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What Are Major Trauma Systems, Why Does the UK Need Them and How Can They Be Improved?

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Abstract

Major trauma, defined by the World Health Organisation (WHO) as 'multiple, serious injuries that could result in disability or death' is a significant cause of death worldwide. Trauma is the leading cause of death for 15–45 years old.

Major Trauma Systems (MTS) should follow defined, evidence-based trauma pathways to optimise patient outcomes. In 2010, the Major Trauma Care in England Report found significant variability in trauma mortality outcomes between hospitals, highlighting a need for the establishment of MTS.

We will review the current models of UK MTS, with a particular focus on the London Trauma System (LTS) and propose strategies to optimise patient care within the current framework. MTS can be divided into Exclusive and Inclusive Systems. In the former, one standalone Major Trauma Centre (MTC) is capable of providing care from start to finish for any major trauma patient. Inclusive systems are comprised of a MTC acts as a central component in a network with smaller Trauma Units (TUs) working in tandem, taking advice or transferring patients, to get the best care for a trauma patient.

The National Major Trauma Registry (NMTR), which keeps detailed records of all trauma patients has shown a 44% increase in "good overall care" to trauma patients since the service began. Close links to research allow rapid implementation of emerging evidence-based medicine into standard care, for example administration of tranexamic acid to haemorrhaging patients.

Limitations of our current MTS include difficulty in transferring non-urgent patients from TUs to the MTCs; repatriating patients after treatment at an MTC; limited image transfer between hospitals; and a widespread lack of rehabilitation resources.

For future improvement, it is imperative to implement trauma prevention methods and community outreach programmes, targeting the population demographics most affected by such trauma.

Additional research is required to determine the effectiveness of changes in rehabilitation funding and policies. Particular attention should also be given to the benefit to long term outcomes, including quality of life and functional recovery scores.

Key words: trauma centres; evidence based medicine; quality of life; multiple trauma; patient care

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Introduction

Trauma remains a significant cause of death worldwide, particularly in younger age groups World Health Organisation (WHO) (World Health Organization, 2014).

Thus care of the trauma patient should, as with other diseases and causes of mortality, have defined pathways in order to optimise outcomes which has translated into the need for Major Trauma Systems (MTS).

Although the UK trauma system has significantly reduced mortality rates, inequitable resource distribution and insufficient rehabilitation resources remain pressing issues.

We aim to systematically analyse the strengths and weaknesses of the current UK MTS, before outlining further improvements which could enhance patient outcomes.

What Is a MTS?

Major trauma can be defined as: 'multiple, serious injuries that could result in disability or death' with an Injury severity score (ISS) 'greater than 15' (NAO, 2010). The ISS is an internationally recognised system used to predict morbidity and mortality outcomes (New South Wales (NSW) Institute of Trauma and Injury Management, 2014). ISS rates the anatomical injury patterns sustained, with the most severe injury in each system being scored. The maximum attainable score is 75, which correlates with an 'unsurvivable trauma'.

MTS can be divided into exclusive or inclusive systems. An exclusive MTS has one standalone Major Trauma Centre (MTC), or Level 1 centre, to which all major trauma patient must be transferred. MTCs only manage trauma patients, hence will have all necessary Specialities and capabilities to provide the care from start to finish for any major trauma patient, as outlined by the American Trauma Society (ATS) (2019). Disadvantages of such a system are that it does not make full use of the other healthcare facilities in the region, which is often accompanied by deskilling of the workforce in smaller units (Pape et al, 2010).

In contrast an inclusive system makes use of all health care facilities in a region. As such, it is comprised of a MTC acting as a central component in a network of trauma hospitals, working in tandem with multiple smaller Trauma Units (TUs) (NAO, 2010). TUs can assess, resuscitate, stabilise and operate on trauma patients (ATS, 2019). An inclusive system allows patients to be brought to a TU, or directly to the MTC, depending on clinical need which is assessed and triaged in the prehospital setting. Patients arriving to a TU may be stabilised for onward transfer to an MTC, or definitively managed at the TU with specialist input from the MTC. Such systems have been found to have a significant reduction in patient mortality of at least 15%, compared to exclusive systems (Utter et al, 2006; Cameron et al, 2008). See Fig. 1.

Why Is a MTS Needed?

