consultant Surgeon on call 24/7 ;
- Immediate (within 30-60 minutes) access to CT scanning and appropriate reporting within 60 minutes of referral;
- 24/7 access to Operating Theatre;
- Access to critical care or high dependency care when required;
- Protocols for accepting patients back from the MTC;
- A rehabilitation service.

## **4. Trauma Triage**

A system of triage (clinical prioritisation) is used by pre-hospital providers to identify those patients who are most likely to have sustained major trauma. Patients with suspected major trauma are taken directly to an MTC where travel times are within 45 minutes or if travel times exceed this, to the nearest TU for rapid stabilisation and subsequent transfer to the MTC if the complexity of their injuries exceeds the capability of the trauma unit. Pre-hospital providers alert the hospital in advance of arriving there to facilitate an alert to all whose services are required, including the



trauma team, laboratories, theatre manager, CT Radiologist etc<sup>33</sup>. Patients who have been incorrectly triaged or have self-presented at a TU with serious injury which exceeds the resources and capability of the TU will be rapidly transferred to an MTC. In addition, some patients will need treatment in the MTC (e.g. complex pelvic fracture surgery) that will require transfer within 48 hours of injury.

#### 4.1 London Ambulance Service Triage Rule<sup>34</sup>

The London Ambulance Service uses the following criteria to decide the destination of trauma patients:

<b>Positive</b> (bypass to Trauma Centre)	<b>Negative</b> (divert to non-specialist hospital)
Vital signs: GCS≤13; SBP <90; RR< 10,>29	Vital signs: GCS>13; SBP> 90; RR>8,< 30
OR	AND
Anatomy: Chest injury with altered physiology; traumatic amputation proximal to wrist/ankle; penetrating trauma to neck, chest, abdomen, back or groin; suspected open/depressed skull fracture; suspected pelvic fracture; spinal trauma suggested by abnormal neurology; trauma with facial/circumferential burns, >20% burns.	Anatomy: <b>No</b> chest injury with altered physiology; traumatic amputation proximal to wrist/ankle; penetrating trauma to neck, chest, abdomen, back or groin; suspected open/depressed skull fracture; suspected pelvic fracture; spinal trauma suggested by abnormal neurology; trauma with facial/circumferential burns, >20% burns.
OR	AND
Injury mechanism*: Traumatic death in same passenger compartment; fall >20 feet; trapped under vehicle; bulls eye windscreen; damage to vehicle "A" post.	Injury mechanism*: <b>No</b> traumatic death in same passenger compartment; fall >20 feet; trapped under vehicle; bulls eye windscreen; damage to vehicle "A" post.
OR	AND
Special considerations*: Aged >55 years; pregnant >20 weeks; bleeding disorder; morbidly obese.	Special considerations*: <b>Not</b> aged >55 years; pregnant >20 weeks; bleeding disorder; morbidly obese.
AND	OR
No airway obstruction	Presence of airway obstruction
*Injury mechanism and special considerations are discretionary domains to guide bypass decisions. NHS LS, Head Injury Transportation Straight to Neurosurgery study: LAS, London Ambulance Service	

Table 2: London Ambulance Service Triage Rule

<sup>33</sup> NHS Clinical Advisory Groups Report: Regional Networks for Major Trauma, September 2010:371-378. Available at: [http://www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Dearcolleagueletters/DH\\_120048](http://www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Dearcolleagueletters/DH_120048). Accessed 20 Oct 2014

<sup>34</sup> Sasser SM, Hunt RC, Faul M, Sugerman D, Pearson WS, Dulski T, Wald MM, Jurkovich GJ, Newgard CD, Lerner EB; Centres for Disease Control and Prevention (CDC). Guidelines for field triage of injured patients: recommendations of the National Expert Panel on Field Triage, 2011. MMWR Recomm Rep. 2012 Jan 13;61(RR-1):1-20.

## 4.2 US Guidelines for field triage of injured patients – CDC<sup>35</sup>

US guidelines for pre-hospital trauma triage are outlined in the following algorithm.

