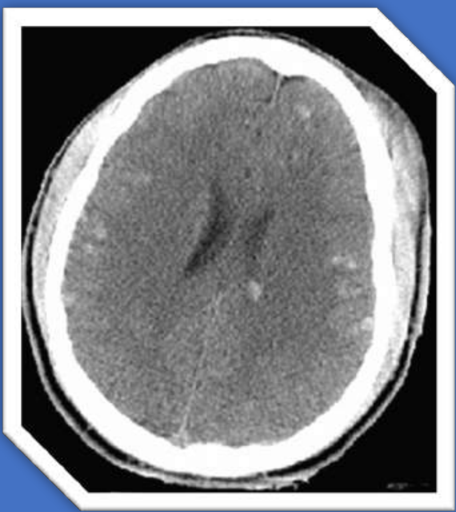
London Major Trauma System

NHS

London Clinical Senate

Traumatic Injury to Brain Across London (TrIBAL) Report



Abbreviations:

CT	Computer Tomography (CT) Scan
DAI	Diffuse Axonal Injury
DOAC	Direct Acting Oral Anticoagulant
EDH	Extradural Haematoma
IEP	Image Exchange Portal
INR	International Normalised Ratio
MTC	Major Trauma Centre
PCC	Prothrombin Complex Concentrate
SDH	Subdural Haematoma
TBI	Traumatic Brain Injury
TARN	Trauma Audit and research Network
TU	Trauma Unit

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Traumatic Injury to Brain Across London (TrIBAL) Report

INTRODUCTION

The demographics of traumatic brain injury (TBI) are changing. While TBI is still one of the commonest causes of death in the under 40s, the incidence and morbidity in the elderly appears to be increasing[1]. This has been noted both in the UK[1] and internationally. Previous studies have demonstrated that the elderly population are less likely to be transferred to Major Trauma Centres (MTCs) with neurosurgical services[2]. There is an additional group of people who sustain what are often considered "mild" traumatic brain injuries (not requiring neurosurgical intervention) who are similarly not transferred to a neurosurgical centre / MTC. Both these groups tend to remain in local Trauma Units (TUs) under the care of a variety of specialities. Brain injury can render previously well patients dependent, requiring community support and potentially long term 24-hour care, the organisation of which can result in long inpatient stays. This group of TBI patients who are not managed in major trauma/neurosurgical centres has traditionally received little focus, but require significant care and resources. Quantifying the epidemiology, patient pathways and outcomes for these patients will enable better care and more effective and efficient service deployment.

METHODS

This prospective audit was commissioned by the London Senate and conducted through the London Major Trauma System. Neurotrauma experts from all of London's Major Trauma Centres and neurosurgical centres that accept traumatic brain injured patients were involved in the design and conduct of this study. The Major Trauma Networks in London comprise the North West London Trauma Network (with the regional MTC at St Mary's), the North East London and Essex Trauma Network (with the regional MTC at the Royal London and a further Neurosurgical Trauma Centre at Queens Romford), the South East London Kent and Medway Network (with the regional MTC at King's College Hospital) and the South West London and Surrey Trauma Network (with the regional MTC at St George's) (figure 1). In North London, Great Ormond Street Hospital advises on and admits children with isolated head injuries.

Inclusion criteria: All patients referred to a neurosurgical centre with acute blood on CT head following trauma were included in this study. Patients with normal CT scans following a TBI including those with "concussion" were excluded. The dates for data collection were from 19th September 2016 to 19th January 2017.

Pre-agreed variables were recorded from the referral registry for patients referred in from non-neurosurgical centres. Retrospectively, these hospitals were subsequently asked about the length of stay of these patients. The subsequent data was assessed, cleaned and where appropriate, clarification was requested. In some regions, a comparison with Trauma Audit Research Network Data was made. For the purposes of reporting, because the Royal London and Queen's Romford act as independent neurosurgical centres within the NELETN, their data is presented separately in this report.