A WHO report 'Injuries and Violence: The facts' reported 9% of the world's deaths are caused by traumatic injuries (World Health Organization, 2014). Furthermore, trauma is the leading cause of death in the 15–45 age bracket (Krug et al, 2000). While significant in themselves, these statistics represent only a fraction of the total number of people who experience trauma each year. As such it

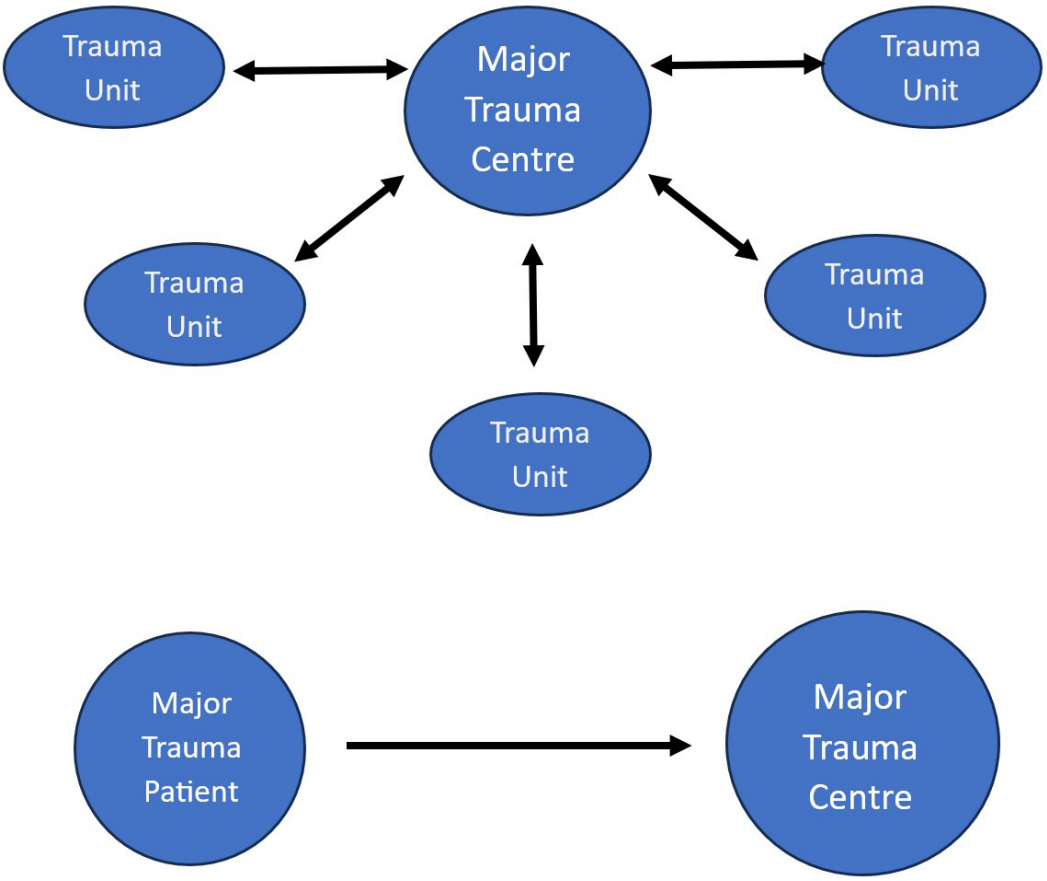

Fig. 1. Flow diagrams illustrate Inclusive Major Trauma System (top) and an Exclusive Trauma Systems (bottom).

is imperative for all countries to have defined trauma pathways just as they would for any other disease in order to optimise outcomes, and England is no exception. The Major Trauma Care in England report (NAO, 2010) found significant variability in trauma mortality outcomes between hospitals; and envisioned 450–600 more trauma patients could potentially be saved annually, via the implementation of a MTS.

Where Are English MTS Now and Where Can They Go From Here? (London Trauma System Case Study)

The London Trauma System (LTS) was the first official trauma system set up in the UK. It is further subdivided into four regional networks. LTS was launched in April 2010 following the National Audit Office report (2010) and the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) report, which highlighted that less than 48% of trauma patients received 'good care' (Smith et al, 2007). The LTS was created as an inclusive trauma system, as they have been shown to be more effective than exclusive trauma systems. Utter et al (2006) found that inclusive systems have a 16% reduction of inpatient mortality when compared to exclusive systems. While Cameron et al (2008) states that having an inclusive

system should be a minimum standard due to a 15% reduction of risk-adjusted inpatient mortality. The LTS acted as a pilot scheme for the implementation of trauma systems in England and Wales which went live in 2012/2013. More recently Scotland's MTS went live in October 2021.