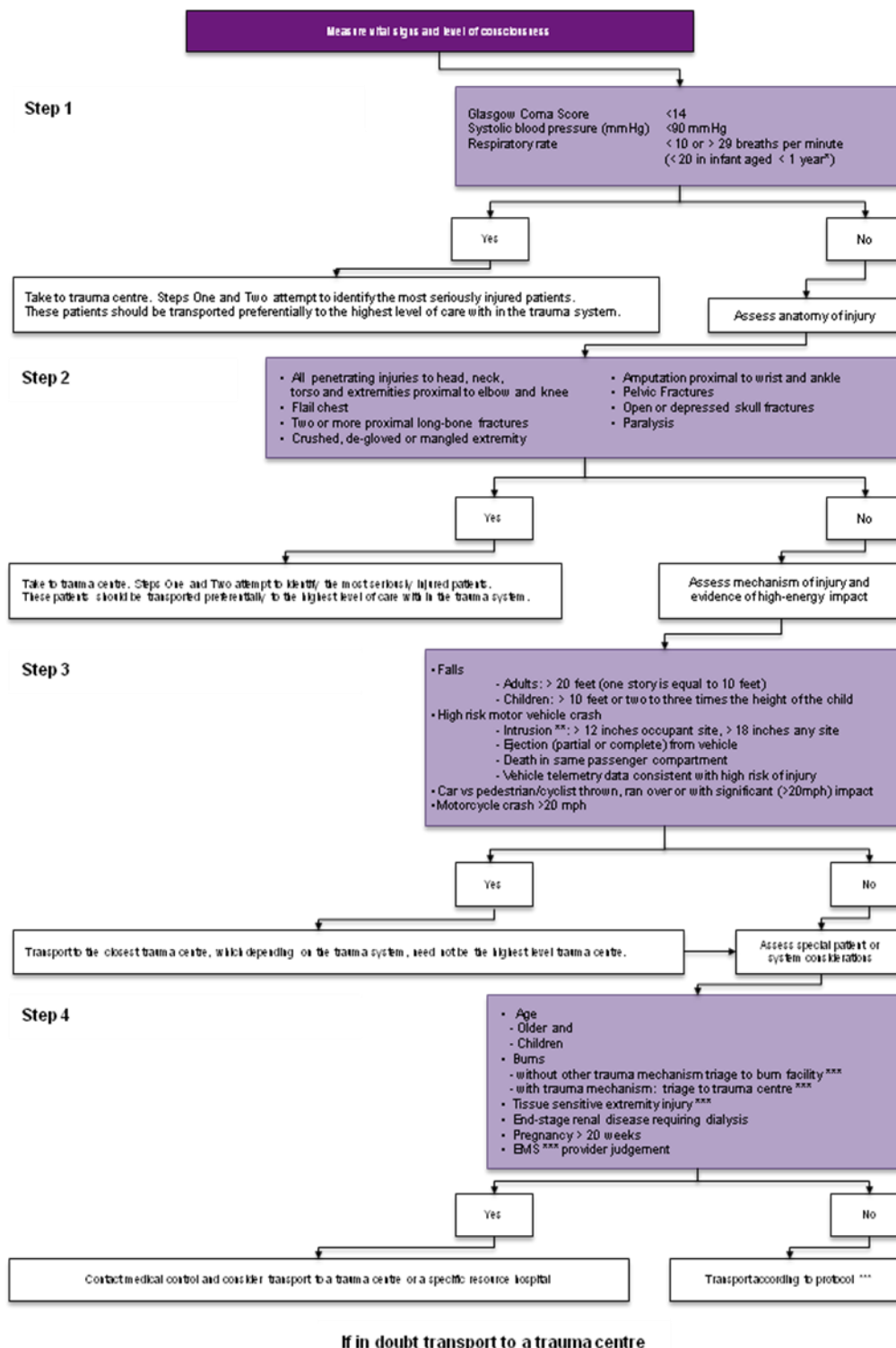


Figure 2: US pre-hospital trauma triage

<sup>35</sup> Fuller G, Lawrence T, Woodford M, Lecky F. The accuracy of alternative triage rules for identification of significant traumatic brain injury: a diagnostic cohort study. Emerg Med J. 2014 Nov;31(11):914-9.

### 4.3 Over-triage and Under-triage

The goal of the pre-hospital trauma system is getting the right patient to the right place at the right time. Lack of clear criteria may result in over-triage (where minimally injured patients are transported to higher-level trauma centres) or under-triage (where severely injured patients are transported to lower-level centres). In general, priority has been given to reduction of under-triage as under triage may result in preventable mortality or morbidity from delays in definitive care. Although over-triage has minimal adverse patient consequences, it results in excessive costs and a greater burden for higher-level trauma centres as well as inconvenience to families of patients. In mass casualty incidents, over-triage can adversely affect patient care and survival and should be minimized. Rigorous multidisciplinary performance improvement is essential to evaluate over-triage and under-triage rates, to attain the optimal goal of <5% under-triage<sup>36</sup>. This level will neither overburden the receiving trauma centres with minimally injured patients nor unnecessarily transport minimally injured patients long distances.

## 5. Pre-Hospital Care

### 5.1 National Ambulance Service

Reconfiguration of major trauma management has significant operational and clinical implications for the National Ambulance Centre (NAS) which will be required to convey the patient longer distances and safely manage the patient until handover at the trauma centre. Pre-alert of the receiving unit should cascade a chain of preparedness for the impending arrival.

Forty-five minutes is the widely accepted travel time within which a patient with major trauma should be transferred to the MTC unless the patient is too unstable and requires immediate optimisation at a TU prior to a secondary transfer to the MTC. Secondary transfers from a TU to a MTC should occur within an hour of the request for transfer to minimise the patient's time from injury to accessing definitive treatment.

Ambulance service response time standards also apply to the trauma care system in the UK include:

- Arrival at the scene of a Category A (immediately life-threatening) incident within 8 minutes;
- Arrival of a vehicle able to convey at the scene of a Category A incident within 19 minutes;
- Transfer within an hour of request for critical transfer from a TU to an MTC.

### 5.2 Air Transportation

Aero-medical transportation is an important method of rapidly transporting injured patients from the scene or the transferring facility to a trauma centre. The medical flight crew should have a structured aero-medical educational curriculum and an ongoing performance improvement

---

<sup>36</sup> Resources for the Optimal Management of the Injured Patient 2014. Committee on Trauma, American College of Surgeons.  
<https://www.facs.org/-/media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.ashx>

programme integrated with the trauma system performance improvement programme<sup>37</sup>. The cost effectiveness of doctor staffed Helicopter Emergency Medical Service (HEMS) is controversial with certain jurisdictions opting for a paramedic-staffed model<sup>38</sup>. The ability of the flight clinician, whether a doctor or paramedic, to safely perform advanced trauma care including rapid sequence intubation and ventilation is important if a patient is being transported by air to definitive care at a trauma centre. In Victoria, Australia flight paramedics are trained to perform all trauma procedures including rapid sequence intubation and ventilation and the published literature is favourable<sup>39</sup>. Ireland, in a unique partnership between the Health Service Executive, Department of Defence and the Air Corps, has an advanced paramedic staffed helicopter EMS stationed in Athlone operational during day time hours.