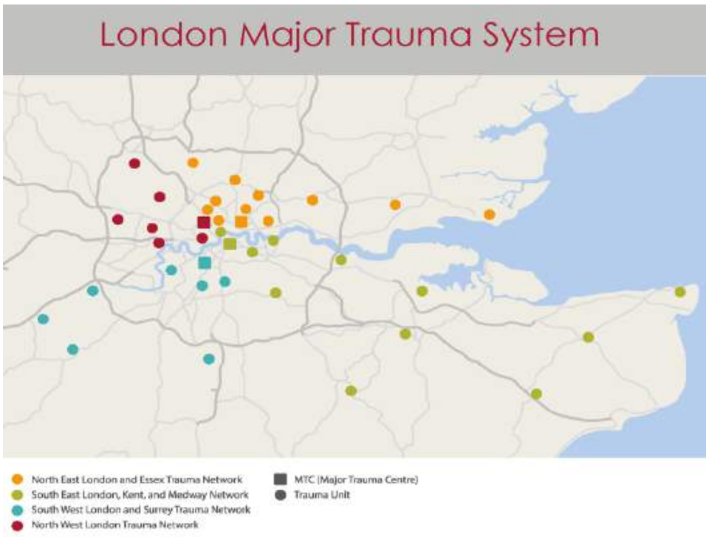

Figure 1) Map of London's Major Trauma Systems – In East London, The Royal London Hospital and Queen's Romford are the main Neurosurgical centres (forming NELETN); The North-West London Trauma Network (NWLTN) utilises St Mary's as its MTC/Neurotrauma centre. The South East London, Kent and Medway Trauma Network (SELKAMTN) has King's as its MTC the South West London and Surrey Trauma Network (SWLSTN) has St George's as its MTC. Additionally, in North London, Great Ormond Street receives referrals for paediatric secondary transfers from Trauma Units.

RESULTS

Epidemiology:

During the four-month period of study a total of 1889 traumatic brain injury episodes were referred to or admitted to the MTC / neurosurgical centres across the regions studied.

Neurosurgical Unit	Number Admitted under Neurosurgical Care into MTC	Number referred from TUs (no. transferred)
King's College (SELKAMTN)	155	374 (33)
Queens Romford (NELETN)	33*	244 (33)
Royal London (NELETN)	197	177 (13)
St George's (SWLSTN)	121	283 (7)
St Mary's (NWLTN)	155	205 (23)
Great Ormond Street	3	54 (3)

Table 1: Number of cases reported to and admitted to the neurosurgical units / MTC for each region. Total = 1,889 individual traumatic brain injuries. * Queen's Romford recorded 61 TBI patients as being under other specialities within their hospital. As such, this data is reported here as presented by Queen's, treating the patients under other specialties as if in a separate place (part of the 244). Although they reported 24 admissions directly though from external referrals, it can be seen that 33 were transferred in.

Gender:

Traumatic Brain Injury has traditionally been considered a disease of young men, usually associated with high speed road traffic collisions (RTCs). Figure 2a and 2b demonstrate the actual numbers of male and female patients referred to MTC / Neurosurgical Units and admitted to the MTC / Neurosurgical Units respectively. In the TU population 776 of 1280 (60.6%) were male. In the MTC population 492 of 652 (75.4%) were male. This increase probably reflects more severe / surgically amenable trauma in males.

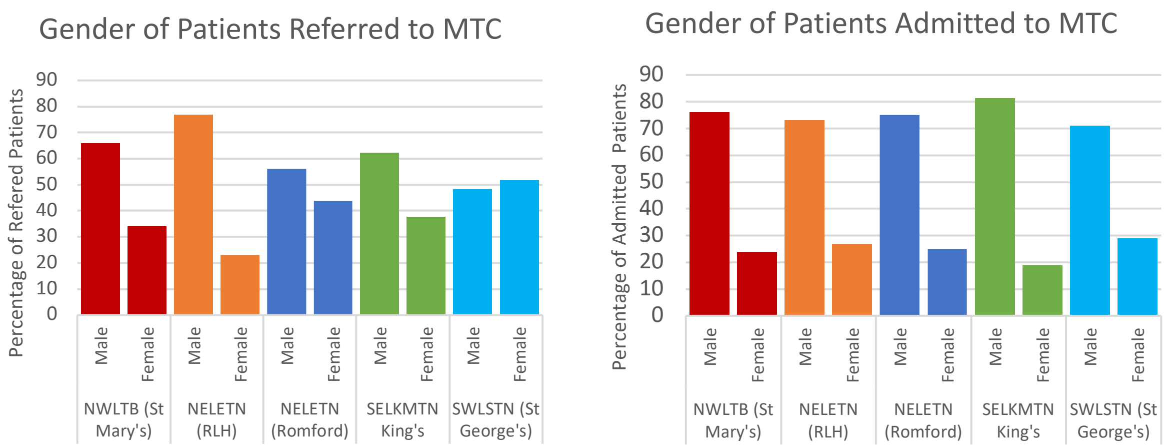

Figure 2: Graphical representation of genders of patients referred with network (a) and admitted to MTC / Neurosurgical Centre (b).

