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The Value of a Major Trauma Network – An Evidence Based Review

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Summary and key points for discussion: This paper provides a summary of an evidence based review undertaken to establish the value of a major trauma network and has informed the case for change.

Review History: reviewed by Dindi Gill, Clinical Lead, Wales Trauma Network

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1	1.0	Dr Rowenna Morris-Clarke	June 2019
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Background

The evidence base that we currently have consistently demonstrates that severely injured patients are 15-20% less likely to die if admitted to a major trauma centre than if admitted to another hospital.¹ From this, in 2010 a document supporting the development of major trauma networks was published by the NHS clinical advisory group. One of its main points being the recommendation of enhanced care teams being available 24/7 to provide care to a major trauma patient.² Taking this evidence on board, in April 2012 NHS England established 16 regional trauma networks and created a series of major trauma centres surrounded by feeding trauma units. In October 2018 Scotland followed suit and opened its first trauma centre in Aberdeen, with Ireland still debating their own trauma network.

A Major trauma Centre within the trauma network, will see an increase in patient numbers to this specialist hospital, an increases survival but does not lead to increase in burden of disease. With specialist care and subsequent specialist rehabilitation, trauma centres also provide the potential to increase return to work rates or return to a normal daily life. Such possibilities only exist with the correct rehabilitation and support services.

A literature search was carried out with the help of Library Services at Morriston Hospital, searching several databases including Medline for papers showing the impact of a major trauma network across the world. Guidelines were also included in this search and also those papers referenced in the guideline.

The evidence base is displayed in the following headings:

- Major Trauma Centre, Trauma Units, Local Emergency Hospitals
- Pre-hospital care and retrieval
- Acute Emergency Care and Surgery
- Ongoing Care and Reconstruction
- Rehabilitation

1. Celso et al. A Systematic Review and Meta-Analysis Comparing Outcome of Severely Injured Patients Treated in Trauma Centers Following the Establishment of Trauma Systems. Trauma 2006 Vol iss 2 pp371-378
2. NHS Clinical Advisory Group. Regional Networks for Major Trauma. September 2010
<http://www.uhs.nhs.uk/Media/SUHTInternet/Services/Emergencymedicine/Regionalnetworksformajortrauma.pdf>

The Major Trauma Network: Major Trauma Centre, Trauma Units and Local Emergency Hospitals

Reference	Type of study/aims	Key results	Conclusions
<p>McDermott et al Management deficiency and death preventability of road traffic accidents before and after a new trauma care system Journal of trauma, injury, infection and critical care. J Trauma. 2007 Aug;63(2):331-8</p>	<p>Regional retrospective data analysis in Victoria Australia.</p> <p>This study compares potentially preventable death rates of road crash fatalities who received treatment before (1997–1998) and after (2002–2004) organization of a major trauma network.</p>	<p>ED admissions increased from 34% to 62% ($p < 0.05$).</p> <p>More patients were attended by Advanced Trauma Life Support paramedics ($p < 0.05$) and scene times increased ($p < 0.05$).</p> <p>Patients admitted within 1 hour decreased from 70% to 45% ($p < 0.05$) – longer transport times to MTS by road.</p> <p>The mean number of deficiencies per patient including those contributing to death was decreased ($p < 0.05$).</p> <p>The preventable death rates decreased from 36% to 28% (22% relative risk reduction).</p> <p>Patient demography and injury severity were unchanged.</p>	<p>Since the introduction of The new Victorian trauma care system, there has been a significant decrease in deficiencies including those contributing to death and a decrease in preventable death rates.</p> <p>The marked improvement has been largely consequent to an increase in admissions to MTS.</p> <p>Despite a longer time at the crash site and longer transport times to the specialist hospital, outcomes for trauma patients had improved.</p>
<p>Moran et al Changing the System - Major Trauma Patients and Their Outcomes in the NHS (England) 2008–17 EClinicalMedicine 2–3 (2018) 13–21</p>	<p>A longitudinal series of annual cross-sectional studies of care process and outcomes from April 2008 to March 2017</p> <p>Data was collected through the national clinical audit of major trauma care.</p>	<p>Analysis carried out on 110,863 patients admitted to 35 hospitals</p> <p>Major Trauma networks were associated with significant changes in</p> <ul style="list-style-type: none"> - increased numbers treated in Major Trauma Centres - more consultant led care and more rapid imaging - patient factors (an increase in older trauma) - changes to clinical care <p>Increase of 0.08% per quarter more survivors, so for every 1000 patients per year, 30 more were</p>	<p>This report demonstrates the multilevel changes which have occurred to provide excellent clinical care, which has subsequently lead to an increase in number of lives saved following major trauma.</p>