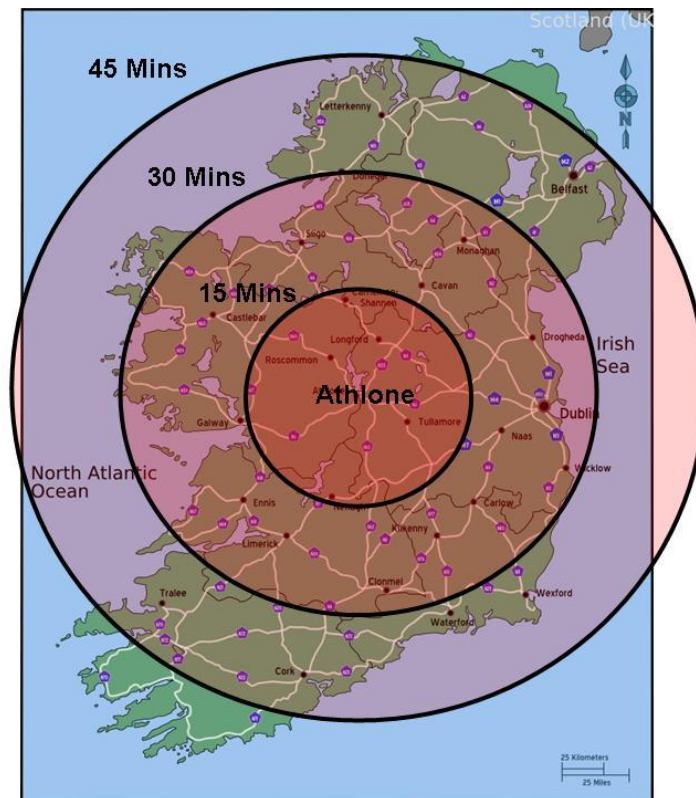


Figure 3: One-way flight times and ranges of Medivac 112 Helicopter EMS based at Custume Barracks, Athlone, Co. Westmeath.

<sup>37</sup> Resources for the Optimal Management of the Injured Patient 2014. Committee on Trauma, American College of Surgeons.

<https://www.facs.org/~media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.ashx>

<sup>38</sup> Taylor C, Jan S, Curtis K, Tzannes A, Li Q, Palmer C, Dickson C, Myburgh J. The cost-effectiveness of physician staffed Helicopter Emergency Medical Service (HEMS) transport to a major trauma centre in NSW, Australia. *Injury*. 2012 Nov;43(11):1843-9. doi: 10.1016/j.injury.2012.07.184. Epub 2012 Aug 13. Review.

<sup>39</sup> Bernard SA, Nguyen V, Cameron P, Masci K, Fitzgerald M, Cooper DJ, Walker T, Std BP, Myles P, Murray L, David, Taylor, Smith K, Patrick I, Edington J, Bacon A, Rosenfeld JV, Judson R. Pre-hospital rapid sequence intubation improves functional outcome for patients with severe traumatic brain injury: a randomized controlled trial. *Ann Surg*. 2010 Dec;252(6):959-65.

## 6. The Trauma Reception and Resuscitation Team

The size and composition of the team may vary with hospital size, the severity of injury and the corresponding level of trauma team activation. A high-level response to a severely injured patient usually includes the following<sup>40</sup>:

1. Specialist in Emergency Medicine;
2. General Surgeon;
3. Anaesthetist;
4. Surgical and Emergency Medicine Registrars;
5. Emergency Department nurses;
6. Laboratory technician;
7. Radiographer;
8. Radiologist;
9. Critical care trained nurse;
10. Operating Theatre nurse;
11. Security officers;
12. Chaplain or social worker;
13. Scribe.

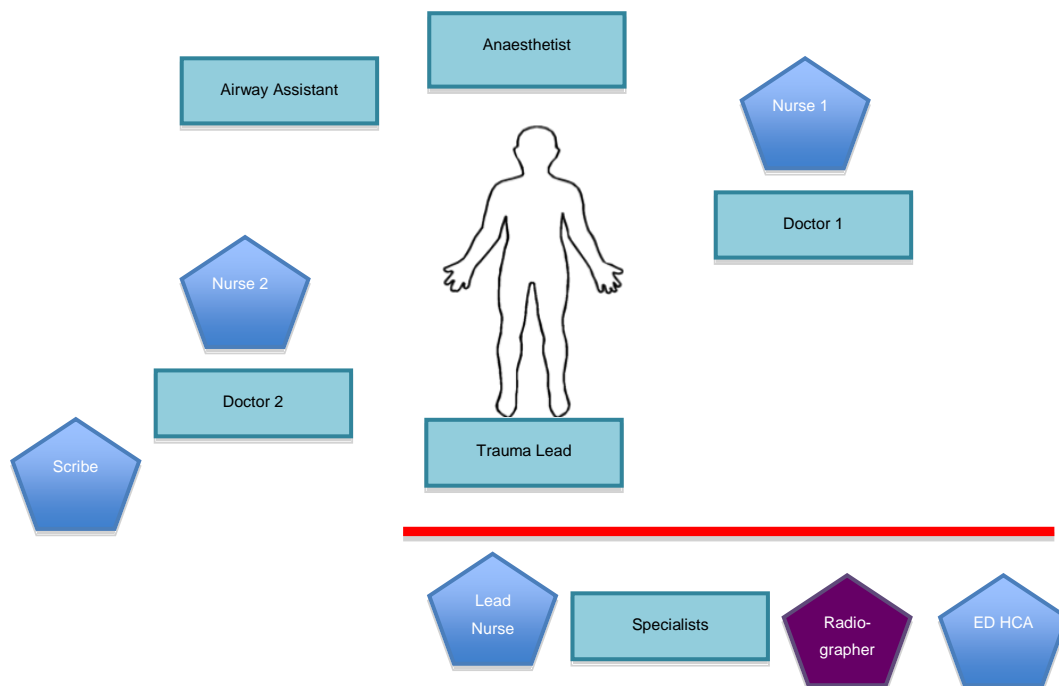


Figure 4: Membership and organisation of the trauma team in the Resuscitation Room

<sup>40</sup> Resources for the Optimal Management of the Injured Patient 2014. Committee on Trauma, American College of Surgeons.  
<https://www.facs.org/-/media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.ashx>

## 7. Clinical Functions of Services Contributing to Trauma Care

### 7.1 Emergency Medicine

In the UK and Australian models, the Consultant in Emergency Medicine is the trauma team leader for the reception and resuscitation component of the patient journey. He/she is familiar with the working environment and the staff of the receiving ED and assumes a natural team leadership role. In both Australia and the UK, designating a hospital a trauma centre has resulted in funding to extend Consultant in Emergency Medicine shop floor presence. This has had a wider positive effect with the increase in senior clinical decision making available within the ED when not team leading a trauma resuscitation<sup>41,42</sup>.

