

IRISH ASSOCIATION FOR
EMERGENCY
MEDICINE



The Trauma Team

A position paper

November 2020

Authors: Dr Shane Broderick, Dr Fran O'Keefe, Professor Conor Deasy,
Ms Caoimhe Fitzsimons

INTRODUCTION

Trauma is the leading cause of death and disability in the first four decades of life¹. A Trauma Team (TT) is a multidisciplinary group of healthcare professionals, working collectively on the assessment and treatment of those who are severely injured. Care of these patients requires a coordinated and integrated system of trauma care¹. The outcome for critically ill trauma patients is optimised by the appropriate activation of a multidisciplinary TT. This can reduce the time to accurate diagnosis and effective intervention, both of which can influence whether the patient lives or dies².

The Major Trauma Audit (MTA) National Report 2018 captured data relating to 5,429 major trauma patients in Ireland, however only 8% (n=425) of these patients were received by a TT on arrival to hospital. Younger patients and those with more severe injuries were more likely to be met by a TT. Currently, there are no accepted TT configurations or standardised major trauma activation criteria in either the pre-hospital and hospital setting in Ireland. The MTA recommended that a national definition and a standard for what should constitute a TT and activation criteria for such a team are required³.

The Irish Association for Emergency Medicine (IAEM) has acknowledged the principle of the right patient being seen by the right person in the right hospital at the right time as being “fundamental to the care of trauma patients” and notes that this can be achieved by “ensuring that TTs with senior leadership are available to receive the injured trauma patient at Emergency Departments (ED) so that the early intervention delivered is both safe and effective”⁴.

Research shows that the most appropriate TT response is one that delivers optimal patient care while minimising disruption to hospital activities⁵. One such model is that of a tiered TT, one to involve an internal ED team and for those that are more severely injured, access to a Hospital TT for extended multidisciplinary input.

The aim of this document is a position paper for IAEM and the Emergency Medicine Programme (EMP) that can be used for collaborative engagement with the National Trauma Office as well as to engage with the key stakeholders including Surgery, Critical Care, Trauma & Orthopaedic Surgery and nursing amongst others to aid the development and roll out of TTs for Ireland.

CONTENTS

INTRODUCTION.....	i
GLOSSARY OF TERMS, DEFINITIONS AND ABBREVIATIONS.....	iii
EXECUTIVE SUMMARY	1
BACKGROUND - THE BURDEN OF TRAUMA IN IRELAND	2
THE TRAUMA TEAM LEADER (TTL).....	3
WHO SHOULD BE PART OF THE TRAUMA TEAM?	4
WHO IS PART OF THE TRAUMA TEAM INTERNATIONALLY?	17
WHAT IS A TIERED TRAUMA TEAM?.....	23
WHEN SHOULD A TRAUMA TEAM BE ACTIVATED?	24
WHEN ARE TRAUMA TEAMS ACTIVATED INTERNATIONALLY?	25
TRAUMA TEAMS – THE HUMAN FACTOR	28
TRAUMA TEAM LEAD / TRAUMA TEAM MEMBER COURSES:	30
ACCOUNTABILITY FRAMEWORK FOR MEMBERS OF THE TRAUMA TEAM	32
WHAT WILL A TRAUMA TEAM LOOK LIKE AT A MAJOR TRAUMA CENTRE IN IRELAND?	33
WHAT WILL A TRAUMA TEAM LOOK LIKE AT A TRAUMA UNIT IN IRELAND?	36
SUMMARY	38
Appendix 1	39
Appendix 2	40
Appendix 3	41
Appendix 4	43
Appendix 5	44
Appendix 6	47
Appendix 7	48
REFERENCES.....	49

GLOSSARY OF TERMS, DEFINITIONS AND ABBREVIATIONS

AMPLE	Allergy, Medications, Past Medical History, Last meal, Events
ASHICE	Age, Sex, History, Injury, Changes, Estimated time of arrival
AIS	Abbreviated Injury Scale A value between 1 (minor) and 6 (maximum) can be assigned to each injury
ASM	Annual Scientific Meeting
BID	Brought in Dead
BP	Blood Pressure
CNM	Clinical Nurse Manager
CRT	Capillary Refill Time
C-Spine	Cervical Spine
CT	Computerised Tomography
CXR	Chest X-ray
E-FAST	Extended Focused Abdominal Sonography in Trauma
EMP	Emergency Medicine Programme
EMS	Emergency Medical Services
ETCO2	End Tidal Carbon Dioxide
ETT	Endotracheal Tube
Exclusive Trauma system	Focus predominately on MTC's with injured patients bypassing other facilities
FBC	Full Blood Count
GCS	Glasgow Coma Scale
G+H	Group and Hold
G+X	Group and cross Match
HCA	Health Care Assistant
HR	Heart Rate
HSE	Health Service Executive
IAEM	Irish Association for Emergency Medicine
ICEMT	Irish Committee for Emergency Medicine Training
IMCN	Irish Medical Council Number
IMIST AMBO	Identify patient, Mechanism, Injury, Signs, Trends, Allergy, Medications, Background, Other
Inclusive Trauma system	All hospitals within the network have a role rather than trauma care being focused on a single institution
IO	Intraosseous
IR	Interventional Radiology
ISS	Injury Severity Score
IV	Intravenous
LFT	Liver Function Test
MRN	Medical Registration Number
MTA	Major Trauma Audit
MTC	Major Trauma Centre. A multi-speciality hospital, on a single site, optimised for the provision of trauma care.
MTP	Massive Transfusion Protocol
NOCA	National Office of Clinical Audit
RCSI	Royal College of Surgeons in Ireland
ROTEM	Rotational Thromboelastometry
RR	Respiratory Rate

SpO2	Oxygen Saturation
SpR	Specialist Registrar
TARN	Trauma Audit Research Network
TBSA	Total Burn Surface Area
Traumadoc ©	National Trauma Document
Trauma Network	The collaboration between the providers commissioned to deliver trauma care services in a specific geographical area.
TT	Trauma Team
U+E	Urea and Electrolytes
UK	United Kingdom
VBG	Venous Blood Gas
#	Fracture

EXECUTIVE SUMMARY

- Trauma care in Ireland is set to undergo reconfiguration with the development of an inclusive system
- Trauma systems in the UK have been associated with a 25% improvement in the risk-adjusted odds of survival
- Trauma Teams (TTs) have been shown to optimise patient care by reducing time to diagnostics and interventions
- The lack of a definition for TTs in Ireland present a challenge in terms of data capture with only 8% of major trauma patients documented as being met by a TT on arrival to ED
- There are currently no accepted major trauma activation criteria in either the pre-hospital or hospital setting in Ireland
- The most appropriate TT response is one which delivers optimal patient care without impacting on other patients or hospital activities
- This can be achieved with a two-tiered TT response, the smaller ED (EDTT) and a larger Hospital TT (HTT) as the situation dictates based on predetermined activation criteria
- Activation of the appropriate TT will be centred around clinical information based on mechanism of injury, physiological status and injuries sustained and other set criteria
- Specialised TTs will be available to respond to trauma in children, the elderly, those with obvious bleeding likely to require massive transfusion, head injury likely to require surgery and those that are pregnant (>20/40)
- Different TT configurations will be required for Major Trauma Centres (MTC), Trauma Units (TU) and those without added specialities such as Paediatrics and Obstetrics and Gynaecology
- TT leaders and members will be appropriately credentialed in the management of major trauma
- TTs will contain a minimum of four doctors (led by a senior specialist 5th or 6th year trainee in Emergency Medicine, Trauma, Trauma & Orthopaedic Surgery, Critical Care or General Surgery), three nurses (one to be a minimum of CNM2 grade), ED Radiographer, Health Care Assistant (HCA), porter and a member of the clerical staff
- TTs in MTCs will be consultant-led 24/7 from the specialities of Emergency Medicine, Trauma, Trauma & Orthopaedic Surgery, General/Vascular Surgery and Critical Care on an opt in/out rota basis
- TTs in TUs will be consultant led where possible or by a senior specialist trainee in the above- mentioned specialities
- Senior trainees in all relevant specialties (Neurosurgery, Spinal and Spinal Cord Surgery, Vascular Surgery, Cardiothoracic Surgery, Plastic Surgery, Maxillofacial Surgery, Ear Nose and Throat Surgery, Diagnostic and Interventional Radiology) should be resident 24/7 with a prescribed response time of thirty minutes for their consultant's physical presence

BACKGROUND - THE BURDEN OF TRAUMA IN IRELAND

The Major Trauma Audit (MTA) is a clinically-led audit established by the National Office of Clinical Audit (NOCA) in 2013 with a focus on care of severely injured patients. MTA define major trauma as serious and often multiple injuries where there is a strong possibility of death or disability ⁴.

Since 2016, all 26 trauma receiving hospitals participate in the MTA. Data on 5,429 major trauma patients was captured in the most recent 2018 report. 56% of these patients were male with falls of

<2 meters being the most frequent cause of injury. 78% of these falls occurred in the patient's own home. 46% of patients were > 65 years of age. Patients suffered trauma of varying severity with 25% recorded as having an Injury Severity Score (ISS) of >15, signifying major trauma. 95% of patients survived. Of those that died, over half were > 75years of age and most (2/3) had sustained a fall of < 2 m.

Many of the critical decisions and lifesaving interventions made are during the early phases of trauma care. The care provided to these trauma patients is challenging and often involves multiple specialist disciplines as part of a TT. Time-to-critical interventions and outcomes are improved when a trained TT is present to receive the severely injured patient ⁵. Despite this, the MTA 2018 National Report showed that the number of patients received by a TT on arrival to hospital was low at only 8%. The lack of a definition of a TT and activation criteria for such a team presents a challenge to data capture with severely injured patients often being met by an assembled team on somewhat of an ad hoc basis. The median age of major trauma patients in the 2018 report was 62 years. Of concern, the report highlighted that younger patients were more likely to be pre-alerted and received by a TT, with a steady decline in the likelihood of receipt by a TT as patient age increased. Appreciating the phenotype of major trauma is fundamental to ensuring an appropriate response.

Trauma care in Ireland is undergoing reconfiguration. The introduction of a trauma network in England in 2012 has been associated with a 25% improvement in the risk-adjusted odds of survival enhancing the necessity for an integrated trauma system in Ireland ⁶.

The reception and resuscitation by a TT are mandatory in the United Kingdom (UK) and robust audit shows that 92% of major trauma patients were met by a consultant-led TT on arrival to an MTC. In Ireland, there is no clear standard for what constitutes a TT or when such a team should be activated. This presents a challenge when attempting to measure TT activity. The MTA report recommended stakeholder collaboration to define the composition of a TT and activation criteria for such a team.

THE TRAUMA TEAM LEADER (TTL)

A team is a reflection of its leadership. Motivating a group of people towards a common goal requires a leader. In challenging trauma resuscitation, an effective TTL is paramount to success. In the first 30 minutes of the management of a severely injured trauma patient, a critical decision leading to a lifesaving intervention occurs every 72 seconds ⁷. The TTL should coordinate interventions, follow established principles, and ensure that each phase of trauma care flows and maintains a forward trajectory.

The TTL does not have to be the most senior clinician available but they should have clinical experience, as well as advanced resuscitation and leadership skills. The physical position of the TTL is key to managing the rapid influx of stimuli ⁸ (typically at the foot of the patient's trolley with a clear line of sight to the patient's monitor). Cognitive bandwidth should be maintained with tasks being delegated where possible. A Team Lead Support (TLS) is vital. Checklists, local protocols, established clinical practice guidelines and aide memoirs will help focus the team in what can often be a challenging environment.

TTLs need to be excellent communicators as well as being efficient, accurate and decisive. Credibility, authority and being liked are powerful tools. The optimal style and structure of leadership is often influenced by patient characteristics and team composition ⁹. Direct leadership is most effective when the Injury Severity Score (ISS) is high or teams are inexperienced, while empowering leadership is most effective when the ISS is low or teams more experienced. Katherine J. Klein spent 10 months studying TTs in action at the Shock Trauma Centre in Baltimore and describes how traditional research is usually based on 'dominant' models which assume a long-term leader- follower relationship. It is important to note however that the role of the TTL may evolve and change as a team matures and varies as a function of team task cycles ¹⁰. She stated that "leadership is a dynamic, socially enabled and socially constrained set of functions which may be filled by the numerous individuals who, over time, occupy key positions of expert authority on the TT".

Strong leadership improves processes of care in trauma resuscitation and yet despite its importance, dedicated leadership education is rarely part of physician training programmes. 'A Trauma System for Ireland' called for a formal trauma training committee to be established with TTL training as a priority⁴.

HOW DO YOU KNOW THAT YOU ARE A GOOD TTL?

Peer observation and reflection should facilitate calibrated consistency amongst TTLs ¹¹. Self-analysis is an integral part of TT leadership ¹². Assessment mechanisms on performance based on 1) observation and 2) feedback and reflection should become embedded into the TTL's daily practice. The TEAM sheet assessment tool has been validated for evaluating TTL performance and provides valuable information to structure the assessment and training of non-technical skills, especially in relation to leadership ¹³.

WHO SHOULD BE PART OF THE TRAUMA TEAM?

An 'inclusive' Trauma System is a network of facilities co-operating in the care of injured patients that integrate prevention, pre-hospital care, acute care, reconstruction, rehabilitation and reablement in a structured and organised way that optimises resources, care and outcomes. Within an inclusive trauma system, Trauma Networks will be organised around a Major Trauma Centre (Hub and spoke model)⁴.

Different TT configurations will be required for both MTCs and TUs and can be adapted locally as necessary.