		surviving. This was without and increased length of hospital or ICU stay.	
<p>Gabbe et al Improved functional outcomes for major trauma patients in a recognized trauma system 2015 Ann Surg 2012;255:1009–1015</p>	<p>Retrospective data analysis of all patients admitted following trauma from 2006-2009 in state of Victoria, Australia.</p> <p>The author collected data regarding a patient's mortality and their functional outcomes following trauma.</p> <p>Data was collected from 138 trauma-receiving hospitals and 3 major trauma centres in Victoria, Australia, following their implemented regional trauma system in 2000.</p>	<p>There were 4986 patients older than 18 years. In-hospital mortality decreased from 11.9% in 2006–2007 to 9.9% in 2008–2009.</p> <p>86% were successfully followed up at 12month Of those 80% reported functional limitations, but the odds of better functional outcome increased in the years studied following the trauma network formation.</p> <p>Cases managed at major trauma services (MTS) achieved better functional outcome (AOR: 1.22; 95% CI: 1.03, 1.45).</p> <p>Female gender, older age, and lower levels of education demonstrated lower adjusted odds of better outcome</p>	<p>Since implementing a major trauma network, there has been an annual decline in mortality.</p> <p>Risk-adjusted functional outcomes improved over time, i.e. not only were more patients surviving, they were doing so with less disability.</p> <p>A point to note is that cases managed at Major trauma centres, usually the most severely injured, demonstrated better functional outcomes.</p>
<p>Metcalfe et al Effect of regional trauma centralization on volume injury severity and outcomes of injured patients admitted to trauma centres Br J Surg. 2014 Jul;101(8):959-64</p>	<p>A retrospective study looking at trauma patients admitted to 4 hospitals, before and after becoming major trauma centres in London in March 2012.</p>	<p>Impact upon the four hospitals following intuition of the trauma network:</p> <ul style="list-style-type: none"> - Patient volume increased from 442 to 1326 which is a 200% increase - operations from 349 to 1231 -253% - critical care bed-days from 1100 to 3704 - 237% - total hospital bed-days from 7910 to 22 772 – 188%. - Patient age increased on MTC designation from 45·0 years before March 2012 to 48·2 years afterwards (P = 0·021), 	<p>This large regional study demonstrates the impact upon a hospital once it becomes a major trauma centre. The volume of patient arriving at ED, having operations and spending time in critical care dramatically increase to over 200% in most cases. This is about the national average of a 20% increase, explained possibly but the location of these hospitals.</p>

		<ul style="list-style-type: none"> - Penetrating injuries increased 1.8% to 4.1% - Fewer patients required secondary transfer to a MTC from peripheral hospitals (19.9 versus 16.1 per cent; P = 0.100). - There were no significant differences in total duration of hospital stay, critical care requirements or mortality. - Significant increase, from 55.5% to 62.3% (P < 0.001), in the proportion of patients coded as having a 'good recovery' at discharge 	<p>More patients were arriving at the appropriate hospital first time, avoiding the need for secondary transfer which can delay treatment and expose the patient to a second transfer.</p> <p>Although no mortality benefit was demonstrated within 6 months of establishing this trauma network, early detectable advantages included improved functional outcome at discharge.</p>
<p>Gabbe et al The Effect of an Organized Trauma System on Mortality in Major Trauma Involving Serious Head Injury: A Comparison of the United Kingdom and Victoria, Australia. Annals of surgery January 2011 - Volume 253 - Issue 1 - p 138–143</p>	<p>Retrospective data analysis of UK trauma data (TARN) and Victoria state trauma registry (VSTR), following implementation of its trauma network.</p> <p>Mortality outcomes following major trauma involving serious head injury managed in the two registries between 2001 to June 2006 was collected and analysed.</p>	<p>A total of 4064 (VSTR) and 6024 (TARN) cases were provided for analysis.</p> <p>Chance of death following major trauma in the UK was significantly higher than that for Australia. [odds ratio = 2.15, 95% confidence interval = 1.95–2.37].</p> <p>Both countries showed similarities in the profile of major trauma patients, with a predominance of blunt trauma related to road trauma and falls, and comparable data registries.</p> <p>In particular risk of mortality was significantly lower for severe head injuries in Australia.</p> <p>In the two groups 17% of patients died in Australia versus a staggering 30.8% in UK.</p>	<p>In the two groups 17% of patients died in Australia versus a staggering 30.8% in UK.</p> <p>Management of the severely injured patient with an associated head injury in where an organized trauma network is absent, was associated with increased risk of death compared.</p>
<p>Simons RU et al 1999 Impact on Process of Trauma Care Delivery 1</p>	<p>Prospective study before and after implementing a dedicated trauma service for patients with</p>	<p>Differences between preprogram and post program performance were assessed</p>	<p>What this study implies is that the major trauma network goes further to improve patient care, by employing a dedicated</p>