### 7.2 General Surgery

The specialty of acute care surgery (trauma, emergency general surgery, surgical critical care) is developing and evolving. ACS-COT recognizes that the general surgeon on call for trauma may also provide care for patients who present with urgent and emergent surgical problems. General surgeons on call for trauma are encouraged to participate in these important aspects of surgical care. The operative treatment of patients with such conditions serves to maintain and enhance the essential skills required for high-quality trauma care<sup>43,44,45,46</sup>.

### 7.3 Neurosurgery

Traumatic brain injury (TBI) accounts for almost 40% of all deaths from acute trauma, occurring at a rate of 150 cases/100,000 population/year. The incidence of spinal cord injury is 40/million population/year with significant disabling neurologic sequelae in more than 50% of cases.

There has been a significant decline in TBI mortality during the past three decades as the understanding and management of secondary brain injury has improved. Neurotrauma specialist care must be continuously available for all TBI and spinal cord injury patients and must be present and respond within 30 minutes<sup>47</sup>.

Before an organized trauma system existed in England and Wales, the severely injured patient with an associated head injury had an increased mortality compared with Victoria, which had an inclusive trauma system. After adjusting for age, gender, cause of injury, injury severity, Glasgow Coma Score and Injury Severity Score, patients from England and Wales had a 3.22 times greater likelihood of death compared with Victorian cases<sup>37</sup>.

---

<sup>41</sup> Gerardo CJ, Glickman SW, Vaslef SN, Chandra A, Pietrobbon R, Cairns CB. The rapid impact on mortality rates of a dedicated care team including trauma and emergency physicians at an academic medical centre. *J Emerg Med.* 2011;40(5):586-591.

<sup>42</sup> Grossman MD, Portner M, Hoey BA, Stehly CD, Schwab CW, Stoltzfus J. Emergency traumatologists as partners in trauma care: the future is now. *J Am Coll Surg.* 2009;208(4):503-509.

<sup>43</sup> Resources for the Optimal Management of the Injured Patient 2014. Committee on Trauma, American College of Surgeons.

<sup>44</sup> <https://www.facs.org/-/media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.ashx>

<sup>45</sup> Committee on Acute Care Surgery of the AAST. The acute care surgery curriculum. *J Trauma.* 2007;62(3):553-556.

<sup>46</sup> Committee to Develop the Reorganized Specialty of Trauma, Surgical Critical Care, and Emergency Surgery. Acute care surgery: trauma, critical care, and emergency surgery. *J Trauma.* 2005;58(3):614-616.

<sup>47</sup> Kashuk JL, Klein Y, Bacchus H, Kluger YS. Acute care surgery: what's in a name? A new specialty comes of age. *Isr Med Assoc J.* 2013;15(4):147-151.

<sup>47</sup> Ibid 39.

Recent UK guidance advises Consultant Neurosurgeons be available for consultation to the Trauma Network 24 hours a day and that patients with severe head or spinal cord injury be managed in a neurosciences centre, irrespective of the need for surgical intervention. Furthermore, patients requiring immediate neurosurgical intervention should have surgery within 2 hours of arrival in the MTC (or within 2 hours of deterioration) depending on the state of resuscitation, haemodynamic and coagulation status and management of other injuries.

#### 7.4 Orthopaedic Surgery

More than half of all hospitalized trauma patients have one or more musculoskeletal injuries that may be life or limb threatening or result in significant functional impairment. Patients with isolated simple fractures with low-grade soft tissue injuries are appropriately treated by orthopaedic surgeons in any well-equipped hospital committed to quality fracture care. Patients who have multiple fractures, fractures associated with multiple injuries, complex fractures (e.g. pelvic, acetabular, intra-articular and spinal column fractures) and high-grade soft tissue injuries should have care in the MTC. In the USA these patients would be treated in a Level I or II trauma centre<sup>48</sup>. The more complex the type and number of injuries, the more important the decision-making process becomes. For example, a patient with an unstable pelvic fracture with significant bleeding and likely intra-abdominal haemorrhage requires rapid and coordinated care by many specialty services. The team decides the priority of laparotomy; angiography and spinal, pelvic and long bone fracture stabilization. Experienced personnel in an MTC with the necessary resources best manage these patients. Musculoskeletal trauma usually requires a prolonged recovery phase because of the extended healing time of soft tissue and bony injuries. Early and continuing physical, psychological, and vocational rehabilitation maximizes functional and physiological outcomes for these patients.

Modern operative musculoskeletal injury care requires well-trained staff, a well-equipped hospital and a readily available operating theatre. Operating theatres must be promptly available to allow for emergency operative procedures such as open fracture debridement and stabilization, external fixator placement and compartment decompression, however the majority of surgical fracture care can be conducted on a semi urgent basis. It is therefore necessary to provide sufficient and timely operating theatre access for semi urgent surgical treatment of musculoskeletal injuries that do not require emergency care out-of-hours. The patient's journey to recovery begins once their operation has been performed.