TEAM MEMBERS - ROLES AND RESPONSIBILITIES

- The over-riding principle is to ensure that the patient receives optimal care
- All duty trauma call-out personnel are required to be contactable and available to attend the trauma call
- The minimum number of doctors on the TT should be four
- TTLs should include senior trainees (5th / 6th year) or consultants, appropriately credentialed in the management of major trauma
- The TT should be capable of providing advanced airway management, resuscitative thoracotomy and other bedside procedures relating to the immediate management of chest, abdominal, pelvic, head, spinal and limb trauma
- The minimum number of nurses on the TT should be three with at least one being CNM2 grade
- TTs must also include non-clinical personnel as the correct registration as well as transfer and movement of patients is paramount in early directed treatment
- Clearly allocated roles and responsibilities are crucial for successful team performance
- Roles should be designated by the TTL
- Team roles should reflect the members capabilities
- Trauma Team Members (TTM) should wear personal protective equipment (PPE)
- TTMs should wear labels clearly identifying their role and name
- TTMs should be given action cards detailing the key tasks they are responsible for
- TTMs should ensure excellent communication at all times
- TTMs should ask for help / clarification if required



TRAUMA TEAM LEADER (TTL)

- Consultant in Emergency Medicine
- Fellow, Specialist Registrar, Registrar in Emergency Medicine
- Trauma Consultant*
- Trauma Fellow*

*Major trauma is often characterised by multiple injuries. This presents considerable challenges with fragmented and somewhat disjointed care being delivered by several specialities. A co-ordinated approach is critical to the provision of person-centred care. Within the proposed Major Trauma Centres in Ireland, patient's care should be overseen and coordinated by a dedicated trauma service. This inpatient service has been successfully employed in the UK, USA and Australia and utilises a hybrid model of senior consultant staffing from the various trauma specialties to ensure optimal care for the complexities associated with major trauma patients. Improvements in outcomes for patients will be achieved by providing this patient-focused and planned trauma care.

The TTL is required to have experience and medical expertise in the management of injured patients. They must also possess excellent non-technical skills in order to effectively optimise team performance.

The TTL should be someone acutely familiar with the environment. A Consultant/Registrar in EM who has the required training should be default TTL in the initial reception and resuscitation. If this is not possible as a result of logistical and/or experience reasons, then there should be clearly defined escalating roles that can be employed from specialities including Surgery, Trauma and Orthopaedic Surgery and Critical Care/Anaesthetics.

Prior to arrival:

- Assesses 'Pre-Alert' and ensures activation of the appropriate TT
- Briefs TT on 'Pre-Alert' ASHICE (Age, Sex, History, Injury, Condition, Estimated

time of arrival) prior to the patient's arrival

- Allocates roles and tasks according to skill and experience and ensures that all TTMs wear personal protective equipment (PPE)
- Anticipates potential injuries
- Anticipates interventions, diagnostics and therapeutics that are likely to be required
- Provides this shared mental model for the TT

On arrival:

- Receives IMIST AMBO (Identify patient, Mechanism of injury, Injury sustained, Vital signs, Treatment / Trends, Allergy, Medication history, Background, Other) handover and ensures room is quiet
- Ensures the accurate and efficient assessment of the patient
- Ensures that any interventions are indicated and if so, delivered successfully and without delay
- Ensures documentation of primary and secondary survey using Traumadoc© (appendix 1 & 2); this responsibility may be delegated to a scribe. Documentation must be signed by TTL.
- If team members are delayed, when they arrive, the TTL identifies them, their speciality, briefs them and delegates roles
- Organises patient disposition
- Performs a formal handover of patient care
- Summarises regularly and vocalises plan / next steps using '10-seconds-for-10-minutes principle'¹⁴.
- Initiates and leads 'hot' debriefing sessions (when relevant) for all TT members at the conclusion of a resuscitation.

TEAM LEADER SUPPORT (TLS)

- Consultant in Emergency Medicine
- Critical care doctor
- Relevant speciality surgeon**
- Trauma Fellow

Provides support to the TTL by maintaining situational awareness helping reduce their cognitive load.

Prior to arrival:

- Actively engages in identifying potential and actual errors
- Ensures excellent team communication
- Assists with contacting the relevant speciality including diagnostics, laboratory etc.

On arrival:

- Reviews the results of investigations
- Seeks collateral history from relatives as applicable
- Reviews patient's relevant past medical history

**With relevant speciality experience in Trauma

NURSE TEAM LEADER

- Senior Emergency Department (ED) nurse

Prior to arrival:

- Preparation of nursing trauma team roles in complement to TTL
- Manages resource in the resus room and is cognisant of other patient needs within the department
- Ensures full PPE is worn
- Ensures all team members are identified with stickers and names are written legibly on them
- Ensures any specific equipment that is required is available for immediate use
- Ensures appropriate TT is activated where criteria are met

On arrival:

- Ensures patient is wearing a wristband
- Anticipates and facilitates logistical aspects of patient care i.e. Bed Management
- Is available for advice and support for team members
- Has overview of patient care and liaises with TTL and TLS
- Organises additional staff/Blood bank/Equipment/Social Worker as required
- Optimises co-ordination of Family Care and ensures their presence as appropriate

SCRIBE

- ED nurse
- Doctor in Emergency Medicine
- TARN data collector
- Trained Health Care Attendant

Prior to arrival:

- Notifies registration staff

- Identifies role to team
- Uses Traumadoc©
- Vocalised gaps in documentation
- Documents pre-alert using ASHICE
- Documents time of activation of the appropriate TT
- Documents TT members, their time of arrival, and allocated roles

On arrival:

Responsible for recording:

- Time of Patient Arrival and starts Digital Clock
- Time of Patient Assessment
- IMIST AMBO handover documentation
- Names of staff in attendance and their roles
- Examination findings of Primary and Secondary Assessment
- Regular Vital Signs and Glasgow Coma Scale
- Communicates trends in vital signs
- Ensure medications are appropriately prescribed
- Time of Massive Transfusion Protocol (MTP) activation
- Ensure blood and blood products are appropriately prescribed
- Documents interventions and procedures
- Documents transfer time and disposition

Acts as auditor and clearly vocalises gaps in documentation / patient care.

AIRWAY DOCTOR

- Anaesthesiologist***
- EM doctor***
- Trauma Fellow***

***With appropriate difficult / trauma airway experience

The TTL is responsible for allocating the team member most able to meet the patient's airway needs.

Prior to arrival:

- Ensures PPE is worn
- Formulates airway plan with airway nurse

- With Airway nurse, utilises RSI checklist to prepare equipment and drugs
- With Airway nurse, ensures RSI checklist completed
- Clearly states airway plan to whole team
- Ensures communication at all times is through the TTL

On arrival:

- Controls and commands safe transfer of patient to resuscitation trolley
- Reassures patient on arrival and explains what is happening
- Ensures high-flow oxygen is applied
- Performs airway and anterior neck assessment to the level of the clavicles
- Assesses GCS and pupil size and reactivity
- Manages potential airway obstruction with suction, basic manoeuvres, uses adjuncts as appropriate (OPA/NPA)
- Assesses need for intervention/intubation and communicates this with TTL
- Performs intubation as appropriate
- Seeks confirmation of endotracheal tube placement using ETCO₂ and 5-point auscultation
- Ensures cervical spine restriction
- Monitors neurological status
- Ensures naso/orogastric tube placed
- Confirms ventilator settings with airway nurse and establishes patient on ventilator
- Ensures appropriate on-going sedation has been commenced as appropriate
- Accompanies patient on transfer and takes equipment and drugs including emergency airway equipment, blood, analgesia, and/or paralytics
- Gives regular updates to TTL

AIRWAY NURSE

- ED nurse****
- ICU nurse****

****With appropriate experience in difficult airway from major trauma

Prior to arrival:

- Ensures full PPE is worn
- Clarifies airway plan with Airway Doctor and TTL
- Completes RSI checklist with Airway Doctor
- Completes equipment checks

- Prepares for intubation as per Rapid Sequence Intubation (RSI) checklist
- Clarifies medications for RSI with Airway Doctor, TTL and infusion nurse
- Prepares and sets the ventilator as instructed by Airway Doctor and TTL

On arrival:

- Assists with safe transfer of patient
- Ensures cervical spine collar is applied and correctly fitted if applicable
- Requests manual in line immobilisation as applicable
- Ensures cervical spine restriction during transfer
- Assists with intubation and airway management as required and secures the ETT
- Provides suctioning as required
- Confirms ETCO₂ reading post intubation
- Ensures continuous monitoring of vital signs
- Manages ventilator together with Airway Doctor
- Assists with (or inserts) nasogastric or orogastric tube and aspirates/suctions as appropriate
- Ensures time of intubation, drugs used, ETT size, distance at teeth, vital signs and ventilator settings are documented
- Performs eye care for the patient, as appropriate
- Accompanies the intubated patient during transfer with appropriate airway equipment for transfer
- Voices any concerns

ASSESSMENT DOCTOR

- EM doctor
- Surgeon (General / Orthopaedic)
- ICU doctor /Anaesthesiologist
- Trauma Fellow

Prior to arrival:

- Ensures full PPE
- Liaises with TTL with regards to anticipated injuries
- Pre-orders blood tests - FBC, U&E, LFT, Coagulation profile, Fibrinogen, Group & Hold/ Crossmatch, VBG and ROTEM sampling as appropriate
- Pre-orders radiology – Portable CXR, Pelvic x-ray and Trauma CT

On arrival:

- Assists with transfer of patient
- Breathing: Identifies life threatening thoracic injuries. Clearly states the RR, SpO2 and ETCO2
- Circulation: Identify presence and cause of shock if present using E-FAST scan. Clearly states the HR, BP, and CRT. Assesses if the pelvic binder is in the correct position
- Disability: With Airway doctor, assesses neurological status before paralysing anaesthetic agents used
- Check blood sugar level reading with procedure doctor/nurse
- Ensure patient is kept warm with external warmer and clearly states the temperature.
- Clearly states findings to TTL/ Nurse Team Leader /Scribe
- Requests relevant X-rays as part of the primary survey
- Takes an AMPLE (Age, Medications, Past medical history, Last meal, Events leading up to accident/injury) history, reassures the patient, and explains what is happening
- Performs secondary survey
- Conveys results of investigations to TTL
- Reviews results of investigations considering clinical findings with TTL

PROCEDURE DOCTOR

- EM doctor
- Surgeon (General / Orthopaedic)
- ICU doctor /Anaesthesiologist
- Trauma Fellow

Prior to arrival:

- Ensures full PPE is worn
- Prepares for catastrophic external haemorrhage with Combat Application Tourniquet (CAT) or similar, haemostatic dressing, splints, pelvic binder etc.
- Prepares other equipment to include pelvic binder, thoracostomy kit etc. as required
- Prepares IV access equipment, including two large bore IV's, rapid infuser equipment, IO equipment
- Locates and prepares ultrasound machine, plugged in, turned on, set up with curved linear probe, ultrasound gel and probe cover
- Ensures all communication is through the TTL

On arrival:

- Assists with transfer of patient
- Obtains IV access: 2 large bore lines & obtains blood for analysis
- Draws venous blood gas for immediate analysis
- Ensures bloods have been sent and checks results
- Performs thoracostomy, thoracotomy, and/or chest drain insertion as appropriate
- Aids airway doctor in difficult airway management, including surgical airway

CIRCULATION NURSES

- *Procedure Nurse*
- *Transfusion Nurse*
- *Infusion Nurse*

PROCEDURE NURSE

- ED nurse

Prior to arrival

- Ensures full PPE
- Ensures special procedures trolley is in resus bay e.g. thoracotomy
- Prepares intravenous access equipment and/or IO kit
- Sets up for procedures as instructed by TTL
- Prepares tuff cut shears, pelvic binder and CAT when instructed by TTL
- Prepares external warming device

On arrival

- Assists with transfer of patient
- Works with procedure doctor to perform procedures
- Assists Assessment Doctor in applying pelvic binder if required
- Assists Procedures Doctor with specific procedures
- Sets up for arterial and central access lines as required

TRANSFUSION NURSE

- ED nurse
- Hemovigilance officer

Primary role of managing blood product transfusions and therefore should be familiar with prevention of coagulopathy.

Prior to arrival:

- Ensures full PPE is worn
- Ensures O negative blood is available to use
- Liaises with TTL and put lab on standby, as applicable
- Ensures porter is present and available
- Is familiar with MTP and prevention of coagulopathy
- Has MTP printed and available to follow
- Primes rapid infuser, if requested
- Liaises with Hemovigilance officer

On arrival:

- Assists with transfer of patient
- Informs lab of patient demographics to ensure that O negative is safe to use
- With assessment doctor and from AMPLE history, establishes if patient is taking antiplatelet or anticoagulant medications
- Reminds procedure team to take G+X-match sample and fibrinogen pre-transfusion
- Manages the rapid infuser and administers blood and blood products if MTP is activated
- Ensures safe practice and appropriate checking and documentation of blood products for transfusion
- Liaises with blood bank regarding transfusions, ensuring medical team involvement
- Liaises with TTL regarding on-going transfusions (e.g. pack 2)
- Liaises with Scribe to ensure strict documentation and pH, Hb, K+, Ca²⁺, Lactate and Base Excess results are updated as transfusions progress

INFUSION NURSE

- ED nurse

Prior to arrival:

- Ensures full PPE is worn
- Prepare drugs and infusions as requested

On arrival:

- Assists with transfer of patient

- Removes clothing and covers with warm blanket or external warming device
- Attaches monitoring and obtains first vital signs as a priority
- Assists with IV access, collecting and labelling bloods
- Confirms and prepares correct medications and doses
- Communicates all medications and fluids administered to the TTL
- Prepares for transfer of patient

RADIOGRAPHER

The TT should include a Radiographer in ED and CT radiographer on-site 24/7.

Prior to arrival:

- Preloads plates on ED trolley for imaging
- Ensures that every team member is wearing a lead apron. (Lead aprons should be clearly marked with role allocation).

On arrival:

- Performs trauma series X-rays (CXR, lateral C-Spine, and/or Pelvis) as requested
- Performs additional imaging after secondary survey, as required
- Alerts TTL to any unusual/critical findings as well as fractures etc.
- Remains with TT until told he/ she is stood down
- Ensures radiology requests are made prior to leaving department

ADVANCED PARAMEDIC

Prior to arrival:

- Ensures pre-alert to hospital using ASHICE (where possible)
- Ensures that hospitals are informed of changes in the patient's condition (where possible)

On arrival:

- Informs TTL of changes in the patient's condition
- Informs TTL immediately of uncontrolled external haemorrhage, unsafe airway or loss of central pulse
- Assists with transfer of patient
- Ensures handover to TTL using IMIST AMBO
- Remains on hand to answer any other questions from the team
- Assists with Airway, Assessment and Procedures (as required)

NON-CLINICAL TRAUMA TEAM MEMBERS

These are essential team members that are vital in terms of flow and forward trajectory of the patient.