<p>Year after the Introduction of a Trauma Program in a Provincial Trauma Centre Journal of trauma Issue: Volume 46(5), May 1999, pp 811-816</p>	<p>multisystem injuries at major trauma centres. It is proposed that Trauma care is necessarily multidisciplinary, and to be optimal, appropriate integration of the care process and prioritization are required.</p>	<p>Results: Trauma unit average length of stay decreased from 10.15 days initially to 9.66 and 9.14* days at 6 and 12 months, thus reducing bed occupancy and reducing costs. Improved survival was also demonstrated by Trauma and Injury Severity Score methodology with z score achieving significance compared with Major Trauma Outcome Study outcomes after program implementation.</p>	<p>multidisciplinary team focusing on the process of care, developing a dedicated trauma service to manage the more seriously injured patients.</p>
<p>McKee et al Right treatment at the right time in the right place Ann Surg 2015;261:558–564</p>	<p>Canadian based study where due to geography, access to trauma centres require lengthy transfer times. Prospective study before and after a new trauma system was implemented creating secondary trauma centre</p>	<p>21,772 major trauma patients were included. Implementation of the new system of trauma care was associated with a decline in transfers directly to level I trauma centres [risk ratio (RR) = 0.91; 95% confidence interval (CI): 0.88–0.94; P < 0.001] and an increase in transfers from level III to level I centres (RR = 1.10; 95% CI: 1.00–1.21; P = 0.04). These changes in trauma care occurred in conjunction with a 12% reduction in the hazard of mortality (hazard ratio = 0.88; 95% CI: 0.84–0.98; P = 0.003) and a decrease in mean trauma patient hospital length of stay by 1 day (95% CI: 1.02–1.11; P = 0.02) after adjustment for differences in case mix</p>	<p>This study demonstrates the importance of getting the distance and spatial arrangement of trauma centres correct, in order for it to have a benefit upon patient outcomes. By differing levels of trauma centres, patients were now reaching an immediate point of care faster.</p>
<p>Hay et al The impact of the Major Trauma Network: will trauma units continue to treat complex foot and ankle injuries?</p>	<p>Retrospective analysis of the epidemiology of foot and ankle injuries, using the Gloucestershire trauma database, from a trauma unit with a population of 750,000 Following the introduction of National trauma Networks in April, it was</p>	<p>Frequency of complex foot and ankle injuries was 4.2% before and 7.5% after the network commenced, showing no significant change. There was no statistically significant change in the numbers of patients with complex foot and ankle injuries treated by application of external fixators in this trauma unit. Analysis of TARN data revealed that only 18% of patients with foot and ankle injuries taken to the MTC had an ISS ≥ 16. The majority of these patients were identified as</p>	<p>This study showed that trauma related injuries will continue to present to trauma units within the Major trauma network. This has to be taken into consideration when planning services appropriately, ensuring trauma units do not lose services that they will continue to require.</p>

<p>Dec 2014 Vol 45, Issue 12, p 2005-2008</p>	<p>predicted that with severely injured patients being transferred to the regional Major Trauma Centre (level 1), trauma units (level 2) would no longer manage certain trauma related specialties thereby obviating the need for them.</p>	<p>requiring plastic surgical intervention for open fractures (69%) or were polytrauma patients (43%). Only 4.5% of patients had isolated, closed foot and ankle injuries.</p>	
<p>Gabbe et al Reduced population burden of road transport-related major trauma after introduction of an inclusive trauma system Ann Surg 2015 Mar; 261 (3) pp 565-72</p>	<p>Aim to describe the burden of transport-related serious injury in Victoria, Australia, since introduction of an integrated trauma system. Retrospective data collection of all road and major trauma-related deaths from coroner and trauma registry data for July 2001 – June 2011. Disability-adjusted life years, combining years of life lost and years with disability were calculated.</p>	<p>Incidence of transport-related deaths decreased. Incidence of hospitalized major trauma increased. Years of life lost decreased by 43%. Years with disability increased by 32% but with an overall 28% reduction in disability-adjusted life years over the decade. The study also showed significant cost saving when taking this into account.</p>	<p>This study demonstrates that since Victoria, Australia introduced their trauma system, the burden of trauma related disease has decreased. Despite the increase in hospitalisation of trauma patients, they demonstrated a decrease in disability burden. So conclude that increase survival in this situation does not lead to an overall increase in nonfatal injury burden.</p>

Pre-hospital Care and Retrieval

Reference	Type of study/Aims	Key results	Conclusions
<p>D.C.Engel, A.Mikocka-Walus, P.A.Cameron, M.Maegele Pre-hospital and in-hospital parameters and outcomes in patients with traumatic brain injury: A comparison between German and Australian trauma registries. Injury Vol41, Issue 9, Sept 2010, p901-906</p>	<p>Retrospective observational study comparing two forms of trauma systems, taking into account injury severity and population demographics – the main difference being the Australian prehospital and major trauma network.</p>	<p>10,183 cases (5665 German, 4518 Australian) were included</p> <p>Mortality was significantly higher amongst German patients even when adjusted for demographics, injury severity and in- and pre-hospital parameters. German patients had a longer hospital and ICU stay.</p>	<p>Underpins the importance of an integrated system of specialist prehospital care and retrieval providing efficient and rapid stabilization and transfer to a major trauma centre. How this can then have knock on effect the effect of improving chance of survival and decreasing hospital stay.</p>
<p>Preston J.FedorMD, BrianBurns, MichaelLauria, ClareRichmond Major Trauma Outside a Trauma Centre: Prehospital, Emergency Department, and Retrieval Considerations. EMCoNA Vol36,Issue 1, Feb2018, p203-218</p>	<p>Overview of the role of the prehospital care teams and retrieval services.</p> <p>Observational study comparing with up to date protocols.</p>	<p>Incoming Emergency Medical Services crews often have crucial information about trauma mechanism, contributing factors, specific injuries, effect of treatment, key timings, personal details, and more.</p> <ul style="list-style-type: none"> -Set up the resuscitation area for success and know the equipment and team capabilities. -Create and rehearse emergency department and hospital procedures -Extensive radiological and laboratory evaluation is often unnecessary and may delay access to definitive care. -Request transfer/retrieval as soon as the need for higher level of trauma care is presumed. A standard preretrieval process (with checklist) can make the 	<p>Care of the critically injured begins well before the patient arrives at a large academic trauma centre. It is important to understand the continuum of care from the point of injury in the prehospital environment, through the local hospital and retrieval, until arrival at a trauma centre capable of definitive care.</p> <p>This article highlights the important aspects of trauma assessment and management outside of MTC.</p>