In order to continuously improve outcomes, trauma systems must be flexible and capable of creating new protocols and altering current ones. This relies on a network's ability to access continuous, high quality data. For this reason, the previously established the National Major Trauma Registry (NMTR) represents an important aspect of trauma care in the UK. NMTR collects data from all the Trauma Systems in England, Wales and Ireland and is used as the central source of data for National Clinical Audits, thus allowing annual publishing of major trauma audits and reports (NHS England, 2024).

The NCEPOD report (Smith et al, 2007) published prior to the creation of the LTS has provided a foundation of statistics, which could then be used by the trauma systems to monitor their improvements and identify which aspects required further work. NMTR has made subsequent research possible such as the Evaluation of the London Trauma System (ELoTS). Reports from ELoTS illustrate how the LTS had brought about considerable improvement to patient care, as highlighted by "good overall care" increasing from 48% to 69% (Cole et al, 2016). Said improvements were primarily driven through enhanced organisational processes. Overall, NMTR has provided the trauma networks with the tools to continuously adapt and improve.

However, NMTR relies on individual hospitals to submit the relevant data. In the current system, such data sets are not always comprehensive, particularly data sets from TUs which unlike the MTCs, lack any monetary incentive to supply complete data sets (Moran et al, 2018). Given the importance of access to accurate datasets, it is imperative to prioritise the submission of complete datasets. Extending the monetary incentive to cover the entire trauma network could be a means to achieve this.

The LTS has been at the foreground of improving trauma patient care. On average it takes 17 years for new research to be incorporated into clinical practice (Morris et al, 2011). However, LTS has been strongly proactive in implementing new practices in accordance with emerging research, thanks to the close ties between research and clinical practice due, in part, to the establishment of the Centre for Trauma Sciences. Helicopter transfer for major trauma patients was facilitated from the initiation of LTS; on account of Helicopter transfer improving patient survival to hospital discharge when compared to ground transfer, both for transfer from scene to hospital and from TU to MTC (Kim et al, 2017; Galvagno et al, 2012). Another prime example of rapid integration of research into clinical practice, is the Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH 2): a randomised, placebo-controlled trial. Published in 2010, the CRASH 2 trial showed that early administration of tranexamic acid to trauma patients, at risk of significant haemorrhage, reduced mortality (CRASH-2 trial collaborators et al, 2010). Despite the longer timeframes predicted in the literature, the use of tranexamic acid was incorporated into the LTS's pre-hospital protocol within four years (London Air Am-

bulance Policy Board, 2013). The close connection between research and clinical practice has also allowed LTS to play a major role not just in following but in establishing new protocols. For instance, in 2014, London Air Ambulance was the first pre-hospital service to perform a roadside Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)—a temporising treatment modality usually performed in hospital to reduce the risk of an exsanguinating patient from having a cardiac arrest, and therefore afford them the time to have further treatment (London's Air Ambulance Charity, 2018). REBOA technology has been proven to significantly improve survival rates in patients with abdominal haemorrhage. As such, new research is rapidly integrated into LTS protocol which is a significant strength of the system, as it ensures patients receive the most up to date standards of care. Such treatments have the benefit of initiating advanced interventions at the trauma scene, and within the 'golden hour' rather than delaying advanced care until the patient is hospitalised (Abhilash and Sivanandan, 2020). Consequently, it provides patients with the greatest opportunity of returning to their pre-trauma baseline.