PORTER

Prior to arrival

- Receives pre-brief from TTL
- Ensures PPE is worn
- Ensures X-ray compatible trolley is available to receive patient
- Brings sample for crossmatch to the laboratory and collects blood for transfusion, as required

On arrival

- Assists with transfer of patient
- Informs TTL when blood products arrive
- Liaises with TTL and transfusion nurse regarding ongoing transfusion requirement
- Ensures lab are aware when MTP is stood down in consultation with the transfusion nurse
- Prepares patient for transfer including ensuring adequate oxygen supply

HEALTHCARE ASSISTANT

Prior to arrival

- Ensures PPE is worn
- Receives pre-brief from TTL

On arrival

- Assists with transfer of patient
- Removes clothing and covers with warm blanket or external warming device
- Liaises with Nurse Team Leader

CLERICAL

Within the proposed trauma network, their role within the TT is to expedite the acquisition of a unique Medical Record Number (MRN) identifying the patient, even before their identity is known. This optimises the speed with which investigations can be performed and blood products administered.

Prior to arrival

- Ensures default Trauma pre-registration

On arrival

- Confirms patient details if available and generates Medical Registration Number (MRN)
- Informs team of previous attendance and/or existing MRN
- The original MRN should not be changed for 24 hours to avoid duplication, reduce risk and confusion
- Only changes the details on system once confirmed with TTL

SOCIAL WORKER

- Greets relatives when they arrive and escorts them to Relatives Room and/or supports them during the resuscitation
- Talks to the family regarding events surrounding the trauma and attempts to ascertain their perceptions
- Informs medical and nursing staff that the family is present
- Obtains a psychosocial history and informs medical and nursing staff if relevant
- If a trauma patient dies in the resuscitation area, or is brought in dead (BID) the social work staff member will:
 - Be present when the family are informed of the death
 - Work with the immediate grief of the family
 - Assist in contacting family, friends and/or clergy if requested
 - Help family decide if they wish to see the body and support them through this
 - Assist family with immediate plans for post-mortem, organ donation, funeral etc.
 - Support family during process of notification to the coroner, identifying body to An Garda Siochana etc.
- Notifies staff when family leaves
- Ensures referral to bereavement counselling as appropriate

WHO IS PART OF THE TRAUMA TEAM INTERNATIONALLY? UNITED KINGDOM (UK)

Several reports including '*Trauma: Who cares?*'¹⁴ highlighted the need for better and more organised trauma care in the UK. In 2010, trauma networks were introduced, initially in London, followed by the roll-out of regional networks by NHS England in 2012⁶.

The key elements of this national, inclusive hub and spoke system are as follows:

TRAUMA NETWORKS (TN)

There are 27 TN serving a population of 65.5m. Each of the TN includes all providers of trauma care, particularly pre-hospital services, hospitals receiving acute trauma admissions and rehabilitation services with appropriate links to the social care and the voluntary/community sector.

MAJOR TRAUMA CENTRE (MTC)

An MTC is the hub of each TN which manages all types of injuries and provides consultant-level care. Each MTC is optimised for the definitive care of injured patients. The MTC provides all the major specialist services relevant to the care of major trauma: Anaesthesiology, General Surgery, Emergency Medicine, Vascular Surgery, Trauma & Orthopaedic Surgery, Plastic & Reconstructive Surgery, Spinal Surgery, Maxillofacial Surgery, Cardiothoracic Surgery, Urological Surgery Neurosurgery, Interventional Radiology and Intensive Care Medicine. They also provide a managed transition to rehabilitation and the community.

There are 27 MTCs in England, 11 treat adults and children, 11 treat adults only and 5 treat children only.

TRAUMA UNIT (TU)

The TU (spoke) is a hospital within a TN that provides care for most types of injuries. Depending on the injuries sustained, major trauma patients can be taken to these hospitals for definitive care rather than to the MTC.

The local Emergency Hospital is a hospital within a TN with an ED that does not have the required range of services or expertise to comprehensively manage every type of trauma patient. It treats other injuries and non-trauma related illnesses requiring urgent treatment.

In 2000, the Royal College of Surgeons in England (RCSEng) suggested that all hospitals should have a TT. This was subsequently supported by the National Confidential Enquiry into Patient Outcome and Death in 2007 (9). The National Health Service (NHS) Clinical Advisory Group (2010) recommended that the TT in an MTC should be led by a consultant and by a registrar with experience working at trauma units. With the re-organisation of trauma care in the UK in 2012 and the implementation of the 27 MTCs, the reception and resuscitation by a

TT are mandatory and have become the standard of care in the reception and resuscitation of severely injured patients.

NATIONAL INSTITUTE FOR HEALTH AND CARE EXCELLENCE (NICE) GUIDANCE

NICE clinical guidelines are recommendations for the care of individuals within the NHS (National Health Service) in the UK based on the best available research evidence with the aim of improving the quality of healthcare.

NICE Clinical Guideline 1.4

Recommendations for senior managers in Trauma Units

1.4.1 Ensure that multispeciality trauma teams are activated immediately in trauma units to receive patients with major trauma.

1.4.2 Do not use a tiered team response in trauma units.

1.4.3 Have a paediatric trauma team available immediately for children (under 16s) with major trauma.

Recommendations for senior managers in Major Trauma Centres

1.4.4 Consider a tiered team response to receive patients in major trauma centres.

This may include:

- a standard multispeciality TT **or**
- a standard multispeciality TT plus specialist involvement (for example, code red for major haemorrhage) and mobilisation of supporting departments and services such as blood transfusion, Interventional Radiology and appropriate Surgical speciality.

1.4.5 Have a paediatric TT available immediately for children (under 16s) with major trauma.

Thus, a multidisciplinary NHS TT should consist of the following as a minimum requirement.

Team member	Typical UK grade
Trauma team leader (TTL)	Consultant, usually from Emergency Medicine
Primary survey doctor	Emergency Medicine specialty trainee
Anaesthetist	Specialty trainee 5–7, Post final FRCA
Operator department practitioner	NHS Agenda for Change Band 5–6
Scribe (Trauma Nurse Coordinator)	NHS Agenda for Change Band 7
Emergency Medicine Nurse 1	NHS Agenda for Change Band 5
Emergency Medicine Nurse 2 and 3	NHS Agenda for Change Band 5
Runner (health care assistant)	NHS Agenda for Change Band 2
Orthopaedic surgeon	Specialty trainee 4–7
General surgeon	Specialty Trainee 4–7
Radiographer	

INDEX CASE 1

THE ROYAL LONDON HOSPITAL (RLH), WHITECHAPEL, LONDON, UNITED KINGDOM

The MTC at the RLH is the busiest in Europe treating more than 1,600 injury patients annually. It is also the home of London's Air Ambulance and the hub of the North East London and Essex Trauma Network, the first and largest Trauma Network in the UK, providing trauma care for more than 5 million people.

'AB, a 27-year-old male with no relevant past medical history, struck by a moped while leaving his house on his way to work. Ambulance called by passer-by. Pre-alert to the RLH identified as having mainly head injuries and documented GCS of 14/15. A Code Black Trauma Call was initiated ensuring the patient was received by a TT and a Neurosurgeon on arrival. His GCS had dropped to 8/15 on reception and his airway was secured prior to transfer to CT. An extradural haemorrhage was diagnosed, and he was immediately transferred to OT for evacuation.'

RLH Trauma call	RLH Team Configuration
Adult	TTL, Orthopaedic SHO, Surgical SHO, EM SHO, ED Nurse, ED Radiographer
Paediatric < 16yrs	TTL, Paediatric Anaesthetist, Paediatric Surgical SpR, Paediatric SpR, Paediatric SHO, ED Nurse x 2, Paediatric nurse x 1, Trauma Operating department Practitioner (ODP), ED Radiographer, Social worker
Advanced	TTL, Anaesthetist, Surgical SpR, & SHO, Trauma & Orthopaedic SpR & SHO, ED Nurse x 2, Trauma ODP, ED Radiographer, Social Worker
Code Red	TTL, Anaesthetist, Surgical SpR, & SHO, Trauma & Orthopaedic SpR & SHO, ED Nurse x 2, Trauma ODP, ED Radiographer, After trauma Team member
Code Black	As above plus Neurosurgical Con / SpR & SHO

AUSTRALIA – STATE OF VICTORIA

Victoria has a population of 6.9 million. The annual report from Victoria State Trauma Registry (VSTR) 2016-17 noted 3460 major trauma cases with 96% of these cases relating to non-penetrating injury. Following publication of the Review of Trauma and Emergency Services - Victoria (RoTES) report in 1999, the Victorian State Trauma System (VSTS) was introduced in 2000. This has led to preventable death and disability from major trauma being reduced significantly. The system is based on the designation of two adult hospitals, (The Alfred Emergency & Trauma Centre and the Royal Melbourne) and one paediatric hospital (Royal Children's Hospital) as MTCs, with other Victorian hospitals assigned to levels within a tiered structure that reflect their different capabilities in trauma management.

INDEX CASE 2

THE ALFRED EMERGENCY & TRAUMA CENTRE, MELBOURNE, AUSTRALIA

The Alfred Hospital is the busiest trauma centre in Australasia with over 5,000 trauma patients are admitted annually, 1,000 of which are classed as major trauma.

'Pre-alerted 44-year-old male, factory worker, trapped between forklift and wall, apparent pelvic and lower limb injuries, hypotensive, tachycardic, clammy and confused. Tranexamic acid given pre-hospital. Binder in situ. Met by Trauma Team on arrival. E-FAST neg. Portable imaging revealed comminuted pelvic ring fracture. MTP initiated but only transiently responded. Transferred directly to Interventional Radiology (IR) for embolization of arterial bleed and subsequently to intensive care for on-going re-warming and management of coagulopathy.'

Trauma Team Configuration at the Alfred Hospital

Mandatory team
Consultant/Registrar in EM Trauma Registrar +/-Trauma Surgeon Anaesthetist Critical Care Nurse Leader Airway Nurse Circulation Nurse Radiographer Trauma Centre Orderly ICU Registrar Specific speciality
Notified Only
Blood bank Director of Trauma Director of Emergency and Trauma Centre Nurse Manager Emergency and Trauma Centre Other designated Staff

UNITED STATES OF AMERICA

In 1966, the US National Academy of Sciences published the influential report titled, *Accidental Death and Disability: The Neglected Disease of Modern Society*. This landmark report was vital in the development of the emergency medical services system in the US, leading to significant improvement in pre-hospital care, co-ordination of care within Trauma Systems, as well as a focus on functional rehabilitation.

Trauma centres in the US are ranked by the American College of Surgeons (ACS) from Level I (comprehensive service) to Level III (limited care). The different levels refer to the resources available in a trauma centre and the number of patients admitted yearly.

The earliest systems of trauma care were founded on two principal components:

(1) Trauma care was concentrated within centres dedicated to the care of those with major trauma; and

(2) Pre-hospital bypass protocols were in place to ensure that patients with major trauma were transported to the dedicated trauma centre and not to the closest facility.

It became evident that this 'exclusive' approach to trauma care was inadequate and an inclusive configuration was implemented.

ATLS (ADVANCED TRAUMA LIFE SUPPORT)

Developed by the American College of Surgeons, ATLS is a training programme for medical practitioners in the management of acute trauma cases. The programme has been adopted worldwide in over 75 countries. Its goal is to teach a simplified and standardised approach to trauma care. Originally designed for emergency situations where only one doctor and one nurse are present, ATLS is now widely accepted as the standard of care for initial assessment and treatment in trauma centres. The premise of the ATLS programme is to treat the greatest threat to life first. The concept of TTs has been mentioned in ATLS since the 1970s but not emphasised. However, its latest edition (10th) states that 'despite advances in trauma care, primary threats to patient safety have been attributed to teamwork failures and communication breakdown'. 'In the dynamic and unique emergency department (ED) environment, complex trauma care requires strong inter-professional teamwork and resource management'. It further states that 'success requires not only individual competence but also a well-coordinated trauma team.' ATLS 10 places emphasis on the TT, including a new teamwork section in each chapter and a new appendix focuses on Team Resource Management.

INDEX CASE 3

SHOCK TRAUMA CENTRE (STC), BALTIMORE, MARYLAND, USA.

In contrast to the Inclusive Trauma systems in the UK and Australia, R Adams Cowley Shock Trauma is a purpose built exclusive Major Trauma Centre. It has been a worldwide

leader in trauma care for over forty years admitting 8,000 injured trauma patients per annum.

'17-year-old male, no relevant past medical history, victim of alleged assault. Ambulance called by passer-by. Paramedics identified the victim as having gunshot wounds to head, chest and abdomen and being haemodynamically unstable. Pre-alert to STC ensured that Priority TT were there to receive and resuscitate the patient. The patient's airway was secured, he received bilateral thoracostomies, the massive transfusion protocol (MTP) was initiated, and he was transferred to the Operating Theatre'.

Trauma Team configuration at STC

Trauma Call	Priority Trauma Call
Fellow - Surgical	Attending Surgeon
Resident - Surgical	Fellow - Surgical
Fellow - Anaesthetics	Fellow - Anaesthetics
ED Nurse 1	Resident - Anaesthetics
ED Nurse 2	ED Nurse 1
ED ODP 1	ED Nurse 2
After Trauma Team	ED ODP 1
Researcher	ED OPD 2
	Theatre Nurse Manager
	Social Worker
	Pastoral care
	Researcher

WHAT IS A TIERED TRAUMA TEAM?

Some studies have found the use of TTs to be both time and labour intensive. However those that evaluated tiered TTs supported the idea of their implementation. Activation criteria are designed to over-triage and it can be challenging to maintain engagement if significant redundancy or recurrent 'stand-downs' of the TT occur. Jenkins, et al. examined a two-tiered trauma response in the UK and demonstrated that it is safe, cost effective and leads to appropriate utilisation of resources¹⁵.

The most appropriate trauma call response is one that gives best patient care but impacts minimally on other patients and hospital resources¹⁶. This can be achieved using a two-tiered TT approach which involves a smaller trauma team, usually from within the ED (i.e. EDTT), with the capability to undertake initial assessment and management, with access to a multispeciality larger team if the situation dictates i.e. Hospital Trauma Team (HTT). These teams are activated (either pre-hospital or in-hospital) in response to information about mechanism of injury, physiology, injuries sustained and/or other set criteria. The EDTT is activated in response to the mechanism of injury alone, while a larger trauma team is only activated when there is further suggestion of severe injury manifested by abnormal physiology, significant anatomic injury, or other criteria. It is important to note that both teams are forms of trauma call response, immediately mobilising appropriately trained staff to assess and treat the patient. The trauma response is thus more flexible and can be escalated or de-escalated as appropriate.