		transition of the patient out of the emergency department safer and more efficient	
<p>Bryce N.Taylor, Niki Rasnake, Kelly McNutt, Catherine Lindsay McKnight, Brian J.Daley. Rapid Ground Transport of Trauma Patients: A Moderate Distance from Trauma Centre Improves Survival Journal of Surgical Research Volume 232, December 2018, Pages 318-324</p>	<p>Retrospectively analysis of patients brought to a level I trauma centre who were admitted with blunt traumatic injuries between 2010 and 2015</p> <p>Two groups existed HEMS and ground transport GEMS. Data was collected for trauma patients' vital statistics, transport times and mortality were analyzed.</p>	<p>400 subjects were included in the analysis of patients - 212 HEMS patients and 188 in the GEMS group.</p> <p>HEMS had a higher mortality rate at 0.184 and GEMS at 0.101, which was statistically significant ($P = 0.019$). When 606 subjects meeting the first step of the NFTG or with a pulse greater than 110 beats per minute were analyzed, the results were statistically significant ($P < 0.001$), with the HEMS category having a higher mortality rate at 0.154 and the GEMS category having a lower mortality at 0.056.</p>	<p>This highlights the challenges in transporting patients to the nearest trauma centre. This London based prehospital study is located over an area where ground transport may be the fastest. However, they do recognize that there may be a subset of patients at these distances who could benefit from HEMS response, particularly if the flight crew can offer more advanced and specialized techniques. This study only analyzed the patients within a moderate distance of the trauma centre and at longer distances or in different environments, HEMS transport may indeed minimize the scene to ED time.</p> <p>With the EMRTS having access to both ground and air retrieval Wales, they will be able to supply the major trauma network in a similar way.</p>
<p>Prehospital care Impact of introducing a major trauma network on a regional helicopter emergency medicine service in the UK McQueen C, et al. Emerg Med J 2014;31:844–850</p>	<p>Retrospective review of the clinical audit database for a 6-month period after the launch of the West Midlands Major trauma network on 26 March 2012. Non trauma requests were excluded from the analysis. The team then</p>	<p>The proportion of HEMS activations for trauma cases was similar in both cohorts (70.84% before MTN vs 71.57% after MTN). The proportion of mission cancellations was significantly lower after the launch of the network (23.71% vs 19.03%). Significantly more scene attendances resulted in interventions by HEMS crews after the MTN launch (44.66% vs 56.92%).</p>	<p>The relevance of this study to the Welsh trauma network, is to demonstrate the affect upon our existing EMRTS helicopter service once a specialist trauma network has been established.</p> <p>This study shows that the impact in a positive one upon an already established and funded system. Since the introduction of the West Midlands MTN, they are able to better equip to target cases involving</p>

	reviewed the corresponding period for the previous year for comparison.		significant injury, and show a reduction in mission cancellations.
<p>Taylor et al The cost-effectiveness of physician staffed Helicopter Emergency Medical Service (HEMS) transport to a major trauma centre in NSW, Australia 2012 Injury, Int. J. Care Injured 43 (2012) 1843–1849</p>	<p>St George Hospital NSW</p> <p>Retrospective cost analysis over 11 year period looking at mortality and cost per life saved, cost per life-year saved at one year and over a patient's lifetime respectively in three patient groups – all patients, seriously injured and traumatic brain injury patients.</p>	<p>Results showed HEMS to be more costly but more effective at reducing in-hospital mortality.</p> <p>When modelled over a patient's lifetime, the improved mortality associated with HEMS led to a cost per life year saved of \$96,524, \$50,035 and \$49,159 in the three patient groups respectively.</p> <p>Sensitivity analyses revealed a higher probability of HEMS being cost effective in patients with serious injury and TBI.</p>	<p>HEMS transport to a major trauma centre is more costly initially for obvious reasons, and those who have more life threatening injuries will go on to need specialist care and therefore increased cost. However, with HEMS intervention combined with treatment at a major trauma centre, there is an improved mortality leading to an estimated cost per life saved between \$519,787 and \$1,566,379 and an estimated cost per life year saved between \$49,159 and \$96,524. The estimated cost effectiveness of HEMS improved in patients with more serious injuries and in patients with traumatic brain injury</p>
<p>SInclair et al Clinician tasking in ambulance control improves the identification of pre hospital critical care team tasking Injury 2018 May pp897-902</p>	<p>Retrospective cohort study over 2 years</p> <p>Pre and post implementation of pre-hospital critical care trauma team clinician led dispatch of PHCCT for potential trauma patients</p>	<p>99,702 trauma related calls were made, including 495 major trauma patients with an ISS >15, and a total of 454 dispatches of a PHCCT. Following the introduction of a PHCCT clinician staffed trauma desk</p> <p>The sensitivity for major trauma was significantly increased from 11.3% to 25.9%. (95% CI 7.4%-21.4%, $p < .001$).</p>	<p>This study supports the use of a trauma desk, recommending that a PHCCT clinician should be located in ambulance control to aid early identification of trauma patients and direct the response.</p>