#### 7.5 ICU Organization and Responsibility

Some controversy exists as to the optimal primary carer of the multiply injured trauma patient while in the Intensive Care Unit (ICU); the American College of Surgeons advises it be a surgeon while Nathens et al's<sup>49</sup> work has shown the positive impact of an Intensivist-model ICU on trauma-related mortality. In Ireland the model has generally been the Intensivist one.

---

<sup>48</sup> Resources for the Optimal Management of the Injured Patient 2014. Committee on Trauma, American College of Surgeons. <https://www.facs.org/-/media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.ashx>

<sup>49</sup> Nathens AB, Rivara FP, MacKenzie EJ, et al. The impact of an intensivist-model ICU on trauma-related mortality. *Ann Surg.* 2006;244:545-552.

## 7.6 Pain Management

Pain management of injured patients begins during the initial phases of care. Early fracture stabilization provides an effective method of providing pain relief during the acute phase of hospitalization. The use of advanced pain management techniques may help to improve a patient's respiratory mechanics and avoid intubation and therefore may dramatically alter the course of recovery<sup>50</sup>.

## 7.7 Care of Injured Children

Injury is the most significant cause of mortality in children over the age of 1. For injured children who survive, severe disability may be a lifelong problem requiring long-term care and further increasing the financial burden on society. Injured children require special resources in any trauma centre dedicated to their care.

The ACS-COT requires that a level I Paediatric Trauma Centre have a designated Trauma Service with a designated Director, two Consultant Paediatric Surgeons, one Consultant Paediatric Neurosurgeon, one Consultant Paediatric Orthopaedic surgeon, two Consultant Paediatric Intensivists and two Consultants in Paediatric Emergency Medicine on its staff. In the USA, a Level I paediatric trauma centre must admit 200 or more injured children younger than 15 years annually and a Level II centre 100. Where paediatric resources are scarce, adult trauma centres may serve as the primary paediatric resource for the region and provide initial care for injured children. If so, they must have the appropriately trained clinicians available. A hospital may be verified as a Level I adult trauma centre and a Level II paediatric trauma centre, or vice versa, depending on how it meets the criteria for each<sup>51</sup>.

While adult and paediatric trauma centres have been shown in some studies to have equal risk-adjusted mortality outcomes, the use of radiation and laparotomy in adult centres was greater<sup>52</sup>.

## 7.8 Geriatric Trauma

As the population ages, the number of older patients with injury is increasing. The presence of co-morbidities combined with their inevitably osteoporotic bone increases the complexity of injury and highlights the need for multidisciplinary involvement, including the involvement of Geriatricians in on-going management of older trauma patients.

---

<sup>50</sup> Ho AM, Karmakar MK, Critchley LA. Acute pain management of patients with multiple fractured ribs: a focus on regional techniques. *Curr Opin Crit Care*. 2011 Aug;17(4):323-7.

<sup>51</sup> Resources for the Optimal Management of the Injured Patient 2014. Committee on Trauma, American College of Surgeons.

<https://www.facs.org/-/media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.ashx>

<sup>52</sup> Matsushima K, Schaefer EW, Won EJ, Nichols PA, Frankel HL. Injured adolescents not just large children: difference in care and outcome between adult and paediatric trauma centres. *Am Surg*. 2013;79(3):267-273.



## 7.9 Rehabilitation

The goal of rehabilitation is to return an injured individual to society with the maximum function consistent with his or her injuries, ideally to pre-injury status or as close to this as possible. A Consultant in Rehabilitation Medicine should manage the overall rehabilitation programme with assistance from appropriate allied health professionals. Rehabilitation should be commenced on the first hospital day and continue until discharge from the system, recognising that return to full activity after major musculoskeletal injury often requires a year or more. Consultant in Rehabilitation Medicine input; occupational therapy; speech therapy; physiotherapy and social services are needed both in the critical care phase and thereafter. Acute care should be consistent with the goal of achievement of optimal functional recovery. Not only is this effort best for the patient; it also is less costly to society. When rehabilitation results in independent patient function, there is a 90% cost saving compared with costs for custodial care and repeated hospitalizations<sup>53</sup>.

## 7.10 Psychiatry, Psychology, and Posttraumatic Stress Disorder Intervention

The disciplines of psychology and psychiatry are important to the MTC's acute care and rehabilitation teams. Research at U.S. trauma centres confirms that 20–40% of injured survivors experience high levels of posttraumatic stress disorder (PTSD) and/or depressive symptoms during the year following injury and deliberate self-harm is a common cause of major trauma<sup>54</sup>.

## 7.11 Support Groups

Many of the techniques used during acute rehabilitation will need to be continued when the patient returns home. Hospital referral may be useful in encouraging participation in such support groups.

## 7.12 Brain Injury

Patients with brain injury require significant rehabilitation, the type and length of which varies greatly. Specific interventions might include: neuropsychological assessment, physiotherapy, occupational therapy, speech therapy, nutritional assessment and psychological support.

## 7.13 Spinal Cord Injury

Although the acute care of patients with spinal cord injury is important, long-term care should begin in parallel. Proper skin care, respiratory care, ventilator use, nutrition, urinary and bowel care are all part of spinal cord injury rehabilitation.

## 7.14 Social Work

Medical social workers are an integral part of the multidisciplinary team caring for trauma patients and should be available 24 hours a day, 7 days a week.

---

<sup>53</sup> Resources for the Optimal Management of the Injured Patient 2014. Committee on Trauma, American College of Surgeons. <https://www.facs.org/-/media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.ashx>

<sup>54</sup> O'Neill F, Leonard M, Lui D, McElwain J, Morris S. Pelvic and acetabular fractures. *Ir Med J.* 2012 Oct;105(9):306.