The American College of Surgeons, Committee on Trauma (ACS/CoT) also refers to a *tiered trauma* response by stating that 'the size and composition of the Trauma Team may vary with hospital size, the severity of injury and the corresponding level of trauma team activation'.

FULL Trauma Team Criteria			LIMITED Trauma Team Criteria	
Persons who sustain injury with any of the following			Persons who sustain injury with any of the following	
PRIMARY SURVEY: PHYSIOLOGIC			MECHANISM OF INJURY	
Airway	Unable to adequately ventilate Intubated or assisted ventilation	Unable to adequately ventilate Intubated or assisted ventilation	<ul style="list-style-type: none"> - Falls; adult >20 ft; child >10 ft or 3x height - Fall from any height if anticoagulated older adult 	
Breathing	Respiratory rate <10 or >29 per minute	Any sign of respiratory insufficiency (hypoxia, accessory muscle use, grunting)	<ul style="list-style-type: none"> - High-risk auto crash with: <ul style="list-style-type: none"> - Intrusion of vehicle >12" in occupant compartment; >18" in other site - Ejection (partial or complete) from automobile - Death in same passenger compartment 	
Circulation	SBP <90 mm Hg perfusion	Any sign of abnormal (capillary refill >2 secs, BP low for age)	<ul style="list-style-type: none"> - Auto vs. pedestrian/cyclist thrown, run over, or with significant (>20 mph) impact - Motorcycle crash >20 mph 	
		Age <1 y 1-10 y >10 y	SBP (mm Hg) <60 <70 + 2x age <90	<ul style="list-style-type: none"> - High-energy dissipation or rapid decelerating incidents, for example: <ul style="list-style-type: none"> - Ejection from motorcycle, ATV, animal, and so on
Deficit	GCS motor score ≤5, GCS ≤13	AVPU: responsive to pain or unresponsive	<ul style="list-style-type: none"> - Striking fixed object with momentum - Blast or explosion 	
<ul style="list-style-type: none"> - Deterioration of previously stable patient - Transfers requiring blood transfusion 			<ul style="list-style-type: none"> - High-energy electrical injury 	
SECONDARY SURVEY: ANATOMIC			<ul style="list-style-type: none"> - Burns >10% TBSA (second or third degree) and/or inhalation injury - Suspicion of hypothermia, drowning, hanging - Suspected nonaccidental trauma - EMS provider judgment 	
<ul style="list-style-type: none"> - Penetrating injuries to the head, neck, torso, or extremities proximal to the elbow/knee - Open or depressed skull fracture - Paralysis or suspected spinal cord injury - Flail chest - Unstable pelvic fracture - Amputation proximal to the wrist or ankle - Two or more proximal long bone fractures (humerus or femur) - Crushed, degloved, or mangled extremity 			<ul style="list-style-type: none"> - Blunt abdominal injury with firm or distended abdomen or with seatbelt sign 	

WHEN SHOULD A TRAUMA TEAM BE ACTIVATED?

Given the lack of a national trauma system for Ireland, there are currently no accepted or standardised major trauma activation criteria in either the pre-hospital and hospital setting.

In response to major trauma and the heterogeneity of patients, the decision to activate a mandated TT response remains a challenge. Internationally, many systems employ pre-hospital as well as intra-hospital ED activation criteria which are often similar and frequently identical. The criteria are centered around clinical information based on mechanism of injury (MOI), physiological status, injuries sustained by the patient¹⁷ and/or other set criteria.

Individually, these criteria are unreliable. MOI is a useful tool but not a consistent predictor of injury severity. Physiological signs are often unchanged in many patients and caution must be applied to different cohorts of patients, e.g., children, the elderly and those on anti-hypertensive or anti-arrhythmic medications. Holcomb, et al. in 2005 showed that despite displaying normal physiology on initial assessment, significant injury was still possible. Similarly, limb-threatening injuries may not cause derangement in vital signs but may still require a multispeciality TT response for optimum patient care¹⁸. Anatomical deformity or significant co-morbidity are helpful when ruling in patients for a trauma response but their absence does not rule out significant injury according to Scheetz, et al., 2010¹⁹.

In 2000, the Royal College of Surgeons in England published guidance suggesting criteria for activation of a TT. Evidence to support these criteria is limited and few departments are currently using them (Larsen et al., 2010)²⁰.

In 2018, Waydhas C et al., developed a consensus-based criteria defining the necessity for TT activation (appendix 4). They sought opinion from a group of international trauma specialists with a specific interest in triage who had previously participated in guideline development. A literature search was conducted to identify criteria that had already been used or suggested. The initial list of criteria was discussed in two Delphi rounds and two consensus conferences. Initially 95 criteria were identified and subsequently reduced to 20 final criteria to indicate the requirement for attendance of a TT. The criteria address aspects related to injury severity, admission to an intensive care unit, death within 24 h, need for specified invasive procedures, need for surgical and/or interventional radiological procedures, and abnormal vital signs within a defined time period. They concluded that the selected criteria may be applied as a tool for research and quality control concerning TT activation but that future studies were necessary to evaluate for redundancy that may allow for further reduction in criteria.

WHEN ARE TRAUMA TEAMS ACTIVATED INTERNATIONALLY? ROYAL LONDON HOSPITAL, WHITECHAPEL, LONDON, UNITED KINGDOM

Five different trauma team calls exist at the RLH. An Adult Trauma Call is activated if the patient satisfies MOI criteria but remains haemodynamically stable. Unstable adult patients will generate an Advanced Trauma Call response. A patient that is felt to be bleeding will generate a Code Red response and a patient that is thought to have a significant head injury likely to require neurosurgical intervention mandates a Code Black response. Injured patients under the age of 16 years will generate a Paediatric Trauma Call.

Type of Trauma call	Activation Criteria
Adult	Trauma due to MOI Activated in ABSENCE of anatomic or physiological injury
Paediatric < 16yrs	Child with evidence of anatomic or physiological injury
Advanced	Activated with evidence of anatomic or physiological injury All helicopter transfers, trauma in the elderly, penetrating injury to chest/abdomen
Code Red	Physiological instability likely to require MTP & damage control surgery or Interventional Radiology
Code Black	Significant head trauma likely to require emergency neurosurgery after CT

THE ALFRED EMERGENCY & TRAUMA CENTRE, MELBOURNE, AUSTRALIA.

The TT responds to *all* patients that satisfy any of the listed criteria regarding MOI, injury sustained, vital sign abnormality, treatments delivered as well as other specified criteria. To maintain standardisation of the TT response, a full TT is generated for every trauma call, regardless of severity.

TRAUMA TEAM ACTIVATION CRITERIA

Mechanism of Injury	MBA/Cyclist impact >30kph Pedestrian impact >30kph Extrication > 30mins Vehicle rollover Fatality in same Vehicle Ejection from Vehicle Fall >3m Explosion
---------------------	---

Injuries sustained	All significant blunt injuries All penetrating head, neck, trunk incl. groin and axilla All injuries involving: Suspected spinal cord injury Traumatic amputation proximal to carpus/talus Pelvic # / pulseless limb / # dislocations with vascular compromise Evisceration Blast injuries Severe crush injuries Serious burns > 20% TBSA (All facial burns)
Vital Signs	SBP < 100mmHg (<75mmHg in a child) GCS <14 SpO2 <90% RR <10 or >30
Treatments delivered	Any airway manoeuvres incl. intubation Assisted ventilation Pleural decompression Haemostatic dressings/tourniquet application >1000mL IV Fluids or Blood transfusion Neuromuscular blockade
Other Criteria	Multiple casualty incident (> 1 patient reception simultaneously) All inter-hospital transfers Pregnancy Significant co-morbidities Anti-coagulant therapy

UNITED STATES OF AMERICA AMERICAN COLLEGE OF SURGEONS COMMITTEE ON TRAUMA (ACS COT)

Specific criteria for TT activation have been suggested by the ACS COT as far back as 1986. The ACS/COT 2006 suggested using pre-hospital data such as MOI, physiological variables, anatomical deformity and co-morbidities.

The criteria for a graded activation must be clearly defined by the trauma centre, with the highest level of activation including the six requiring criteria listed below;

Confirmed blood pressure < 90mm Hg at any time in adults and age-specific hypotension in children
Gunshot wounds to the neck, chest or abdomen or extremities proximal to the elbow/knee
GCS <9 with mechanism attributed to trauma
Transfer patients from other hospitals receiving blood to maintain vital signs
Intubated patients transferred from scene
Patients who have respiratory compromise or are in need to emergent airway
Emergency physician's discretion

ACS suggests that the field triage decision scheme should have a rate of over triage below 25–35% should be achieved and that the rate of under triage should not exceed 5%.

EASTERN ASSOCIATION FOR THE SURGERY OF TRAUMA (EAST)

The EAST Practice Management Guidelines Working Group examined 52 clinical studies to determine what factors should determine triage of the major trauma patient:

A	Physiology
B	Anatomy
C	Mechanism
D	Co-morbidities / modifying factors
E	Field triage scores

The Group felt that the primary message from existing literature was that a combination of physiologic, anatomical, and select mechanistic criteria provided the best performance for pre- hospital and in-hospital triage of the trauma patient. Physiologic criteria gave the highest yield followed by anatomical criteria. Certain mechanisms of injury performed better than others and comorbidities and field personnel judgment had the lowest yields.

It offered the view that extremes of age should be given more importance in the triage of the trauma patient but none of these should be used as the sole criterion for triage decisions.

The working group found that triaging patients into a tiered trauma response in-hospital can be highly effective and reduce unnecessary resource utilisation while maintaining quality of care.

SHOCK TRAUMA, BALTIMORE, MARYLAND, USA

All patients arriving to the STC are met by a TT, however injured patients that satisfy set criteria which include injuries sustained, abnormal vital signs, mechanism of injury and others will be met by a Priority Trauma Team on arrival.

PRIORITY TRAUMA ACTIVATION CRITERIA

Injury
2 or more long bone fractures
Amputation proximal to the ankle
Chest wall injuries or deformity (e.g. Flail Chest)
Crushed, mangled, degloved or pulseless extremity
Open or depressed skull fracture
Penetrating injuries to head, neck, torso or extremities proximal to elbow and knee

Pelvic fracture ('Open book', i.e. pelvic binder placed)
Paralysis (indicating spinal injury)
Vital Signs
SBP <90mmHg (Adult); or SBP <60mmHg (Children)
RR <10 or >29
Need for ventilatory support
GCS <13
Mechanism of Injury
Intrusion, Ejection, Death of another Passenger in same vehicle, Rollover w/o restraint
Pedestrian v Motor Vehicle > 20mph
Motorcycle > 20mph
Falls (Adult > 20 ft; Children > 10Ft or x 3 times the child's height)
Blast exposure or Explosion
Other
Age >55 years
Burns
Pregnancy > 20/40
EMS provider judgement
Anticoagulants or Bleeding disorders

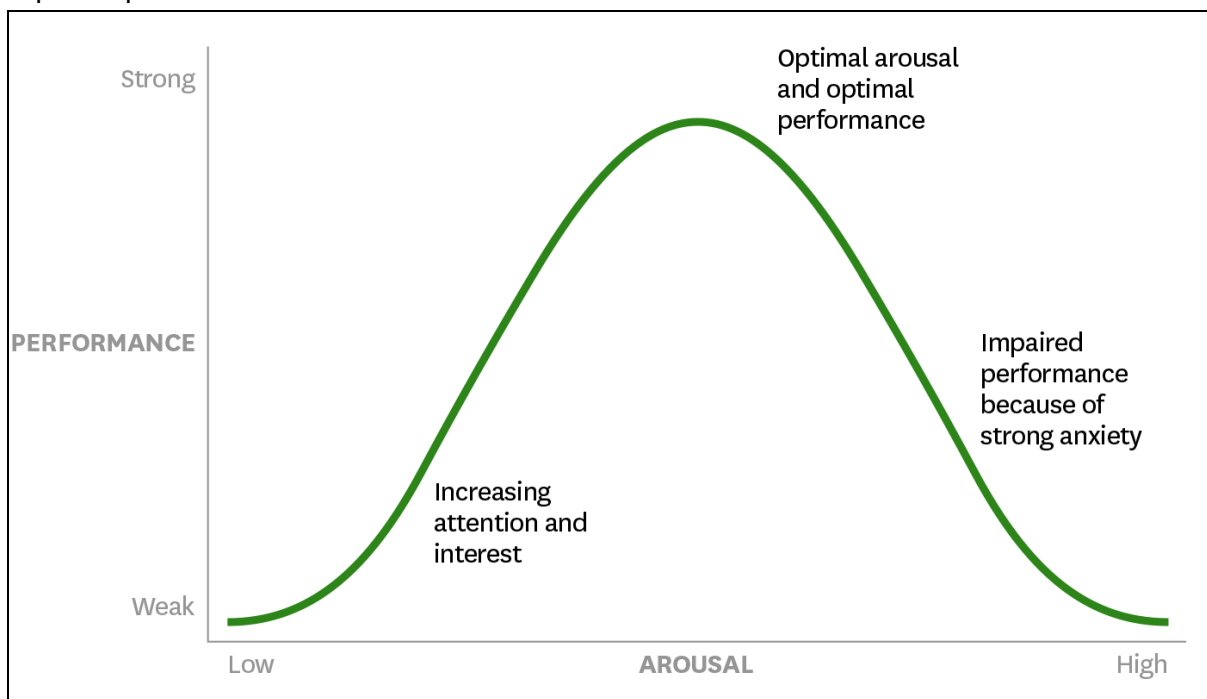
It is clear that a tiered TT response is required for Ireland to ensure that the hospital system is minimally impacted by the activation of a TT while ensuring that the injured patient receives the optimum response.

TRAUMA TEAMS – THE HUMAN FACTOR

Trauma resuscitation is a challenging dynamic on both a technical and non-technical level. The Zero- point survey suggests that successful resuscitation begins before the point of first patient contact. TT members must prepare themselves, their team, their environment, and the system ²¹.