Acute Emergency Care and Surgery

Reference	Type of study/aims	Key results	Conclusions
<p>Kehoe et al The changing face of major trauma in the UK EMJ Vol 32 Issue 12 pp911-915</p>	<p>Retrospective observational data analysis of major trauma from the Trauma Audit Research Network from 1990 to 2013. The aim was to describe the changes in the demographics of trauma over the 13 years.</p>	<p>The mean of age of major trauma in 1990 was 36.1, with the largest age group being 0-24. Most common cause was road traffic collision.</p> <p>By 2013 the mean age had increased to 53.8 with the single largest group being 25-50 year olds and then the over 75s (26.9%). The most common mechanism was now low falls.</p>	<p>The face of trauma has changed over the 13 years in this study, highlighting that over 25% of trauma is now in the >75 years olds. The specific needs of the elderly must be considered in the design of major trauma services for significant improvements in trauma to be seen.</p>
<p>Baarr LV et al The effect of becoming a major trauma centre on the outcomes for elderly hip fracture injury Injury. 2015 Feb;46(2):384-7</p>	<p>Retrospective data analysis over 1 year.</p> <p>The aim of this study was to ascertain whether becoming an MTC has affected outcomes for elderly hip fracture patients at one institution in England since 2012.</p> <p>824 patients aged ≥ 60 years who sustained 841 consecutive hip fractures over a two-year period were included.</p>	<p>There were 381 fractures during the year prior to (pre-MTC group), and 460 fractures during the year after (post-MTC group) becoming an MTC.</p> <p>Outcomes analysed were time to theatre, length of acute hospital stay, post-operative complications, and mortality at 30, 120 and 365.</p> <p>There was no difference seen in the average length of stay before or after MTC established (13 days vs 14 days, $p=0.2888$).</p> <p>In the post-MTC group, there was a significant increase in delay to theatre (25.5h vs 31.5h, $p<0.0001$)</p> <p>There was a significant increase in post-operative medical complications (29.7% vs 37.6%, $p=0.0160$).</p> <p>There was no statistically significant difference in overall mortality rates, however 30-day mortality rose from 4.7% to 8.0% ($p=0.0678$).</p>	<p>What this study suggests in comparison to the national Hip fracture audit data, is that a newly appointed MTC, with increased demands upon its existing infrastructure, can have an impact upon its existing services. Whether there are other factors attributable to the increase in postoperative complications and 30 day mortality seen in this study, it may still be of benefit to recognize the possibility of a negative impact that such increase in demand on services can cause.</p> <p>It highlights the need for preparation and readiness for</p>

			the changes in becoming an MTC.
<p>Batrach et al Impact on an acute trust after opening a major trauma centre BJ of hospital medicine Feb2013 Vol 74 no2 p64-65</p>	<p>Observation analysis editorial of the London major trauma network following its implementation Discussion regarding how the hospital has changed</p>	<p>Increased workload has had a major impact on all departments with the need for full rotas. Consultant Trauma is now based onsite 24/7 and this also has rota and financial implications for the trust. ED need to be well equipped, large enough to cope with multiple traumas and care delivered by senior clinicians. Radiology workload increased with need for increase image interpretation, the radiologist became part of the trauma team. Expansion of theatres with dedication trauma theatre was needed to cope with the workload. Hospital bed number and ICU bed number increased. A dedication rehabilitation consultant with a focus on rehab prescription and funding were essential.</p>	<p>Dedication trauma facilities at the major trauma centre results in better outcomes for severely injured trauma patients. However there is need for modification of working practices by staff in many specialties to facilitate a rapid response for the most severely injured. This observational report brings to light some of the changes that may need to be implemented in order to facilitate the same positive outcomes seen in MTC trauma patient studies.</p>
<p>Davenport RA et al A major trauma centre is a specialty hospital not a hospital of specialties. Br J Surg. 2010 Jan;97(1):109-17</p>	<p>An Observational multimodal study was performed using the database from the Trauma Audit and Research Network (TARN) for England and Wales, the Royal London Hospital (RLH) trauma registry and the US National Trauma Databank (NTDB) with an analysis of preventable deaths from trauma.</p>	<p>Mortality from critical injury at the RLH was 48 per cent lower following dedicated trauma service establishment. (P = 0.001). Overall mortality rates were unchanged for acute hospitals (4.3 versus 4.4 per cent) and other multispecialty hospitals (8.7 versus 7.3 per cent). Preventable death rates fell from 9 to 2 per cent (P = 0.040) and significant gains were made in critical care and ward bed utilization</p>	<p>Directly comparing large hospitals receiving trauma with a multitude of specialties on site, versus one which has a dedicated trauma service shows that a benefit in mortality comes from this dedicated acute care bundle, dedicated staff, protocols and facilities. This is suggestive of how Wales' MTC can follow suit to decrease preventable deaths related to trauma.</p>

	Aim: A dedicated trauma service within a hospital (RLH) receiving major trauma improved mortality of trauma patients		
McKechnie PS et al Time to CT and Surgery for HPB Trauma in Scotland Prior to the Introduction of Major Trauma Centres World J Surg. 2017 Jul;41(7):1796-180	Retrospective study to assess the time taken to CT and Emergency Surgery for trauma patients with an injury to Liver, Spleen or Pancreas prior to the introduction of Major Trauma Centers (MTCs) in Scotland.	In Scotland the goal time to CT is within 60 minutes. In England this is 30 minutes. This study shows that prior to MTC initialization, only 27% of patient were receiving this level of care. Median time to urgent surgery was 199.5 minutes.	We would expect that after a hospital adopts the role of a MTC, that there is an availability of specialized services and facilities. This study highlights the use of a CT scanner which is vital in the rapid diagnosis of trauma, and enables appropriate care, quickly. Also the speed at which a patient can receive emergency surgical care. This is in-keeping with European studies which shows a reduction in time by 38% post MTC.