### 7.15 Operating Theatre of the Major Trauma Centre

In the USA, an operating theatre must be adequately staffed and available within 15 minutes at Level I and II trauma centres. This criterion is met by having a complete operating theatre team in the hospital at all times in order for the injured patient to receive expeditious operative care. If the first operating theatre is occupied, a staffed additional theatre must be available. Level I, II and III trauma centres should have the necessary operating theatres equipment for the patient populations they serve<sup>55</sup>. All trauma centres must have rapid fluid infusers, patient thermal control equipment, intraoperative radiologic capabilities, equipment for fracture fixation and equipment for bronchoscopy and gastrointestinal endoscopy. Full Neurosurgical and Cardiothoracic surgery capabilities should be available 24-hours per day with cardiopulmonary bypass equipment present. An operating microscope must also be available 24 hours per day. A MTC in Ireland must meet similar standards.

### 7.16 Radiology

Conventional radiography and CT must be available in all trauma centres 24-hours per day<sup>39</sup> with qualified Radiologists available within 30 minutes in person or by tele-radiology for the interpretation of studies. In the US Level I and II trauma centres, qualified Radiologists must be available within 30 minutes to perform complex imaging studies or interventional procedures<sup>39</sup>. In Level I and II facilities, a Radiologist must be appointed as liaison to the trauma programme and should educate and guide the entire trauma team in the appropriate use of radiological services. Interventional radiological procedures and ultrasonography must be available 24 hours per day at MTCs as must Magnetic Resonance Imaging (MRI) capability.

### 7.17 Clinical Laboratory

In MTCs, laboratory services must be available 24-hours per day supported by a Transfusion Specialist / Haematologist. The blood bank must have adequate in-house supplies of red blood cells, fresh frozen plasma, platelets, cryoprecipitate and appropriate coagulation factors to meet the needs of injured patients<sup>56</sup>.

### 7.18 Burn Centre Referral Criteria

The pathways of care for patients with isolated burns injury, burns with concomitant trauma and burns with significant co-morbidities are outlined in the referral criteria used by the National Burn Centre, at St. James's Hospital, Dublin. They include:

- Partial-thickness burns of greater than 10% total body surface area;
- Burns that involve the face, hands, feet, genitalia, perineum or major joints;
- Third-degree burns in any age group;
- Electrical burns, including lightning injury;

---

<sup>55</sup> Resources for the Optimal Management of the Injured Patient 2014. Committee on Trauma, American College of Surgeons. <https://www.facs.org/-/media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.ashx>

<sup>56</sup> Nunez TC, Young PP, Holcomb JB, Cotton BA. Creation, implementation, and maturation of a massive transfusion protocol for the exsanguinating trauma patient. *J Trauma*. 2010;68(6):1498-1505.

- Chemical burns;
- Inhalation injury;
- Burn injury in patients with pre-existing medical disorders that could complicate management, prolong recovery or affect mortality;
- Burns and concomitant trauma (such as fractures) when the burn injury poses the greatest risk of morbidity or mortality. If the trauma poses the greater immediate risk, the patient's condition may be stabilized initially in a trauma centre before transfer to a burn centre. Physician judgment will be necessary in such situations and should be in concert with the regional medical control plan and triage protocols.
- Burn injury in patients who will require special social, emotional or rehabilitative intervention.

#### 7.19 Paediatric Patients with Burns

Children with burns should be transferred to a Paediatric Burn Centre. In the absence of a regional paediatric burn centre, an adult burn centre may serve as a second option for the management of paediatric burns;

## 8. Rural Trauma Care

A trauma system is deemed rural when the optimal care of injured patients is delayed or limited by geography, weather, distance or resources. Optimal care demands consistent and frequent trauma education and training. The use of telemedicine, teleconferencing, Web conferencing and other Internet-based educational programmes is increasing access to trauma education in rural areas. Telemedicine also provides opportunities for real-time consultation between rural healthcare providers and experts at higher-level trauma centres<sup>57,58</sup>.

---

<sup>57</sup> Byrnes MC, Irwin E, Becker L, et al. A trauma outreach programme provided by a level I trauma centre is an effective way to initiate peer review at referring hospitals and foster process improvements. *J Trauma*. 2010;68(4):778-782.

<sup>58</sup> Dharmar M, Romano PS, Kuppermann N, et al. Impact of critical care telemedicine consultations on children in rural Emergency Departments. *Crit Care Med*. 2013;41(10):2388-2395.

## 9. Required Trauma Centre Performance

ACS-COT<sup>59</sup> mandates US Trauma Centres to assess performance under the following headings:

- Mortality and morbidity review;
- Trauma surgeon response to the Emergency Department. The minimum response is within 15 minutes of patient arrival for Level I and II and within 30 minutes for Level III and IV trauma centres;
- Trauma team activation (TTA) criteria. All TTAs must be categorized by the level of response and quantified by number and percentage.
- Monitoring of response parameters for Consultants addressing time-critical injuries (e.g. extradural hematoma, open fractures and haemodynamically unstable pelvic fractures);
- Potential over-triage and under-triage cases to be identified and reviewed monthly;
- Analysis of acute transfers out of an institution;
- Trauma centre diversion-bypass hours to be routinely monitored and not exceed 5%;
- Delays in operating theatre availability to be routinely monitored;
- Response times of operating theatre and post anaesthesia care unit personnel when responding from outside the trauma centre to be routinely monitored;
- Response times of CT radiographer (<30 minutes); MRI radiographer (<60 minutes) and Interventional Radiology team (<30 minutes) when responding from outside the trauma centre:
- Transfers to a higher level of care within the institution:
- Solid organ donation rate:
- Trauma Registry completion:
- Multidisciplinary trauma peer review committee attendance:
- Trauma centre volume:
- A Level I trauma centre must meet one of the following:
  - Admit >1,200 trauma patients annually;
  - Admit >240 admissions with an ISS >15.
- Orthopaedic surgery
  - Number of pelvic and acetabular cases performed annually;
  - Number of pelvic and acetabular cases transferred out:

---

<sup>59</sup> Resources for the Optimal Management of the Injured Patient 2014. Committee on Trauma, American College of Surgeons.  
<https://www.facs.org/-/media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.ashx>

- Time to open reduction and internal fixation for femur fractures;
- Time to washout for all open fractures;
- Appropriateness and timing of intravenous antibiotics for all open fractures.
- Blood bank:
  - Turnaround time for massive transfusion protocol (MTP) use;
- Burn patient numbers (if not a burn centre);
- Vertebral column injuries;
- Other occurrences;
- Adverse ventilator-associated events;
- Surgical site infection;
- Venous thromboembolism events;
- Decubitus ulcer rate.

The multidisciplinary trauma peer review committee must systematically review fatalities, significant complications and process variances associated with unanticipated outcomes and determine opportunities for improvement<sup>60</sup>.

---

<sup>60</sup> Evans C, Howes D, Pickett W, Dagnone L. Audit filters for improving processes of care and clinical outcomes in trauma systems. Cochrane Database Syst Rev. 2009.

## 10. Trauma Audit, Research and Scholarship

### 10.1 Trauma audit

The care of the severely injured patient requires a multidisciplinary team, often working across more than one hospital. This differs from most other types of medical care where usually only one specialist is involved and means that special arrangements have to be made to develop a system that coordinates the complex interactions between the different individuals involved in trauma care. A robust audit system, ideally evaluating both processes and outcomes, is required to show whether or not these arrangements are working well.

This type of audit is more effective if the data presented allows comparisons with other hospitals (i.e. benchmarking) to occur. Trauma audit follows this benchmarking pattern in America, Germany, Scandinavia and Australia. In the USA, trauma audit is a mandatory requirement for Trauma Centre status.

In the UK, the Trauma Audit and Research Network (TARN)<sup>61</sup> is a well-established process and outcome audit in trauma care, originally derived from the methods used in the American Major Trauma Outcome Study (MTOS). TARN data is used in three ways to close the cycle of trauma audit:

- To highlight individual cases where unexpected outcomes occur (either good or bad);
- Four times a year the Quarterly Report focuses on a particular specialist area of trauma management – comparing performance with standards set by the Royal College of Surgeons of England<sup>62</sup> and also benchmarking performance of one hospital against the rest of the TARN contributing hospitals.
- Comparisons of outcome between hospitals allowing the identification of outliers with either very good or very poor trauma outcomes, allowing potential causes to be identified.

In the new model of Trauma Care in England, hospitals' remuneration for treating major trauma is contingent on them contributing each individual trauma case to TARN, effectively making TARN submission the equivalent of an invoice for services rendered.

In Ireland, the National Office for Clinical Audit<sup>63</sup> is successfully implementing Major Trauma Audit using TARN methodology; currently 25 of the 28 major trauma-receiving hospitals are contributing to TARN.

### 10.2 Trauma Research

Research is the process to advance knowledge and is essential to optimize the care of injured patients. The large volume of severely injured patients, a core of experienced trauma clinicians and

---

<sup>61</sup> <https://www.tarn.ac.uk/>

<sup>62</sup> <https://www.rcseng.ac.uk/surgeons/surgical-standards/working-practices/trauma>

<sup>63</sup> <http://www.noca.ie/>

an academic infrastructure has enabled US Level I trauma centres to be effective and productive in research and scholarly activity. As a minimum, ACS-COT<sup>64</sup> mandates a Level I Trauma Centre to have 20 peer-reviewed articles published in journals included in Index Medicus or PubMed in a 3-year period.

## 11. Disaster Planning and Management

Management of a mass casualty event requires a paradigm shift in the care of injured patients. An integrated trauma system is the backbone of such a robust response. The maxim is to do “the greatest good for the greatest number” and triage is the tool that guides this concept<sup>65</sup>.

## 12. Organ Donation

Approximately 75% of donated organs originate from deceased donors with >40% of donors dying because of trauma. Although the death of a loved one may be very traumatic for relatives, some solace is achieved if their loved one’s organs are successfully transplanted into others, allowing the deceased to give the gift of life to another. Identifying potential organ donors, contacting relevant procurement services and providing critical care to potential organ donors to prevent cardiovascular collapse before organ donation is an important role of the inclusive trauma system.

---

<sup>64</sup> Resources for the Optimal Management of the Injured Patient 2014. Committee on Trauma, American College of Surgeons. <https://www.facs.org/-/media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.ashx>

<sup>65</sup> Cryer HG, Hiatt JR. Trauma system: the backbone of disaster preparedness. J Trauma. 2009;67(suppl 2):S111-113.

## 13. Emergency Medicine Facilities in Ireland

There are currently twenty-nine Emergency Departments (EDs) open 24 hours per day, 7 days per week and 11 Local Injury Units (LIUs). There are therefore 40 Emergency Medicine service units (EDs and LIUs) on 39 acute hospital sites. Tallaght Hospital has separate Adult and Paediatric EDs. LIUs are bypassed for major trauma transported by Ambulance.

A model of there being a hub ED at the centre of Emergency Care Networks has been proposed by the Emergency Medicine Programme (EMP). The Programme has also recognised the particular need for reconfiguration of services within the greater Dublin region.

The proposal to develop an integrated trauma system for Ireland will require the development of a small number of hospital sites with EDs as Major Trauma Centres (MTCs); many of the remaining EDs in hospitals with the necessary facilities (defined as Type A EDs in the Report of the National Emergency Medicine Programme in June 2012<sup>66</sup>) as Trauma Units (TUs) and the reclassification of remaining facilities as Local Injury Units (LIUs). The number of TARN-eligible patients and the facilities for trauma care available in EDs at present are outlined in Appendix 1.