INDIVIDUAL PREPARATION

TTMs need to be equipped with a suite of psychological skills to manage stress. Stress brings with it a level of arousal. Managing this stress and should lead to optimum performance, however, as the Yerkes-Dodson law suggests, excessive anxiety can result in impaired performance.



TTMs must manage their own stress with controlled breathing exercises and visualisation of the task at hand. Self-prep talk before the procedure and during scheduled pauses can help optimise the stress response during complex trauma resuscitation²².

TEAM INTERACTION

A high-performance TT should maintain excellence in communication, use an adaptive structure and co-ordinated workload effectively and efficiently. Successful resuscitation begins with mental rehearsal before the patient contact. Team performance can be boosted by building a shared mental model of trauma care²³.

In trauma, TTs should expect the unexpected as resuscitation can often take unanticipated twists. Discussing these as a team ahead of time allows troubleshooting and building of shared cognitive processes. Common goals should be set; 'what do we know? What can

we expect? What will we change? What are our roles?’

Interactions between individual TTMs are often challenging. A common language must be maintained. TTMs should practice concise and precise language without being impolite or offensive. Defining resuscitation terminology can help deliver focused questions leading to direct answers, ‘confirm’, ‘I repeat’, ‘I request’, ‘read back’ etc.

Error-free trauma resuscitations are uncommon⁷ and adverse events occur in hospital in 1 in 10 patients. This is commonly due to communication breakdown between healthcare professionals. TTMs must practice closed-loop communication. Concern about a course of action can be expressed in a graded assertiveness fashion using the two-challenge rule Concerned-Uncomfortable-Safety issue (C-U-S). In 2016 the World Health Organisation (WHO) introduced a trauma care checklist (appendix 7) for use in between Primary and Secondary Surveys. Time-out protocols such as this have been proposed to improve team dynamics, communication, promote common team goals and create standardised care pathways thereby reducing adverse events and improving patient outcomes⁸.

ENVIRONMENTAL OPTIMISATION

Chaotic Resuscitation rooms can create a gap between strategy and logistics. Improving awareness can attempt to address this. Poorly designed spaces lead to sequential failures. Preparation is key; failing to prepare is preparing to fail.



Clinical logistics (space, equipment and process) should be optimised involving an iterative

Quality Improvement process of design, testing and refinement. This facilitates provider focus on performance and execution and not searching for equipment.

SYSTEM RESILIENCE

Systems capable of resilient performance are robust and dynamic and thereby function in both expected and unexpected conditions.

Well-designed systems should have the ability to;

1. Respond
2. Monitor
3. Learn
4. Anticipate

TRAUMA TEAM SIMULATION TRAINING

Getting trauma care right involves repetitive exposure and constructive adaptation. Trauma Team Simulation Training (TTST) allows for preparation as a team; to manage the environment and debrief case complexity²⁴. Stress inoculation training has been shown to improve team-based technical and non-technical performance²⁵. In-situ simulation facilitates TTs training in the resuscitation area and incorporates elements of clinical logistics that are difficult to reproduce in a simulation laboratory²⁶.

'Hot' debriefs are designed to identify latent safety threats and constructive feedback can improve team performance. Debriefing after real-time events poses additional challenges in terms of physical, emotional, and cognitive availabilities of team members²⁷. To help the system respond, monitor, learn and anticipate, documentation and follow-up of issues identified during debriefings are essential to ensure safety concerns are addressed²⁵.

TRAUMA TEAM LEAD / TRAUMA TEAM MEMBER COURSES:

Members of the TT should be skilled and appropriately credentialed in the management of major trauma patients.

ATACC - ANAESTHESIA, TRAUMA AND CRITICAL CARE

Established over 20 years ago in the UK, ATACC is now widely accepted as the most advanced trauma course currently available across the globe. ATACC is fully accredited by the RCS Eng. The three-day course trains candidates in the management of the trauma patient from the roadside to critical care with half of the course pre-hospital and half in-hospital. ATACC includes all of the essential elements for pre-hospital care and all the requirements for staff working in a major trauma centre.

RESUSCITATE- EMERGENCY SURGICAL SKILLS COURSE IN TRAUMA

RESUSCITATE teaches practitioners the emergency surgical skills required for resuscitation in trauma. Using fresh donor cadavers, the course is held at the ASSERT centre on the campus of University College Cork (UCC). The national and international faculty are from the disciplines of Emergency Medicine, Critical Care, Pre-hospital, Trauma Surgery and Obstetrics and Gynaecology. Skills taught on the course include craniotomy, lateral canthotomy, thoracotomy, hysterotomy and more.

THE PROCEDURES COURSE

The Procedures Course is a two-day course that teaches a wide range of basic and complex resuscitative procedures. It is a collaboration between The Alfred Trauma Service, Alfred Emergency & Trauma Centre, National Trauma Research Institute and Monash University in Australia. The course is taught on fresh, donor cadavers, and is held in Melbourne, Sydney, Brisbane, Adelaide (Australia) and Leuven (Belgium). Sessions place a heavy emphasis on acquiring hands-on skills for the management of the multiply injured complex trauma patient.

ATLS (ADVANCED TRAUMA LIFE SUPPORT)

Developed by the American College of Surgeons, ATLS is a training programme for doctors in the management of acute trauma cases. The program has been adopted worldwide in over 75 countries. Its goal is to teach a simplified and standardised approach to trauma care. Originally designed for emergency situations where only one doctor and one nurse are present, ATLS is now widely accepted as the standard of care for initial assessment and treatment in trauma centres. The premise of the ATLS programme is to treat the greatest threat to life first.

EUROPEAN TRAUMA COURSE

The ETC is a joint programme of the European Resuscitation Council (ERC), the European Society of Anaesthesiology (ESA), the European Society for Trauma and Emergency Surgery (ESTES) and the European Society for Emergency Medicine (EuSEM). It is a 2.5-day Life Support course for doctors and other medical health care professionals that are involved in the acute care of major trauma patients. ETC provides trauma training with a strong focus on teamwork and non-technical skills. The ETC is a hands-on course where candidates spend 85% of their time practicing in scenario-based workshops. Candidates are trained in small groups simulating trauma teams working in a shock-room environment. The scenarios are simulations with a strong focus on teamwork, communication, and non-technical skills.

ACCOUNTABILITY FRAMEWORK FOR MEMBERS OF THE TRAUMA TEAM

Trauma should generate the same call to action that is seen in other time-sensitive clinical scenarios such as cerebrovascular accidents (FAST - Face, Arms, Speech and Time) and myocardial infarction (STEMI - ST Elevation Myocardial Infarction).

PRESCRIBED RESPONSE TIME

The ACS suggests that in Level I and II trauma centres, the highest level of activation requires the response of the full trauma team *within 15 minutes of arrival of the patient*. In Level III and IV trauma centres, the team must be fully assembled *within 30 minutes*.

WHAT WILL A TRAUMA TEAM LOOK LIKE AT A MAJOR TRAUMA CENTRE IN IRELAND?

The recommendations in this TT position paper assumes human resource support for altered working patterns and numbers of the required specialists on 24/7 basis.

An inclusive system consisting of regional Trauma Network organised around a Major Trauma Centre has been recommended as the most appropriate configuration to adopt for Ireland (3).

The MTC will serve as the hub of the network and will be equipped and organised to manage all patients with major trauma, including those with time-critical injuries (e.g. major haemorrhage, traumatic brain injury) in addition to the multiply injured requiring complex or subspecialised reconstruction.

Each MTC will have:

- a TT with clearly identified expertise and appropriate credentials in the area of trauma care
- a TT led by a Consultant in one of Emergency Medicine, Trauma, Trauma and Orthopaedic Surgery, General Surgery or Anaesthesiology/Critical Care and available on a 24/7 basis
- Consultants will be asked to opt-in or out of inclusion in such a rota
- TTs in MTCs should include members of each of the following specialties (as required):

Emergency Medicine, Trauma & Orthopaedic Surgery, General Surgery and Anaesthesiology/Intensive Care 24/7, with prescribed response times for additional specialties which may be needed (these include Neurosurgery, Spinal and Spinal Cord Surgery, Vascular Surgery, Cardiothoracic Surgery, Plastic Surgery, Maxillofacial Surgery, Ear Nose and Throat Surgery, Diagnostic and Interventional Radiology).

- Senior trainees in all relevant specialties should be resident 24/7 and their consultants be available for physical attendance within 30 minutes
- Escalation to consultant level for additional in-patient specialties will be determined by the TTL in consultation with the relevant registrar
- Consultant Radiologist to be informed of TT activation
- In the case of Diagnostic Radiologists, the appropriate sub-specialists are those with special interest in Emergency Radiology or Musculoskeletal Radiology
- The TT should include a minimum of three ED nurses, at least one of whom should be of CNM2 grade or higher, a Health Care Assistant, a porter and a member of the clerical staff

ACTIVATION PROCESS

Activation of an appropriate TT response at an MTC will be triggered from the gathered pre-hospital/in-hospital data in terms of mechanism of injury, physiological variables, anatomical deformity, co-morbidities and other set criteria.

This can be initiated in two ways:

1. Prior to arrival of an injured patient in the ED on notification of a 'pre-alert' from ambulance control.
2. On arrival and assessment of the patient in the ED

Note: It is the responsibility of the person receiving the pre-hospital call to clearly document all information received in TRAUMADOC© and activate the appropriate trauma team.

Activation criteria will generate a tailored trauma team response to ensure optimal patient management but which impacts minimally on other patients as well as hospital resources. The optimal system to contact the members of a TT will depend on local communications infrastructure and it is envisaged that an MTC will have a robust communication system.

If the patient has a dangerous MOI but has normal vital signs, no anatomic injuries or other criteria as listed

- Emergency Department Trauma Team – EDTT

If the patient has a dangerous mechanism of injury and has abnormal vital signs, anatomic injuries or other criteria

- Hospital Trauma Team – HTT

If the patient has a GCS ≤ 8 with a suspicion of significant head injury likely to require neurosurgical intervention after CT or has unilateral or bilateral pupil changes suggestive of impending herniation

- **TRAUMA CODE BLACK**

If the patient has a systolic blood pressure of ≤ 90 mmHg, has a poor response to initial transfusion, suspected active haemorrhage or is likely to require a Massive Transfusion Protocol (MTP), damage control surgery or Interventional Radiology (IR)

- **TRAUMA CODE RED**

If the patient is <16 years of age

- **TRAUMA CODE PURPLE**

If the patient is pregnant ($\geq 20/40$ gestation)

- **TRAUMA CODE PINK**

If the patient is > 65 years of age and has suffered a dangerous MOI but is haemodynamically stable

- **TRAUMA CODE SILVER**

If the patient is > 65 years of age and has suffered a dangerous MOI and is

haemodynamically unstable, has anatomic injuries or other criteria as listed

- Activate **HTT***

* A lower threshold should be maintained for HTT activation in response to trauma in the elderly. (HTT call out via switchboard)

All incoming trauma notifications should be directed to the CNM2 and the Consultant in Emergency Medicine on Call.

GOVERNANCE OF TT ACTIVATION

All duty trauma call-out personnel are required to be contactable and available to attend the trauma call.

Non-attendance of 'must-attend' TT members should be escalated via a repeat call to switchboard.

Attendance at trauma calls will be audited with feedback to the hospital trauma audit governance committee and involve individual specialties as appropriate.

MECHANISM OF INJURY

- Motor Vehicle Accident $\geq 60\text{kph}$
- Motor/Cyclist impact $\geq 30\text{kph}$
- Pedestrian impact $\geq 30\text{kph}$

- Ejection from Vehicle
- Same vehicle rollover
- Fatality same vehicle

- Prolonged extrication >30 mins
- Explosion
- Fall ≥ 2 meters
- Fall (any height) on anticoagulation

WITH THE FOLLOWING

NORMAL PHYSIOLOGY

- RR 10-30bpm
- SpO₂ $\geq 90\%$
- SBP $\geq 90\text{mmHg}$
- HR 50 - 120bpm
- GCS ≥ 14



ACTIVATE ED TRAUMA TEAM

MECHANISM OF INJURY

- Motor Vehicle Accident $\geq 60\text{kph}$
- Motor/cyclist impact $\geq 30\text{kph}$
- Pedestrian impact $\geq 30\text{kph}$
- Ejection from Vehicle
- Same vehicle rollover
- Fatality same vehicle
- Prolonged extrication $\geq 30\text{mins}$
- Explosion
- Fall ≥ 2 metres
- Fall (any height) on anticoagulation

WITH ANY ONE OF THE FOLLOWING

PHYSIOLOGY

- RR ≤ 10 or $\geq 30\text{bpm}$
- SpO₂ $< 90\%$
- SBP $< 90\text{mmHg}$ (at any time)
- HR ≤ 50 or $\geq 120\text{bpm}$
- GCS < 13

ANATOMY

- Airway compromise (Actual or Potential)
- Airway/Facial burns
- Intubated patient
- Suspected severe chest/pelvic/upper thigh injury
- Crush injury
- ≥ 2 Long bone fractures
- Limb amputation proximal to wrist/ankle
- Pulseless limb
- Major burns ($> 20\%$ TBSA)
- Spinal paralysis
- Open or depressed skull fracture
- Evisceration

AND/OR OTHER

- Penetrating neck/chest/abdominal injury
- Gunshot Wounds
- ≥ 3 patients expected
- Near Drowning/Submersion
- All HEMS Trauma transfers



ACTIVATE HOSPITAL TRAUMA TEAM

TRAUMA ≥65 YEARS OF AGE

MECHANISM OF INJURY

- Fall > 3 steps
- Fall (any height) on anticoagulation or 2 antiplatelets
- Motor Vehicle Accident >50kph
- Pedestrian impact any speed
- Ejection from Vehicle
- Same vehicle rollover
- Fatality same vehicle
- Prolonged extrication >30 mins

WITH ANY ONE OF THE FOLLOWING

PHYSIOLOGY

- RR ≤12 or ≥ 24bpm
- SpO2 ≤90%
- Shortness of Breath
- SBP ≤90mmHg (at any time)
- HR ≥65bpm
- GCS <15
- Severe pain
- Lactate ≥ 2
- Base Excess ≤ -2