Ongoing Care and Reconstruction

Reference	Type of study/aims	Key results	Conclusions
<p>Ali et al Experience of managing open fractures of lowers limbs in MTC Ann R Coll Surg Engl. 2015 May; 97(4): 287–290</p>	<p>April 2012 the John Radcliffe Hospital in Oxford became a major trauma centre (MTC). Multistep audit of compliance with BOAST 4 was conducted to assess referral patterns, timing of surgery and outcomes (surgical site infection rates), to determine changes following local intervention and the establishment of the MTC.</p>	<p>Following development of MTC: There was an increase in the proportion of patients receiving definitive fixation median time from injury to soft tissue cover fell from 6.0 days to 3.5 days ($p=0.051$) median time from definitive fixation to soft tissue cover fell from 5.0 days to 2.0 days The deep infection rate fell from 27% to 8%</p>	<p>This small study shows the benefit of the improved ongoing and definitive care to patients at a major trauma centre as written.</p>
<p>Yip et al Capacity planning for the implementation of major trauma centres https://publishing.rcseng.ac.uk/doi/pdf/10.1308/rcsbull.2016.122</p>	<p>Retrospective review was performed to analyse Cambridge University Hospitals NHS Foundation Trust for the first full year of activity since acquiring MTC status (1 April 2012 – 31 March 2013) Primary outcome measures were time of additional theatre usage and additional bed days (recorded as length of stay).</p>	<p>Our results give an estimate of the minimum resources required in the first year of becoming a MTC for a population of 5.9 million in a rural region. Major trauma is unpredictable, and there is a natural ebb and flow of workload. A MTC is always on standby, which requires added resources. As a 24-hour emergency service is to be provided, more staff are needed. This affects all departments involved in the trauma pathway.</p>	<p>An additional one-day orthopaedic trauma list and three extra beds are needed for the increased number of patients admitted to the MTC during the first year of its inception.</p>
<p>HAQ J et al Implementation of an oral and maxillofacial surgery trauma team in a major trauma centre Haq, J. et al.</p>	<p>Retrospective data analysis of Oral and maxillofacial (OMF) services in Kings College London, following its designation as a Major trauma centre. An integrated oral and maxillofacial team of the week</p>	<p>To assess the effect of the new system as an MTC, they compared the duration of stay between 1 October and 31 January 2011-2012 with the same period in 2012-2013. The mean total duration of stay had decreased significantly by 0.84 days ($p =$</p>	<p>OMF services are integral part of the trauma team. Kings College London adapted their services as they became a Major trauma centre, which had the net result of reducing</p>

<p>British Journal of Oral and Maxillofacial Surgery , Volume 55 , Issue 4 , 396 - 399</p>	<p>was created in 2012, with the aim to provide a consultant-led, emergency service dedicated to acute care.</p>	<p>0.03), the mean delay to operation had decreased by 0.3 days, and the mean postoperative stay had decreased by 0.5 days.</p>	<p>the total duration of stay. Improving services improves patient's outcomes and has cost benefits for the centre.</p>
<p>Hendrickson S et al Plastic surgical operative workload in major trauma patients following establishment of the major trauma network in England: A retrospective cohort study. J Plast Reconstr Aesthet Surg. 2016 Jul;69(7):881-7. doi: 10.1016/j.bjps.2016.02.003. Epub 2016 Feb 12</p>	<p>Retrospective data analysis of the TARN database, compared with historical data of a London hospital pre MTC designation in 2013</p>	<p>In 2013 Of the 2606 trauma calls, 416 patients required surgical intervention. 29.3% of these patients (n = 122) were operated on by plastics. Emergency general extremity referrals increased from an average of 65/year to 484/year in the period 2011 to 2013, whilst plastics operative workload increased from an average of 53 cases/year to 407/year in the same period. This represents a more than sevenfold increase in the plastic surgery operative workload.</p>	<p>In this London MTC there was a 7 fold increase in emergency plastic surgery activity following designation of major trauma centre status. plastic surgical operative workload is at least on par with other tertiary surgical specialties The quantity of plastic surgical operative workload in major trauma must be considered when planning major trauma service design and workforce provision, and for plastic surgical postgraduate training.</p>