The expertise and organisation found in MTS allows for normally hospital-based skills to be brought to the patient on scene. London Air Ambulance consists of a team of two to three medical professionals including a Consultant in Pre-Hospital Care (usually with a background in Emergency Medicine, Anaesthesia or, much more rarely, Surgery). This specially trained team can carry out life-saving interventions such as rapid sequence induction of anaesthesia and surgical procedures on scene in order to increase patient survival rates (Newberry, 2016). The presence of a Pre-Hospital Care Team (Doctor + Paramedic) on scene is also a major strength of trauma systems as their decision-making skills are an important pre-hospital factor in determining patient outcome. Baxt and Moody (1987) were the first to publish a Randomised Control Trial (RCT) which established the advantage provided by a doctor lead pre-hospital team. It reported a decreased mortality rate of 35% in a pre-hospital team consisting of a doctor and a nurse compared to teams consisting of a nurse and a paramedic. This RCT is significant as the nurses were trained to perform the same interventions and administer the same medications as their doctor counterparts. As such the trial concluded that the improved outcomes in the doctor-led team were based on medical expertise and appropriate decision making, rather than procedural capability. Kim et al (2017) performed a similar helicopter transport study which re-iterated that doctor-led teams had increased survival rates, with greater than 6 per 100 major trauma patients surviving to hospital discharge, compared to non-Doctor led teams.

However, owing to its charity status, London Air Ambulance must fundraise in order to finance the service it provides (Department of Health and Social Care, 2019). The struggles to raise appropriate funds are well documented (London's Air Ambulance Charity, 2021). Unfortunately, it has made National news headlines as a result of situations whereby the helicopter fleet has been grounded, in part due to insufficient funding (BBC News, 2015).

Where Do We Go From Here?

One of the significant challenges faced by the MTS in the NHS, and indeed London, is the lack of rehabilitation beds. When trauma systems were created, no concurrent action was taken to redesign the rehabilitation services, causing them to remain massively underfunded. The National Clinical Audit of Specialist Rehabilitation following major Injuries (NCASRI) report (2019) found 91% of patients were successfully transferred to specialised rehabilitation facilities within the established timeframe of six-weeks from time of fit to transfer (London North West University Healthcare NHS Trust, 2019). Although this may be viewed as a success, the six-week target period means that patients actually miss out on the early high intensity specialised rehabilitation advised by Königs et al (2018). Early rehabilitation is crucial as it increases patient functional outcomes, thus improving their independence (Andelic et al, 2012). One potential reason for the current six-week target is, that the lack of available funding prevents more ambitious targets. The NCASRI report calculated that to adequately meet specialist rehabilitation bed requirements for trauma patients, rehabilitation bed capacity would need to increase by 2.5 times the current capacity (London North West University Healthcare NHS Trust, 2019). But as trauma patients only make up 20% of patients reported to the United Kingdom specialist Rehabilitation Outcomes Collaborative (UKROC), this is a serious under investment. There is particular need for increased investment in neurorehabilitation, as delineated in the 'Time for Change' report (All-Party Parliamentary Group, 2018), which identified the need for an additional 10,000 neurorehabilitation beds nationwide. Increasing specialist rehabilitation beds does not just improve patient outcomes but is also highly cost effective (Turner-Stokes, 2008). The NCASRI report concluded that adequate numbers of rehabilitation beds would lead to £500,000 in savings per patient when long-term care costs are considered (London North West University Healthcare NHS Trust, 2019). Therefore, the costs of additional rehabilitation beds are offset within 17 months, making them a worthwhile investment to prioritise. Hyperacute in-patient rehabilitation services have also been shown to be cost effective, as costs are offset in 27.3 months. Crucially this would free up much needed hyperacute inpatient beds (Turner-Stokes et al, 2016). Given the above, an immediate priority must be given to further development of regional rehabilitation centres within UK trauma systems in order to increase specialised rehabilitation beds.

Although the aforementioned reports and audits have outlined definitive points where optimisation could occur, the majority of previous studies have focused on the performance of trauma centres. As such there is a paucity of systematic analysis regarding resource optimisation and improvements in long term patient outcomes, in particular regarding functional recovery rates and quality of life measures.