ANATOMY

- Injury ≥ 2 body regions
- Suspected head/spine chest/pelvic/upper thigh injury
- Open fracture
- Suspected shaft of femur fracture

Caution: Antiarrhythmics/antihypertensives may mask physiological response



ACTIVATE HOSPITAL TRAUMA TEAM

Trauma Team Members

CONSIDER CODED RESPONSE

Team

Indication

HOSPITAL TRAUMA TEAM

Consultant/Snr Registrar
in Emergency Medicine
Trauma Consultant/
Registrar
ICU/Anaesthetics Reg
Surgical Reg &
SHO
Ortho. Reg & SHO
Radiology Registrar
EM SHO
ED Nurse x 2
ED Radiographer
ED HCA
Porter
Ward Clerk
*

Dangerous MOI with abnormal
physiology, anatomic injury or
other criteria

After Trauma Team **ED TRAUMA TEAM**

Consultant/Snr Registrar
in Emergency Medicine
EM SHO
ED Nurse - CNM 2
ED Nurse - Resus
ED Radiographer
ED HCA
Porter
Ward Clerk

Dangerous MOI with normal
physiology and no anatomic
injury as listed

CODE BLACK

HTT Team members plus
Neurosurgical
Consultant/Registrar & SHO
*

GCS < 8 with
Suspicion of severe head injury
Pupillary changes suggestive of
impending herniation

Alert only (On call as applicable)

Consultant in EM, Radiology Consultant, General Surgery Consultant, Trauma & Orthopaedic Surgery Consultant, Anaesthesiology and ICU Consultant*

In cases outside of EDTT and Code Silver responses, the following should be alerted: Theatre Nurse manager, Patient flow, Blood bank

Trauma Team Members

CONSIDER CODED RESPONSE

Team

Indication

CODE RED

HTT Team
Members plus
Haemovigilance

SBP > 90mmHg
Poor response to initial transfusion
Suspected active haemorrhage

CODE PURPLE

HTT Team Members plus
Paediatric ICU Consultant / Snr
Registrar
Paediatric Surgery Consultant /
Snr Registrar & SHO
Paediatric Consultant /
Snr Registrar & SHO
Paediatric ED/ICU Nurse

< 16 years of age
(Abnormal vital signs for age)

CODE PINK

CODE PURPLE Team Members
plus
Obstetrics
& Gynaecology Consultant/
Snr Registrar & SHO
Theatre Nurse x 2

> 20/40 gestation
PV bleed
Foetal HR <100bpm

CODE SILVER

EDTT Team
Members plus
Frailty team

> 65 years of age

Alert only (On call as applicable).

Consultant in EM, Radiology Consultant, General Surgery Consultant, trauma & Orthopaedic Consultant, Anaesthesiology and ICU consultant*

In cases outside of EDTT and Code Silver responses, the following should be alerted: Theatre Nurse manager, Patient flow, Blood bank

WHAT WILL A TRAUMA TEAM LOOK LIKE AT A TRAUMA UNIT IN IRELAND?

The recommendations in this TT position statement assumes human resource support for altered working patterns and numbers of the required specialists on 24/7 basis.

A TU will be a hospital designated within the Trauma Network that provides care for most types of injuries including:

- Injuries that are within the expertise of the TU at that time
- Injuries that are considered time critical where emergent management necessitates direct transfer to the nearest TU and where TU deferral with direct transfer to the MTC is considered unsafe
- TTs in the TU should be networked with the MTC with excellent communication as a prerequisite
- The TT within a TU will be led by a Consultant in one of Emergency Medicine, Trauma, Trauma and Orthopaedic Surgery, General Surgery or Anaesthesiology/Critical Care on a 24/7 basis. Consultants will be asked to opt-in or out of inclusion in such a rota. Where this is not possible, the TT should be led by a senior Registrar (5th / 6th year trainee) in one of the above-named specialties, with a consultant attending within 30 minutes of receiving notification of imminent arrival patient from pre alert
- Escalation to consultant level for additional in-patient specialties will be determined by the TTL in consultation with the relevant registrar
- At least one experienced General Surgeon, Trauma & Orthopaedic Surgeon and Anaesthesiologist on-site 24/7, to respond to TT activation. In the TU, this will be an experienced Non-Consultant Hospital Doctor (NCHD), with ready access to consultant advice as required
- The TT should include a minimum of three ED nurses, at least one of whom should be of CNM2 grade or higher, a Health Care Assistant, a porter and a member of the clerical staff
- The TT should include a Radiographer
- Radiologist on call to be informed of TT activation
- Interventional Radiology needs to be promptly available 9am-5pm, Monday-Friday, on-site in all TUs, and outside these times at the network MTC in line with network protocols.

ACTIVATION PROCESS:

Activation of an appropriate TT response at a TU will be triggered by the gathered pre-hospital or in-hospital information e.g. mechanism of injury, physiological variables, anatomical deformity and co-morbidities.

This can be initiated in two ways:

1. Prior to arrival of an injured patient in the ED on notification of a 'pre-alert' from ambulance control.
2. On arrival of the patient in the ED

Note: It is the responsibility of the person receiving the pre-hospital call to clearly document

all information received in TRAUMADOC© and activate the appropriate trauma team.

All incoming trauma notifications should be directed to the CNM2 and Consultant in Emergency Medicine on call.

Call out activation sequence commences with either;

- **EDTT** Dangerous MOI with normal physiology and no anatomic injury or other criteria as listed
- **Silver TT** >65 years of age. Dangerous MOI with normal physiology and no anatomic injury or other criteria as listed

*Note: A low threshold is necessary for **HTT** response to those over 65 years of age*

- **HTT** Dangerous MOI with abnormal physiology and/or anatomic injury or other criteria as listed
- **Paediatric TT** <16 years of age

GOVERNANCE OF TRAUMA TEAM ACTIVATION

All duty trauma call-out personnel are required to be contactable and available to attend the trauma call.

Non-attendance of TT members should be escalated via a repeat call to switchboard. Attendance at trauma calls should be audited with feedback to the hospital trauma audit governance committee and involve individual specialties as appropriate.

MECHANISM OF INJURY

- Motor Vehicle Accident $\geq 60\text{kph}$
- Motor/Cyclist impact $\geq 30\text{kph}$
- Pedestrian impact $\geq 30\text{kph}$

- Ejection from Vehicle
- Same vehicle rollover
- Fatality same vehicle

- Prolonged extrication >30 mins
- Explosion
- Fall ≥ 2 meters
- Fall (any height) on anticoagulation

WITH THE FOLLOWING

NORMAL PHYSIOLOGY

- RR 10 - 30bpm
- SpO₂ $\geq 90\%$
- SBP $\geq 90\text{mmHg}$
- HR 50 - 120bpm
- GCS ≥ 14



ACTIVATE ED TRAUMA TEAM

MECHANISM OF INJURY

- Motor Vehicle Accident $\geq 60\text{kph}$
- Motor/cyclist impact $\geq 30\text{kph}$
- Pedestrian impact $\geq 30\text{kph}$
- Ejection from Vehicle
- Same vehicle rollover
- Fatality same vehicle
- Prolonged extrication $\geq 30\text{mins}$
- Explosion
- Fall ≥ 2 metres
- Fall (any height) on anticoagulation

WITH ANY ONE OF THE FOLLOWING

PHYSIOLOGY

- RR ≤ 10 or $\geq 30\text{bpm}$
- SpO₂ $< 90\%$
- SBP $< 90\text{mmHg}$ (at any time)
- HR ≤ 50 or $\geq 120\text{bpm}$
- GCS < 13

ANATOMY

- Airway compromise (Actual or Potential)
- Airway/Facial burns
- Intubated patient
- Suspected severe chest/pelvic/upper thigh injury
- Crush injury
- ≥ 2 Long bone fractures
- Limb amputation proximal to wrist/ankle
- Pulseless limb
- Major burns ($> 20\%$ TBSA)
- Spinal paralysis
- Open or depressed skull fracture
- Evisceration

AND/OR OTHER

- Penetrating neck/chest/abdominal injury
- Gunshot Wounds
- ≥ 3 patients expected
- Near Drowning/Submersion
- All HEMS Trauma transfers



ACTIVATE HOSPITAL TRAUMA TEAM

TRAUMA ≥65 YEARS OF AGE

MECHANISM OF INJURY

- Fall > 3 steps
- Fall (any height) on anticoagulation or 2 antiplatelets
- Motor Vehicle Accident >50kph
- Pedestrian impact any speed
- Ejection from Vehicle
- Same vehicle rollover
- Fatality same vehicle
- Prolonged extrication >30 mins

WITH ANY ONE OF THE FOLLOWING

PHYSIOLOGY

- RR ≤12 or ≥ 24bpm
- SpO2 ≤90%
- Shortness of Breath
- SBP ≤90mmHg (at any time)
- HR ≥65 bpm
- GCS <15
- Severe pain
- Lactate ≥ 2
- Base Excess ≤ -2

ANATOMY

- Injury ≥ 2 body regions
- Suspected head/spine chest/pelvic/upper thigh injury
- Open fracture
- Suspected shaft of femur fracture

Caution: Antiarrhythmics/antihypertensives may mask physiological response



ACTIVATE HOSPITAL TRAUMA TEAM

SUMMARY

Trauma is the leading cause of death and disability in the first four decades of life. Trauma in Ireland is currently undergoing reconfiguration with the development of an inclusive system to ensure that the right patient is seen by the right person in the right hospital at the right time. Evidence has shown that care of critically ill patients with severe injuries is improved when met by a TT on arrival. A TT is a *multidisciplinary group of healthcare workers who collectively work together on the assessment and treatment of those who are severely injured*. Currently, only 8% of patients are received by a trauma team on arrival to hospital in Ireland, which falls considerably short of international standards.

There is no international consensus on what should constitute a TT and several different TT configurations exist. Activation criteria based on the mechanism of injury, the patient's vital signs, injuries sustained, and other special circumstances should trigger a TT response to ensure optimal patient management.

What is proposed is a tiered system within Trauma Units with an EDTT and a HTT, which will be activated in response to set criteria. Within MTCs, a similar EDTT and HTT system will operate and use the same activation criteria. However, a Code Black, Code Red, Code Silver, Code Purple and Code Pink TT response should also operate for trauma in special patient populations.

The aim of this document is to offer perspective from Irish Emergency Medicine that can be used by the Irish Association for Emergency Medicine for collaborative engagement with the national trauma office as well as with key stakeholders including Surgical, Critical Care, Trauma & Orthopaedic Surgery and Nursing to aid in the development of TTs for Ireland.

Appendix 2

PATIENT NAME: AGE: MRN:

PRIMARY SURVEY

MAJOR EXTERNAL HAEMORRHAGE

Massive Transfusion Protocol: Y N Time Tourniquet 1: Y N Time on / Time o

Tranexamic Acid: Y N Time Tourniquet 2: Y N Time on / Time o

Direct Pressure Y N Time Pelvic Binder: Y N Time on / Time o

Anticoagulants/ Antiplatelets Y N Consider reversal guidance.

AIRWAY WITH C-SPINE PROTECTION

C-Spine: Airway: Patent / Obstructed Supraglottic Airway

Collar / Blocks / Tape 100% O2 NRB Time Size

Vacc. mattress NPA Time Size Time

Sandbags OPA Time Size

Pre-Intubation: RSI Checklist Y N ETT Time: Intubator 1: Intubator 2:

Pupils: R Size Reactivity Size: View Grade: 1 / 2 / 3 / 4

L Size Reactivity Tied at: cm(at teeth) ETCO2:

Drugs: O2 sats:

BREATHING

Neck: Thoracostomy: R:

Trachea: L:

Veins:

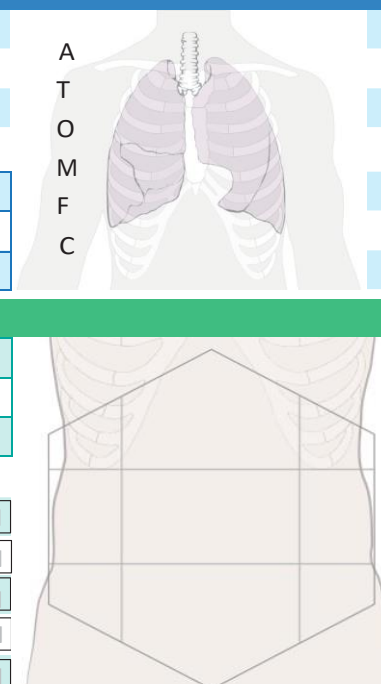
RR:

Sa O²

ETCO²

Chest Drain 1: Time Size Blood / Air Volume:

Chest Drain 2: Time Size Blood / Air Volume:



CIRCULATION

Time:

HR:

BP:

Cap Re Il: Secs

Fast Response Y N

Transient Response Y N

No Response Y N

E-FAST: Y N

Free Fluid Y N

Abdomen: Soft Distended

Bruising (E) Tender (T)