Rehabilitation

Reference	Type of study/Aims	Key results	Conclusions
<p>Specialist Rehabilitation in the Trauma pathway: BSRM core standards Version 1.4 – October 2013</p> <p>https://www.bsrn.org.uk/downloads/bsrm-core-standards-for-major-trauma-24-10-13-version1.4newlogo-forpublication-finalforweb-checked1-12-14.pdf</p>	<p>The British Society of Rehabilitation Medicine has guidelines on major trauma rehabilitation, recommending all those with an ISS of ≥ 9 should receive specialist rehabilitation.</p> <p>The recommendations given in this guideline are important for trauma services planning. Many areas of the UK have focused on the acute care elements of the pathway. However, this guideline suggests that rehabilitation is key, both for supporting individual patients' needs and increasing flow to remove bottle-necks in the acute patient pathway.</p>	<p>Key points from the guideline:</p> <ul style="list-style-type: none"> - After trauma many patients will need input from rehabilitation services including from rehabilitation consultants. - input may be limited to assessment, giving advice and setting expectations, and possibly organising relatively simple interventions. - A significant number of patients will have more complex needs requiring more prolonged input from a multidisciplinary team with expertise, and a smaller group will need more prolonged specialist rehabilitation (in- or out-patient). - There is now a substantial body of trial-based evidence and other research to support both the effectiveness and cost-effectiveness of specialist rehabilitation. - Despite their longer length of stay, the cost of providing early specialist rehabilitation for patients with complex needs is rapidly offset by longer-term savings in the cost of community care, making this a highly cost efficient intervention. - Application of a rehabilitation prescription 	<p>Specialist rehabilitation is a critical component of the Trauma Care Pathway without which the Major Trauma networks will inevitably fail.</p> <p>From this guideline, it is suggested that Rehabilitation Medicine Consultants play a vital role in the Major Trauma Centres, and should be closely involved both at a clinical level and in the planning and delivery of services across all parts of the Major Trauma Networks.</p>

<p>Spreadborough et al 2018 A study of outcomes of patient Rx at a UK MTC for mod-severe injuries</p>	<p>Retrospective population based Norway study, examining return to work outcomes and associated factors with following major trauma.</p>	<p>With care and rehabilitation in a MTC, 66% of patients with moderate to severe injuries return to work. Patients experiencing minor or major trauma received high levels of medical benefits.</p>	<p>There are more aspects to rehabilitation that trauma patients benefit from - Psycho-social/physical and functional health</p>
<p>The National Clinical Audit of Specialist Rehabilitation following major Injury (NCASRI)</p> <p>https://www.hqip.org.uk/wp-content/uploads/2018/02/SbAilk.pdf</p>	<p>Ongoing quality improvement program by the British Society of rehabilitation medicine. In England, in the absence of central guidance on what form the rehabilitation prescription should take, individual MTCs had each developed their own systems with little commonality between them.</p>	<p>A 'Rehabilitation Prescription' (RP) was a requirement for the enhanced 'best practice' tariff in the MTCs, but the mandated data collection comprised just 4 data fields in the TARN database. Fewer than half the MTNs complied with the national recommendation for consultants in Rehabilitation Medicine (RM) to be appointed to provide clinical and strategic leadership of acute trauma rehabilitation services, and many MTCs had little or no input from RM consultants at any level.</p>	<p>New and emerging sets of guidelines with national audits. BRSM aims to bring together MTCs to deliver excellence for patients experience trauma. It is likely Wales should take advise from these guidelines when expanding and developing their rehabilitation services to accommodate and improve the major trauma centre for Wales</p>
<p>Khan F et al</p> <p>Systematic review of multidisciplinary rehabilitation in patients with multiple trauma</p> <p>BJS Jan 2012 Volume99, IssueS1</p> <p>Supplement: Trauma Supplement</p> <p>p88-96</p>	<p>Systematic review using MEDLINE, Embase and several other databases including Studies that compared multidisciplinary rehabilitation intervention in multiple trauma survivors with routinely available local services or lower levels of intervention, or studies that compared multidisciplinary care in different settings</p>	<p>No randomized and/or controlled clinical trials were identified. 15 observational studies involving 2386 participants with injuries were included. The Grading approach assessed methodological quality as 'poor' in all studies. Patients with low functional scores showed improvement after rehabilitation,</p>	<p>This review has highlighted the lack of high-quality studies for effective multidisciplinary rehabilitation in survivors of multiple trauma.</p>

		<p>however, they were unable to resume their pre-trauma level of activity.</p> <p>Functional ability was significantly associated with motor independence on admission and early acute rehabilitation, which contributed to a shorter hospital stay.</p>	
<p>Wood RL et al Clinical and cost effectiveness of post-acute neurobehavioural rehabilitation. Brain Injury 1999;13(2):69–88.</p>	<p>Cohort study analyzing rehabilitation for brain injury patients</p>	<p>76 patients with brain injury were followed up following discharge.</p> <p>People who have received rehabilitation with a minimum of 6 months rehabilitation, many severely damaged individuals can progress to less dependent placements in the community, and maintain higher levels of social activity (independence) with fewer hours of care support.</p> <p>This paper deduced this can amount to a per capita lifetime reduction of over 1 million pounds per annum in the cost of supporting such people in the community.</p> <p>Factors affecting outcome were time between injury and the beginning of rehabilitation</p> <p>Longer periods of rehabilitation (beyond 12 months for the most seriously disabled) is not associated with a better outcome.</p>	<p>The appropriate cognitive and behavioural rehabilitation following severe brain injury led to an increased rate of return to independence. Thus in this paper, led to estimated life-time savings in the cost of care of over £1 million.</p>
<p>Slade A et al A randomised controlled trial to determine the effect of intensity of therapy on length of stay in a</p>	<p>Randomised controlled single blind study based in Leeds, comparing a controlled trial of standard (n = 81) versus intensive (n = 80) rehabilitation.</p>	<p>Findings:</p> <ul style="list-style-type: none"> - Higher intensity rehabilitation was associated with increased staff costs - A significantly shorter length of stay was seen (mean reduction 14 days) 	<p>A small randomized control trail displaying that whilst rehabilitation can be expensive for the health care system, on</p>

<p>neurological rehabilitation setting. J Rehabilitation Med 2002;34(6):260–66.</p>		<ul style="list-style-type: none"> - The result, an overall saving of £1,737 per patient in the net cost of providing the rehabilitation programme. 	<p>analysis there is actually an over net cost saving.</p>
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Summary of Findings

The benefits and consequences of implementing a Major Trauma network are summarized in several papers. Since implementation of major trauma networks across England in 2012 and Scotland following suit in 2018, we are seeing promising early data from the UK population cohort.