## 14. Consultant in Emergency Medicine Staffing in Ireland

There are currently 79 WTE Consultant in EM posts in Ireland (71 Consultants in post) and the EMP has advised that 180 posts are required to provide a 16-hour Consultant presence in larger hub EDs. A North American model of 24/7 Consultant in EM staffing would require 256 posts to be developed. No ED in Ireland has more than 5 WTE Consultants in EM and most large units have 3-4 WTE. There has been no increase in Consultant in EM staffing in Ireland since 2011. Victoria, Australia has a population of 5.4 million people served by 34 EM facilities designated as 3 Major Referral EDs, 15 Urban District EDs, 10 Major Rural EDs and 6 Private EDs. There were 314 Consultants in Emergency Medicine in Victoria in 2011, a ratio of 1:17,608 per head of population compared with 1:65,757 in Ireland<sup>67</sup>.

---

<sup>66</sup> National Emergency Medicine Report 2012. <http://www.hse.ie/eng/about/clinicalprogrammes/emp/empreport2012.pdf>

<sup>67</sup> Irish Committee for Emergency Medicine Training, Irish Association for Emergency Medicine, National Emergency Medicine Programme. A guide to building and sustaining the Emergency Medicine Medical Workforce in Ireland. <http://www.iaem.ie/images/stories/training/2013/emp%20icem%20building%20and%20sustaining%20the%20emergency%20medicine%20medical%20workforce%20in%20ireland%20260413.pdf>



## 15. Conclusions

Data from the East Midlands region in England would suggest that 5 patients per day (or 1825 per annum) with severe injuries would require MTC-level care in Ireland<sup>68</sup>.

IAEM strongly supports the development of an Irish Major Trauma System along the lines of the UK model to offer these patients the optimum management and best opportunity not only to survive their injuries but also to recover to independent and productive living. In collaboration with other relevant stakeholders, a national coordinating group should be established without delay to decide the configuration and detail of the system.

The designation and appropriate resourcing of Trauma Receiving Hospitals represents a good starting point for improving trauma care in Ireland. Currently, ambulance-borne major trauma is being brought to a number of hospitals that do not have the facilities to deal with this type of patient and this must be addressed as soon as possible. In due course a decision will be taken as to which 2-3 institutions will be designated Major Trauma Centres and which will be designated Trauma Units.

In those hospitals to be designated as Trauma Receiving Hospitals, at a minimum 24/7 access to the following specialities and services must be established as a priority:

- Senior Emergency Medicine clinicians (Consultants, Staff Grades and Specialist Registrars);
- Immediate definitive airway control capability (Anaesthesia/Critical care and/or Emergency Medicine);
- 30-minute access to senior General/Trauma Surgeons experienced in emergency haemorrhage control in both adults and children;
- Timely 24/7 access to Diagnostic Imaging, particularly CT;
- Adequate in-patient bed capacity at hub hospitals.

In addition, the impact on the National Ambulance Service of the direct transfer of trauma patients within networks must be considered and appropriately planned and monitored.

---

<sup>68</sup> Professor Chris Moran, Presentation to Irish Institute of Orthopaedic and Trauma Royal College of Surgeons in Ireland 19<sup>th</sup> September 2014 (personal communication)

Site	ED presentations	Consultant in Emergency Medicine Whole Time Equivalent	General Surgery	Orthopaedic Surgery	Neurosurgery	Plastic Surgery	Cardiothoracic Surgery	Specialist Designation	TARN Eligible Patients
Beaumont Hospital, Dublin	51,948	4	✓	✓	✓	✓			446
Mater Misericordiae University Hospital, Dublin	53,134	3	✓	✓			✓	National Spinal Unit	426
University Hospital, Waterford	53,453	4	✓	✓					400
Tallaght Hospital, Dublin (Adult & Paediatric)	76,296	5	✓	✓				Pelvic and Acetabulum National Centre	392
Cork University Hospital	64,830	4.5	✓	✓	✓	✓	✓		375
St. Vincent's University Hospital, Dublin	44,322	5	✓	✓		✓			350
Our Lady of Lourdes Hospital, Drogheda	57,524	3	✓	✓					335
St James's Hospital, Dublin	46,281	5	✓	✓		✓	✓	National Burns Centre National Centre for Hereditary Coagulation Disorders	333
University Hospital, Limerick	61,153	4	✓	✓					260
Midland Regional Hospital, Tullamore	30,700	2.8	✓	✓					236
University Hospital, Galway	65,292	5	✓	✓		✓	✓		236
Kerry General Hospital, Tralee	36,517	2	✓	✓					178
Connolly Hospital, Dublin	32,638	3	✓	✓					160
Mayo General Hospital, Castlebar	35,203	1	✓	✓					157
Letterkenny General Hospital	37,312	3	✓	✓					144
Sligo Regional Hospital	39,639	3	✓	✓					140
Naas General Hospital	26,929	2	✓						88
Children's University Hospital, Temple Street, Dublin	47,761	3	✓	✓	✓				87
St. Luke's General Hospital, Kilkenny	41,514	0.8	✓						75
Midland Regional Hospital, Mullingar	36,932	1	✓						73
Our Lady's Children's Hospital, Dublin	33,505	3	✓	✓		✓	✓		54
Wexford General Hospital	37,574	0.8	✓						54
Cavan General Hospital	35,734	3	✓						48
South Tipperary General Hospital, Clonmel	36,654	0.8	✓	✓					47
Portiuncula Hospital, Ballinasloe	23,833	1.5	✓						42
Mercy University Hospital, Cork	30,950	1.1	✓						26

(Source – HSE Service Management Data Report, April 2014)