As outlined by the British Society of Physical and Rehabilitation Medicine (BSPRM) (2018) and reiterated in the NCASRI report (2019), there is a need for increased Rehabilitation Medicine (RM) Consultants within MTCs to triage and oversee patient rehabilitation management. Said RM Consultants reduce the duration of in-patient stay by six days via early identification of complex needs (London

North West University Healthcare NHS Trust, 2019). Unfortunately, however, only 45% of MTCs receive adequate input from RM Consultants and, dishearteningly, almost 20% receive none, further highlighting the need for additional posts (London North West University Healthcare NHS Trust, 2019). The presence of an RM Consultant ought to be a priority for all MTCs to ensure efficiency of the rehabilitation service (BSPRM, 2018). RM Consultants allow for prompt identification and transfer of patients requiring rehabilitation, aiding patient flow pathways while ensuring patient functional outcomes are maximised. As per the BSPRM (2018) the current curriculum for specialist training in rehabilitation medicine does not appropriately train physicians in the necessary competencies of trauma rehabilitation medicine. This glaring omission from current Medical Training, must be addressed, starting with an increased rehabilitation medicine training pathways for doctors in order to have a fully functioning trauma rehabilitation system.

Another weakness of the LTS is the lack of a single, unified imaging system which staff from different hospitals could automatically view imaging carried out in other centres. The Image Exchange Portal (IEP) can be used to transfer imaging between centres. However, as reported in the NHS Improvement report (NHS England and NHS Improvement, 2019) the IEP system is 'slow and time consuming' as images must be either 'pushed' from the referring centre or 'pulled' by the MTC. The inevitable delay in viewing said images, delays diagnosis and decision making with regards to patient transfer and also decreases time available for pre-operative planning in time critical major trauma. Furthermore, once the images have been sent, the IEP system does not allow for a report or any editing of the report to be documented; a crucial flaw which will inevitably lead to adverse patient events. Trauma systems should prioritise establishing one network wide Picture Archive and Communication System (PACS) to reduce delays and avoid potential negative outcomes.

Trauma prevention should also be promoted by the MTS, particularly among high-risk population demographics. Corfield et al (2016) outline the significant impact population demographics have on trauma incidence, as individuals with a lower socioeconomic status, have a higher incidence of penetrating trauma requiring hospital attendance. Successive London Ambulance Service Clinical Audit Annual Reports (Cannon and Fothergill, 2017; Shaw and Fothergill, 2018) also demonstrate similar trends with increased incidence of penetrating trauma among young males. With London's knife crime increasing it is important that the LTS targets prevention and incentivises education strategies toward the most vulnerable populations (Allen and Harding, 2021). Charities, such as StreetDoctors, should be encouraged and promoted in order to ensure that the most affected populations receive adequate education around first response to trauma and trauma prevention strategies (StreetDoctors, 2021). Organisations which are based on peer-led education are an effective method of obtaining best results from educational sessions, as literature highlights peers are more influential and exert longer term effects on youths, than that exerted by experts (Allikmets and Vink, 2016; Mellanby et al, 2000).

Conclusion

To conclude, the above analysis of the MTS in the NHS, particularly the LTS, demonstrates how current systems have enhanced the outcomes of major trauma patients. Such improvements have occurred through improving organisational structure and efficiency of trauma systems.

We propose key improvements to further enhance patient outcomes; in particular the MTS should strengthen multidisciplinary collaboration, alongside bolstering trauma rehabilitation pathways. Such change would require prioritisation of the establishment of regional trauma rehabilitation centres, alongside providing additional rehabilitation medicine training pathways and expediting the development of a unified imaging system.

It is imperative to implement trauma prevention methods and community outreach programmes, targeting high-risk population demographics most affected by such trauma.

Future research should be focused on the effectiveness of the above changes in rehabilitation funding and policies. Particular attention should also be given to the benefit to long term outcomes, including quality of life and functional recovery scores.

Key Points

- Trauma is a leading cause of death and must be treated as such.
- Experience and decision making skills increase survival rates.
- Trauma systems must be adaptable to obtain the best possible patient outcomes.
- Good quality data enhances patient outcomes, and allows effective auditing of the current system.
- Rehabilitation services in England require reorganisation and better funding.
- Further trauma prevention strategies are needed.

Curriculum Checklist

This article addresses the following requirements from the general internal medicine curriculum:

- Able to successfully function within NHS organisational and management systems.
- Is focused on patient safety and delivers effective quality improvement in patient care.
- Managing a multi-disciplinary team including effective discharge planning.

Availability of Data and Materials

All data included in this study are available from the corresponding author upon reasonable request.

Author Contributions

VG and JF were responsible for the article design and data research. JF, VG and IP analysed data and drafted the manuscript. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Not applicable.

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Conflict of Interest

The authors declare no conflict of interest.

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