IVC: 1 / IO Time

IVC: 2 / IO Time Warmed IV Fluids: Y N

Prescribe Blood: Y N

Bloods Sent: G+H Y N G+X Y N

Coagulation pro le Y N Fibrinogen Y N

NGT Y N OGT Y N

Note: Antihypertensives / Antiarrhythmics may mask physiological response

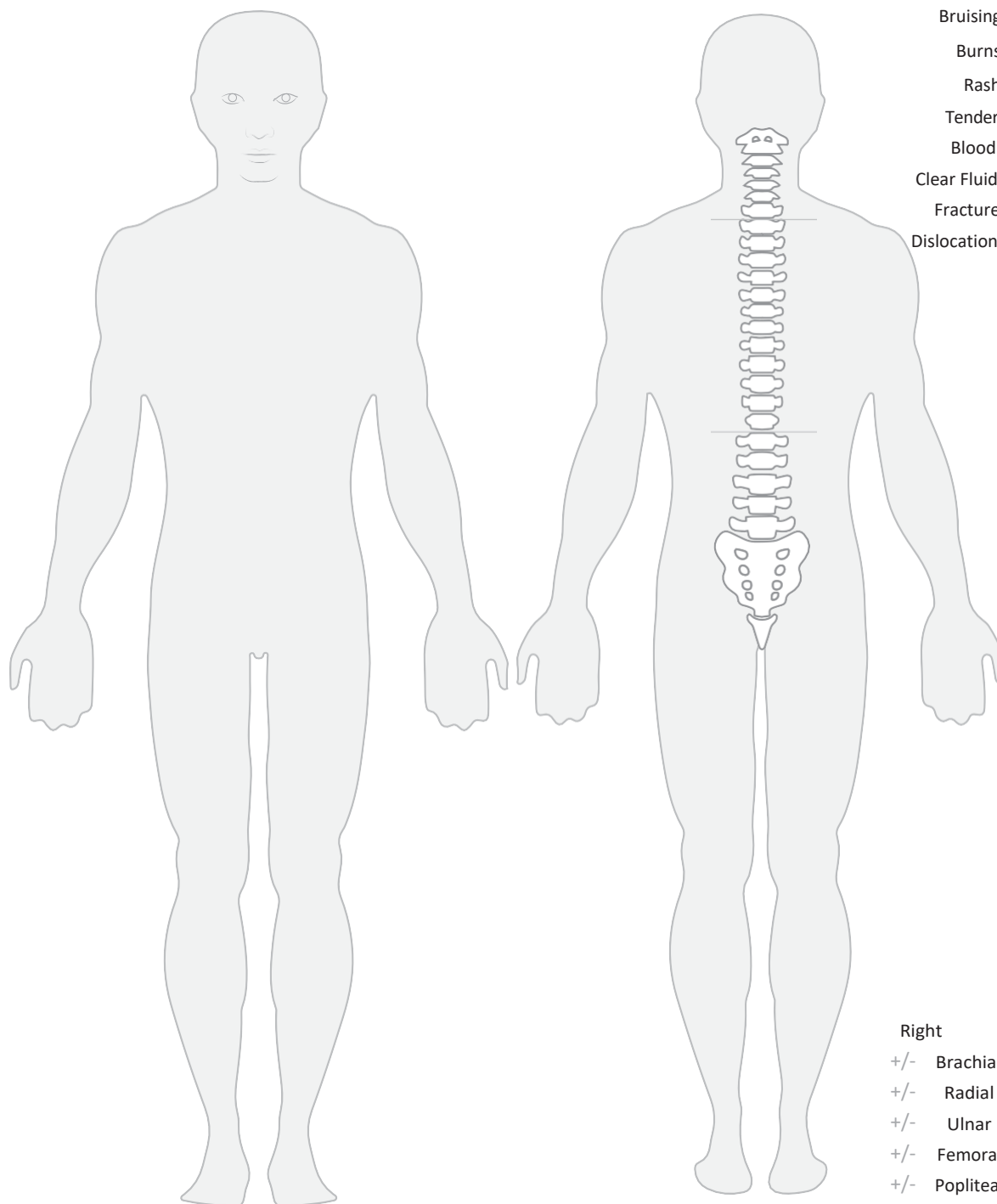
DISABILITY

Pupils: Right:	Size	Reaction	GCS	/15	Capillary blood glucose
Left:	Size	Reaction	E	/4	
Limb Movement:	RUL	RLL	V	/5	
	LUL	LLL	M	/6	
Act. spinal injury	<input type="checkbox"/> Y <input type="checkbox"/> N	Susp. spinal injury	<input type="checkbox"/> Y <input type="checkbox"/> N	Priapism	<input type="checkbox"/> Y <input type="checkbox"/> N
Total:					/15

EXPOSURE:

Temperature: Rewarming: Y N Warming Blanket: Y N

PATIENT NAME: AGE: MRN:



FRONT

BACK

- Laceration (L):
- Abrasion (A):
- Bruising (E):
- Burns (B):
- Rash (R):
- Tender (T):
- Blood (H):
- Clear Fluid (C):
- Fracture (#):
- Dislocation(D):

PATIENT NAME: AGE: MRN:

SECONDARY SURVEY Completed / Deferred

Consider medical cause for Fall/Trauma

EYES

Right: /6 V/A Left: /6 V/A

EARS

Right: Left:

TM Assessment:

Right: Left:

PELVIS

Urinary Catheter insertion:

Blood Meatus: Y N

Urinalysis:

Toxicology:

HCG:

RUL				
LUL				
RLL				
LLL				

PLANTARS

RIGHT ↑ ↓ LEFT ↑ ↓

LOG ROLL

C-Spine: +/- Brachial +/-

T-Spine: +/- Radial +/-

L-Spine: +/- Ulnar +/-

ASIA score: +/- Femoral +/-

PR: +/- Popliteal +/-

Tone: +/- P Tibial +/-

Sensation: +/- Dorsalis +/-

Blood PR: +/-

Tertiary Survey to be completed by Admitting team

Please Check Compartments

MOUTH

ASIA Classification of spinal cord injury

Right LT PP	Sensory Key Sensory Points	Left LT PP
C2		C2
C3		C3
C4		C4
C5		C5
C6		C6
C7		C7
C8		C8
T1		T1
T2		T2
T3		T3
T4		T4
T5		T5
T6		T6
T7		T7
T8	T8	
T9	T9	
T10	T10	
T11	T11	
T12	T12	
L1	L1	
L2	L2	
L3	L3	
L4	L4	
L5	L5	
S1	S1	
S2	S2	
S3	S3	
S4-5	S4-5	
Total: Max 56 56	Light Touch Score: /112	Total: Max 56 56
	Pin Prick Score: /112	

0 = absent
1 = impaired
2 = normal
NT = not testable

Motor Key Muscles

0 = Total paralysis
1 = palpable / visible contraction
2 = active movement
3 = active movement + gravity
4 = active movement + resistance
5 = active movement full resistance
NT = not testable

Total: Max 50 50

Sensory: Right Left

Motor: Right Left

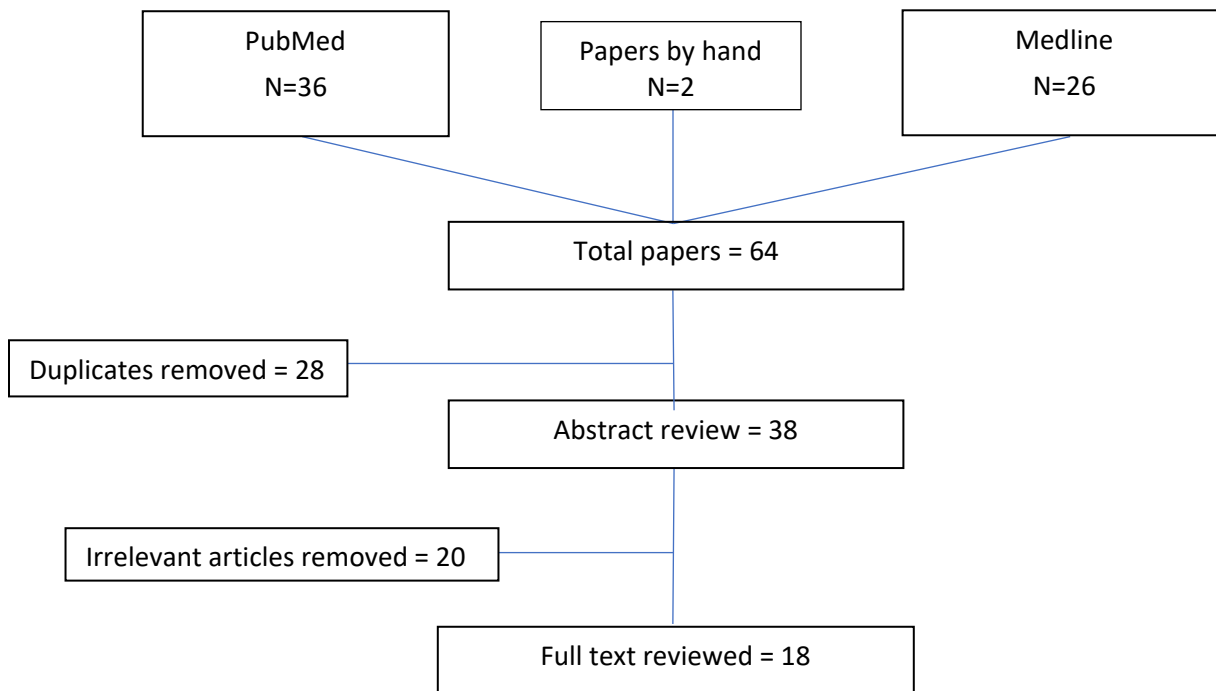
PRINT NAME: SIGNED:

Appendix 3

Evidence base for Tiered Trauma Team

Source(s) consulted*:	<i>Pubmed, MedLine.</i>
Keywords Used:	<i>trauma team, trauma response, trauma call, tiered, two-tier, differential</i>

CONSORT diagram



Tiered Trauma Team Literature Review

*Dinh MM, Hsiao KH, Bein KJ et al. Use of computed tomography in the setting of a tiered trauma team activation system in Australia. <i>Emerg Radiol</i> 2013
*Gomez MJ, Ferraro CA, Charlson DA. The costeffectiveness of a two-tier trauma response. <i>J Trauma</i> . 1991
*Phillips JA & Buchman TG. Optimizing prehospital triage criteria for trauma team alerts. <i>J Trauma</i> . 1993
Jenkins P, Rogers J, Kehoe A et al. An evaluation of the use of a two-tiered trauma team activation system in a UK major Trauma Centre. <i>Emerg Med J</i> 2015
Jenkins P, Kehoe A, Smith J. Is a two-tier trauma team activation system the most effective way to manage trauma in the UK? <i>Trauma</i> 2013
Rehn M, Lossius HM, Tjosevik KE et al. Efficacy of a two-tiered trauma team activation protocol in a Norwegian trauma centre. <i>Br J Surg</i> 2012
Curtis K, Olivier J, Mitchell R et al. Evaluation of a tiered trauma call system in a level 1 trauma centre. <i>Injury</i> . 2011
Davis T, Dinh M, Roncal S et al. Prospective evaluation of a two-tiered trauma activation protocol in an Australian major trauma referral hospital. <i>Injury</i> . 2010
Kouzminova N, Shatney C, Palm E et al. The efficacy of a two-tiered trauma activation system at a level I trauma centre. <i>J Trauma</i> 2009
Bevan C, Officer C, Cramer J et al. Reducing "cry wolf"--changing trauma team activation at a pediatric trauma centre. <i>J Trauma</i> . 2009
Nuss KE, Dietrich AM and Smith GA. Effectiveness of a pediatric trauma team protocol. <i>Paediatr Emerg Care</i> . 2001
Ryan JM, Gaudry PL, McDougall PA et al. Implementation of a two-tier trauma response. <i>Injury</i> . 1998
Plaisier BR, Meldon SW, Super DM et al. Effectiveness of a 2-speciality, 2-tiered triage and trauma team activation protocol. <i>Ann Emerg Med</i> 1998

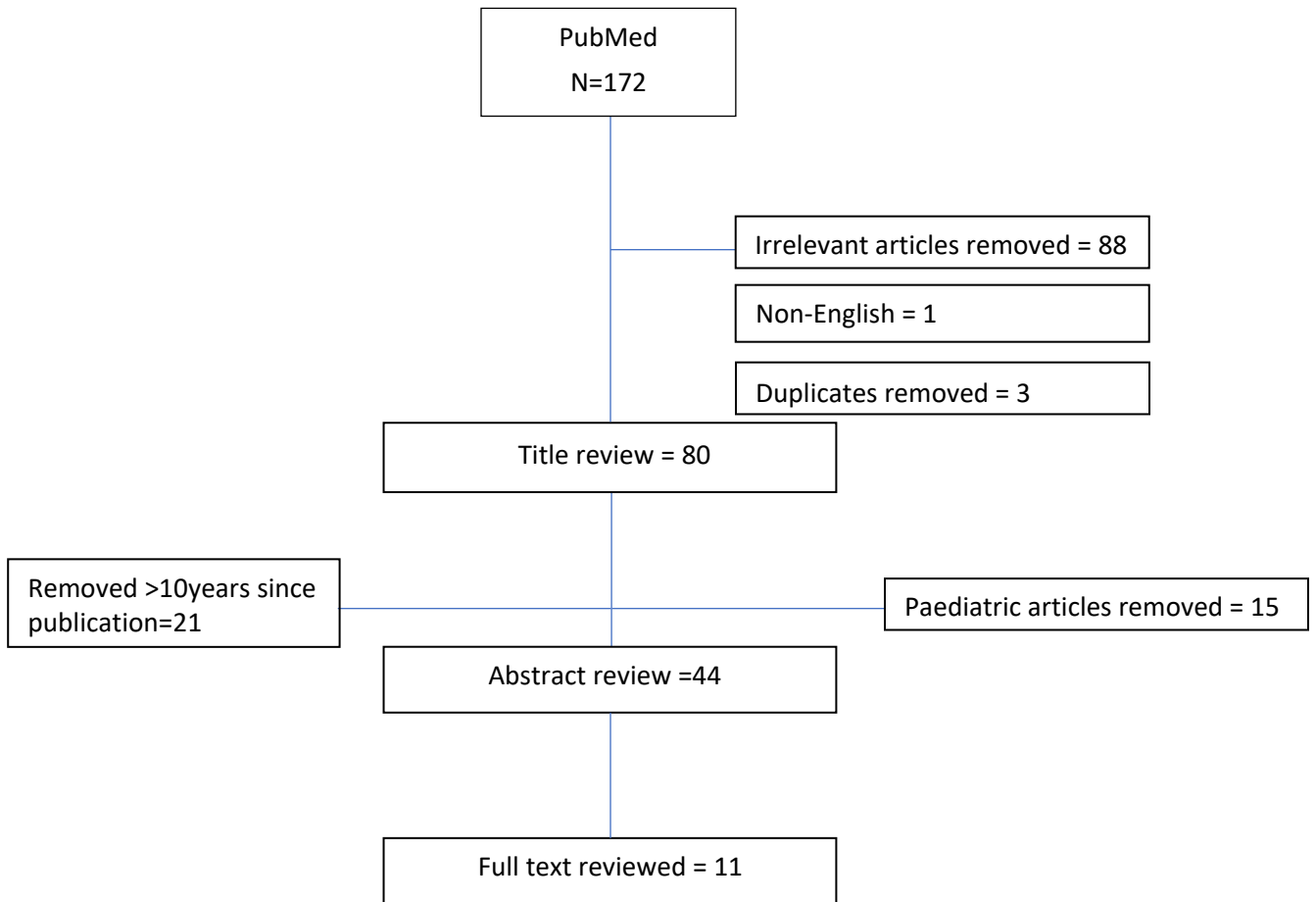
Appendix 4

Final consensus of 20 criteria that, if present, require the presence of a TT in post hoc analysis (Waydhas C et al.)