What we can extrapolate from the tables mentioned is as follows:

Benefits

- A reduction in preventable deaths.
- More consultant led care.
- Increase in survival seen in UK studies since MTN establishment.
- Better functional outcome from trauma patients admitted to a major trauma centre
- Less need for secondary transfers
- Trauma continues to present at trauma units, so not all services will need to be centralised. (Major trauma centre is a specialist hospital not a hospital of specialties)
- Opportunities for education and training,

Problems

- Increase in hospital workload – some studies quoting between 20 and 200%
- Increase in theatre operating/demand
- Increase in bed occupancy
- Knock on effect for existing trauma waiting for theatre – some studies demonstrating an increase in mortality for hip fractures at 30 days
- Studies quoting 25% of trauma is in the over 65year olds, with Wales' aging population this poses its own specific set of demands and the need to design the health care system around the population
- An increase in demand for all surgical specialties involved within the trauma team – example given -oral and maxillofacial, Plastics
- Rehabilitation for trauma patients - increase demand for psycho-social and functional rehabilitation to decrease burden and improve socioeconomic outcomes

Conclusions

The importance of a major trauma network and major trauma centre for our health care system here in Wales is represented in these examples given above. It shows what our health care system should be in order to deliver an excellent level of care, improve quality of lives and continue to advance with the rest of the World in a modern health care system design. In order for Wales to succeed in this goal, the NHS Wales needs to take in to consideration the challenges of establishing a major trauma centre or face failing at the first hurdle. It goes further than simply designating one hospital as a Major trauma centre. The hospital will need to change and adapt in order to be in a position to cope with these challenges. The level of care given at our new major trauma centre will need to be in keeping with the level of care given in London and Victoria Australia, in order for our trauma patients to experience the benefits mentioned in these studies, and also, so not to have an impact on the existing services and inpatients. Examples as to how

this is achieved are more consultant led care, increase in capacity/facilities, education and training.

When you look at a major incident such as the Manchester Arena Bombings, you can see that trauma patients flow through the hospital was in waves in a ripple effect on the rest of the health care system.³ Now this is obviously an extreme event, however it does demonstrate a trauma patient's pathway through a care system and the levels of stress on a system. The first wave hitting the emergency and radiology departments, within hours the second peak of activity is in the theatre suite, followed by days in the intensive care and weeks in hospital, with these patients needing return trips to theatre for definitive surgery in the days and weeks following the initial injury. These patients, in order to leave hospital need the next phase which is a level of rehabilitation to facilitate their transition from ICU to ward and eventually home.

In order for there to be a continuous flow of patients through the trauma centre, there will need to be staged rehabilitation and discharge planning to accommodate new patients arriving at ED. With the increase in pressure on the system, there needs to be an adequate 'back door' so that the system does not become over loaded and under pressure so much so, that the dedicated level of care becomes difficult to provide. Trauma is the main cause of significant disability in adults of working age, and according to the World Health Organization (WHO), trauma is associated with moderate to severe disability for over 45 million people each year worldwide. Trauma, therefore has a huge socioeconomic burden. In order to get the working man back to work, Wales needs to include the Specialist Rehabilitation in the trauma pathway, British Society of Rehabilitation Medicine Core standards. Trauma CAG advised that every patient with ISS ≥ 9 in either a Major Trauma Centre or a Trauma unit should have their needs for rehabilitation assessed, and that a rehabilitation prescription should be provided for all patients with rehabilitation needs. The Specialist Rehabilitation in the Trauma pathway: BSRM core standards Version 1.4 October 2013, gives Trauma centres guidance as how to set about tackling this challenge with a multidisciplinary approach and the application of a rehabilitation prescription. With rehabilitation in trauma patients so variable throughout the trauma networks of England, the quality evidence base for it is missing at present. It is hoped with the guidance and ongoing audit and data collection by the British Society of Rehabilitation Medicine, more evidence will be gathered.

The final point to be made from this discussion is that of 'Silver Trauma' – trauma in the over 65 year olds. Greater than 25% of trauma now effects people aged 65 years old and older, and is increasing each year. In many cases this may only involve a fall from standing. This subset of trauma patients will bring with them their own specific needs and challenges which will need to be addressed in order for these patients to thrive at Wales' Major trauma centre.

3. NHS Confederation: When tragedy strikes. Reflections on the NHS response to the Manchester Arena bombing and Grenfell Tower fire pdf
<https://www.nhsconfed.org/-/media/Confederation/Files/Publications/When-tragedy-strikes-report-June-2018-WEB.PDF>