Injury severity
Abbreviated injury scale (AIS) C4 Intensive care unit (ICU) admission (without intermediate care unit) ICU-length of stay < 24 h
Mortality
Death within 24 h
Invasive procedures (pre-hospital or in the emergency room)
Cardiopulmonary resuscitation Advanced airway management Chest tube or needle decompression Pericardiocentesis Tourniquet use (pre-hospital) Catecholamine administration Transfusion Surgical/therapeutic radiological intervention Vascular, neurosurgical, abdominal, thoracic, pelvic, spinal or extremity-sparing surgery Radiological therapeutic intervention C2 external fixators (humerus, femur, pelvis)
Abnormal vital signs
Pulse oximetry (SpO ₂ <90%) Respiratory rate <9 or >29/min Systolic blood pressure < 90 mmHg Shock index < 0.9 Glasgow Coma Scale (GCS) < 9 Deterioration of GCS > 2 points before admission Hypothermia < 35 degrees

Appendix 5
Evidence base - Trauma Team Activation Criteria

Source consulted*:	<i>Pubmed</i>
Keywords Used:	Trauma team AND Activation Criteria



Trauma team activation criteria literature review

Maliziola C	2019	Sensitivity and specificity of trauma team activation protocol criteria in an Italian trauma centre: Int Emerg Nurs. 2019 Feb 26.
Bang M	2018	Validation of the Korean criteria for trauma team activation.
Cameron M	2019	The performance of trauma team activation criteria at an Australian regional hospital.
Nordgarden T	2018	Undertriage of major trauma patients at a university hospital
Vinjevoll OP	2018	Evaluating the ability of a trauma team activation tool to identify severe injury:
Hung KK	2019	Trauma team activation criteria and outcomes of geriatric trauma
Trinder MW	2018	Evaluation of the trauma triage accuracy in a Level 1 Australian trauma centre
Tominaga GT	2017	Trauma resource designation: an innovative approach to improving trauma system overtriage
Braken P	2018	Simple modification of trauma mechanism alarm criteria published for the TraumaNetwork DGU(®) may significantly improve overtriage
Benjamin ER	2018	The Age of Undertriage: Current Trauma Triage Criteria Underestimate The Role of Age and Comorbidities in Early Mortality.
Waydhas C	2018	A Consensus-Based Criterion Standard for the Requirement of a Trauma Team.
Linder F	2018	Better compliance with triage criteria in trauma would reduce costs with maintained patient safety.
Jensen KO	2019	Which pre-hospital triage parameters indicate a need for immediate evaluation and treatment of severely injured patients in the resuscitation area?
Tignanelli CJ	2017	Non-compliance with ACS-COT recommended criteria for full trauma team activation is associated with under triage deaths.
Davis JW	2017	Attempting to validate the over triage/under triage matrix at a Level I trauma centre.
Connolly R,	2018	Factors associated with delay in trauma team activation and impact on patient outcomes.
Ruter D	2017	Implementation of a Trauma Activation Checklist.
Dehli T	2016	Evaluation of a trauma team activation protocol revision
Kuo SC	2016	The use of the reverse shock index to identify high-risk trauma patients in addition to the criteria for trauma team activation
Brown JB	2016	Prehospital lactate improves accuracy of prehospital criteria for designating trauma activation level.
Wuthisuthimethawe e P	2017	Trauma team activation criteria in managing trauma patients at an emergency room in Thailand
Harbrecht BG	2016	Intubated Trauma Patients Do Not Require Full Trauma Team Activation when Effectively Triage.
Wuthisuthimethawe e P	2016	Sustainable Effectiveness of Applying Trauma Team Activation in Managing Trauma Patients in the

		Emergency Department.
Egberink RE		Trauma team activation varies across Dutch emergency departments: a national survey
Dehli T,	2015	Implementation of a trauma system in Norway: a national survey.
Bressan S	2015	Establishing a standard for assessing the appropriateness of trauma team activation
Rogers A	2013	Increased mortality with undertriaged patients in a mature trauma centre with an aggressive trauma team activation system.
Rados A	2013	Does trauma team activation associate with the time to CT scan for those suspected of serious head injuries?
Stuke LE	2013	Mechanism of injury is not a predictor of trauma centre admission.
Burén LA	2013	Visitation by physicians did not improve triage in trauma patients.
Mejaddam AY	2013	Real-time heart rate entropy predicts the need for lifesaving interventions in trauma activation patients.
Dinh MM	2013	Use of computed tomography in the setting of a tiered trauma team activation system in Australia.
Ryb GE	2012	Delayed trauma team activation: patient characteristics and outcomes.
Lillebo B	2012	What is optimal timing for trauma team alerts? A retrospective observational study of alert timing effects on the initial management of trauma patients.
Granström A	2012	Activation of the trauma team is related to injury severity. Triage stringency can yield optimal use of resources.
Rehn M	2012	Rogaland Trauma System Study Collaborating Group. Efficacy of a two-tiered trauma team activation protocol in a Norwegian trauma centre
Sarkar B,	2011	American College of Surgeons' Committee on Trauma Performance Improvement and Patient Safety program: maximal impact in a mature trauma centre. J Trauma.
Adams JM	2011	Does patient age and height of fall alone require trauma team activation?
Dehli T	2011	Evaluation of a university hospital trauma team activation protocol.
Claridge JA	2010	Trauma team activation can be tailored by prehospital criteria
Curtis K	2011	Evaluation of a tiered trauma call system in a level 1 trauma centre
Larsen KT	2010	Differences in trauma team activation criteria among Norwegian hospitals
Kouzminova N	2009	The efficacy of a two-tiered trauma activation system at a level I trauma centre.
Rehn M	2009	Precision of field triage in patients brought to a trauma centre after introducing trauma team activation guidelines.

Appendix 6

Table 2 Specific communication aspects of the trauma call (Certain aspects of this have been adapted from the Trauma WHO Check List⁸)

Communication element	Description
Team brief	Once the trauma team has assembled, the trauma team leader briefs the team with information from the pre-hospital alert and explains what they expect to happen. At this point, roles and responsibilities are determined
Handover from pre-hospital team	This is undertaken using the acronym AT-MIST ⁴ : Age Time of injury Mechanism of injury Injuries sustained Signs and symptoms Treatment given so far
Situational updates	The trauma team leader will pause activity at regular intervals (maybe every 10 minutes or so) to update the team. This ensures good situational awareness and followership among team members
Command huddle	Once the initial examination of the patient is complete, a decision on the next steps of treatment is made by senior members of the team. This is then communicated to the whole trauma team

Appendix 7

TABLE 1. World Health Organization trauma care checklist

Immediately after primary and secondary surveys				
Is further airway intervention needed?	Yes, done	No		
May be needed if:				
GCS 8 or below				
Hypoxaemia or hypercarbia				
Face, neck, chest or any severe trauma				
Is there a tension pneumo-haemothorax?	Yes, chest drain placed	No		
Is the pulse oximeter placed and functioning?	Yes	NA		
Large-bore IV placed and fluids started?	Yes	Not indicated	Not available	
Full survey for (and control of) external bleeding, including:	Scalp	Perineum	Back	
Assessed for pelvic fracture by:	Exam	X-ray	CT	
Assessed for internal bleeding by:	Exam	Ultrasound	CT	Diagnostic peritoneal lavage
Is spinal immobilisation needed?	Yes, done	Not indicated		
Neurovascular status of all four limbs checked?	Yes			
Is the patient hypothermic?	Yes, warming	No		
Does the patient need (if no contraindication)	Urinary catheter	NG tube	Chest drain	None indicated
Before team leaves the patient				
Has the patient been given?	Tetanus vaccine	Analgesics	Antibiotics	None indicated
Have all tests and imaging been reviewed?	Yes	No, follow-up plan in place		
Which serial examinations are needed?	Neurological	Vascular	Abdominal	None
Relevant trauma chart or form completed	Yes	Not available		

REFERENCES

1. National Office of Clinical Audit (2016). Major Trauma Audit National Report 2016. http://s3-eu-west-1.amazonaws.com/noca-uploads/general/Major_Trauma_Audit_National_Report_2014-2015_FINAL.pdf (accessed 20 December 2016).
2. Rainer TH, Cheung NK, Yeung JHH, et al. Do trauma teams make a difference? A single centre registry study. *Resuscitation* 2007; 73(3):
3. National Office of Clinical Audit (2019). Major Trauma Audit National Report 2017. http://s3-eu-west-1.amazonaws.com/noca-uploads/general/MAJOR_TRAUMA_AUDIT_NATIONAL_REPORT_2017_FINAL.pdf (accessed 04 December 2019).
4. Department of Health (2018). A Trauma System for Ireland: Report of the Trauma Steering Group. <https://health.gov.ie/wp-content/uploads/2018/02/Report-of-the-Trauma-Steering-Group-A-Trauma-System-for-Ireland.pdf> (accessed 20 November 2018).
5. Driscoll PA, and Vincent CA. Variation in trauma resuscitation and its effect on patient outcome, 23(2) ed. *Injury*: 1992.
6. Moran CG, Lecky F, Bouamra O, Lawrence T, Edwards A, Woodford M, Willett K. and Coats TJ. . Changing the system – major trauma patients and their outcomes in the NHS (England) 2008-17. *EclinicalMedicine* 2018; 2(3):
7. Fitzgerald M., P. Cameron, C. Mackenzie, and et al. Trauma Resuscitation Errors and Computer- Assisted Decision Support. *Archives of Surgery* 2011; 146(2):
8. Hicks C1, Petrosniak A2. The Human Factor: Optimizing Trauma Team Performance in Dynamic Clinical Environments. *Emerg Med Clin North Am.* 2018; 36(1):
9. Yun S1, Faraj S, Sims HP Jr. Contingent leadership and effectiveness of trauma resuscitation teams. *Montclair: J Appl Psychol.* 2005; 90(6):
10. Katherine Klein. A Leadership System for Emergency Action Teams: Rigid Hierarchy and Dynamic Flexibility. *Wharton Magazine*: 2005. <https://magazine.wharton.upenn.edu/issues/winter-2005/teamwork-in-a-shock-trauma-unit/> (accessed 27 April 2019).
11. Kelsey Ford, MD,* Michael Menchine, MD, MPH,* Elizabeth Burner, MD, MPH,* Sanjay Arora, MD,* Kenji Inaba, MD,† Demetrios Demetriades, MD, PhD,† and Bertrand Yersin, MD‡. . Leadership and Teamwork in Trauma and Resuscitation. *West J Emerg Med.* 2016; 17(5):
12. Flowerdew L, Gaunt A, Spedding J, Bhargava A, Brown R, Vincent C, Woloshynowych M.. A multicentre observational study to evaluate a new tool to assess emergency physicians' non- technical skills. *Emergency Medicine Journal* 2013; 30(): .13. Haukoos JS, Byyny RL, Erickson C, et al.. Validation and refinement of a rule to predict emergency intervention in adult trauma patients. *Annals of Emergency Medicine* ; 58(2):
13. Cooper S1, Cant R, Porter J, Sellick K, Somers G, Kinsman L, Nestel D. Rating medical emergency teamwork performance: development of the Team Emergency Assessment Measure (TEAM). *Resuscitation* 2010; 81(4):
14. A report of the National Confidential Enquiry into Patient Outcome and Death (2007). Trauma: Who cares? https://www.ncepod.org.uk/2007report2/Downloads/SIP_report.pdf (accessed 11 December 2018).
15. Jenkins, P, Rogers, J. Kehoe, A. Smith, J. E. (2015) 'An Evaluation of the Use of a Two-

Tiered Trauma Team Activation System in a UK Major Trauma Centre', *Emergency Medicine Journal*, May(32(5)), pp. 364-7.

16. Validation and refinement of a rule to predict emergency intervention in adult trauma patients. Haukoos JS, Byyny RL, Erickson C, et al. 164–171, s.l. : *Annals of Emergency Medicine* 58(2): 164–171, 2011, Vol. 58(2).

17. Prehospital identification of major trauma patients. Ocak G, Sturms L, Hoogeveen J, et al. s.l. : *Langenbeck's Archives of Surgery*, 2009.

18. Holcomb, J. B. Niles, S. E. Miller, C. C. Hinds, D. et al. (2005) 'Prehospital Physiologic Data and Lifesaving Interventions in Trauma Patients', *Military Medicine*, 170(Issue 1), pp. 7-13.

19. Scheetz, L. (2010) 'Prehospital factors associated with severe injury in older adults', *Injury*, 41(9), pp. 886-893.

20. Larsen, K. T. Uleberg, O. Skogvoll, E (2010) 'Differences in trauma team activation criteria among Norwegian hospitals', *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, 18(21), pp.

21. Reid C, Peter Brindley P, Hicks C, Carley S, Richmond C, Lauria M, and Weingart S.. Zero point survey: a multidisciplinary idea to STEP UP resuscitation effectiveness. *Clin Exp Emerg Med* ; Sept(5(3)):

22. Lauria MJ.. Psychological Skills To Improve Emergency Care Providers' Performance Under Stress.. *Ann Emerg Med* 2017; April():

23. Lorello, Kicks, Ahmed. T. Mental practice: a simple tool to enhance team-based trauma resuscitation.. *Canadian Journal of Emergency Medicine* 2016; 18(): .

24. Lai S, Jain A, Mason J, Grock A.. Beyond ATLS: Demystifying the Expert Resuscitator. *Ann Emerg Med*. 2018; 72(3): .

25. Saunders T, Driskell JE, Johnston JH, et al. The effect of stress inoculation training On Anxiety and Performance. 1996; 1(2)

26. Petrosniak A, Auerback M, Wong A, et al. In-situ simulation in emergency medicine:moving beyond the simulation lab. *Emerg Med Australas* 2016; 29(): .

27. Kessler DO, Cheng A, Mullan PC.. Debriefing in the emergency department after clinical events: a practical guide. *Ann Emerg Med* 2015; 65(6):