Age:

The mean age of those who presented to a TU was 69.0, while of those admitted to an MTC was 53.2. Figure 3 and 4 represents the distribution of this data graphically.

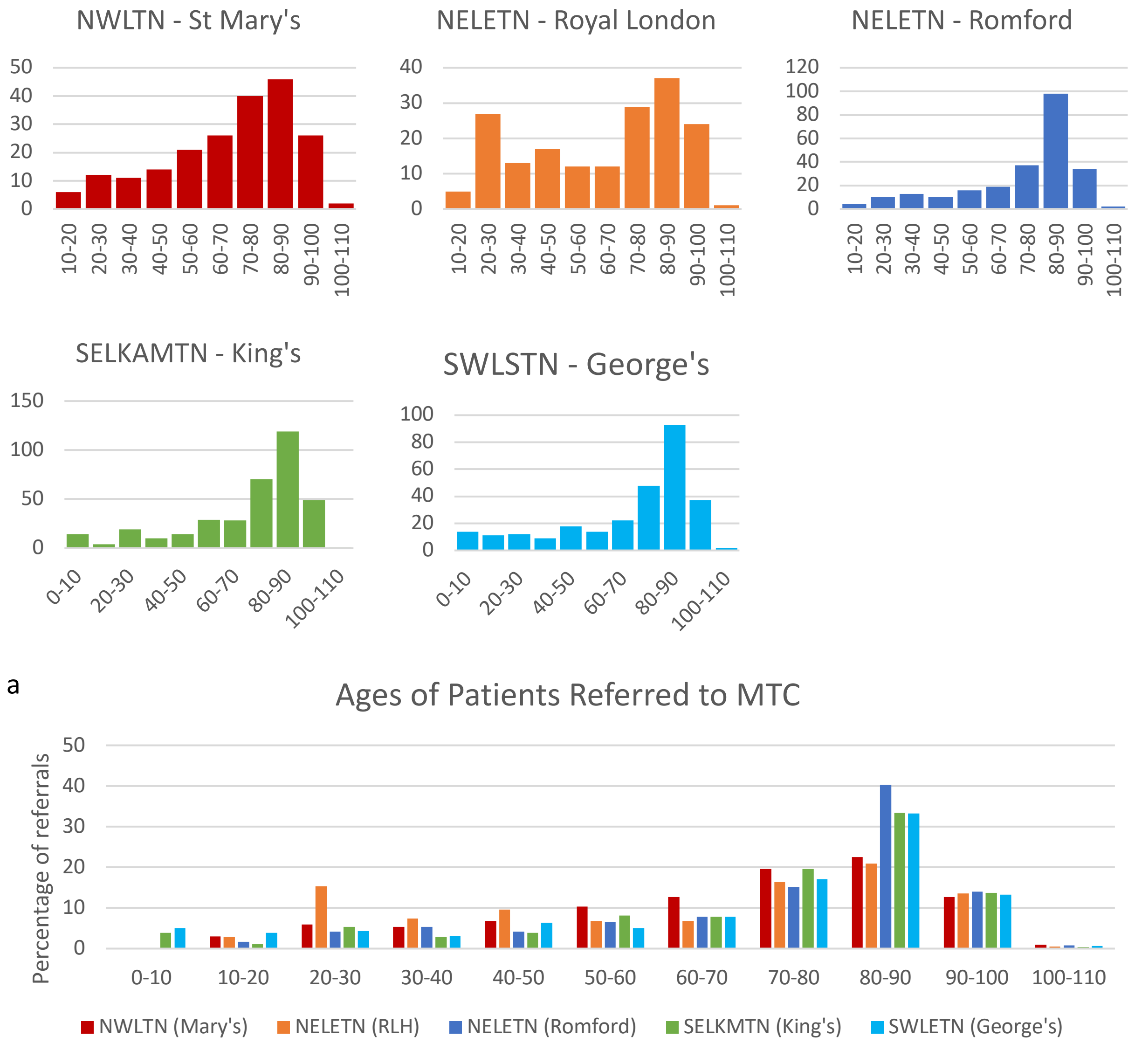

Figure 3) Age distributions of patients referred in each network (a) and combined (b). X axis are age ranges, Y axis are actual numbers of patients in a, percentages in b.

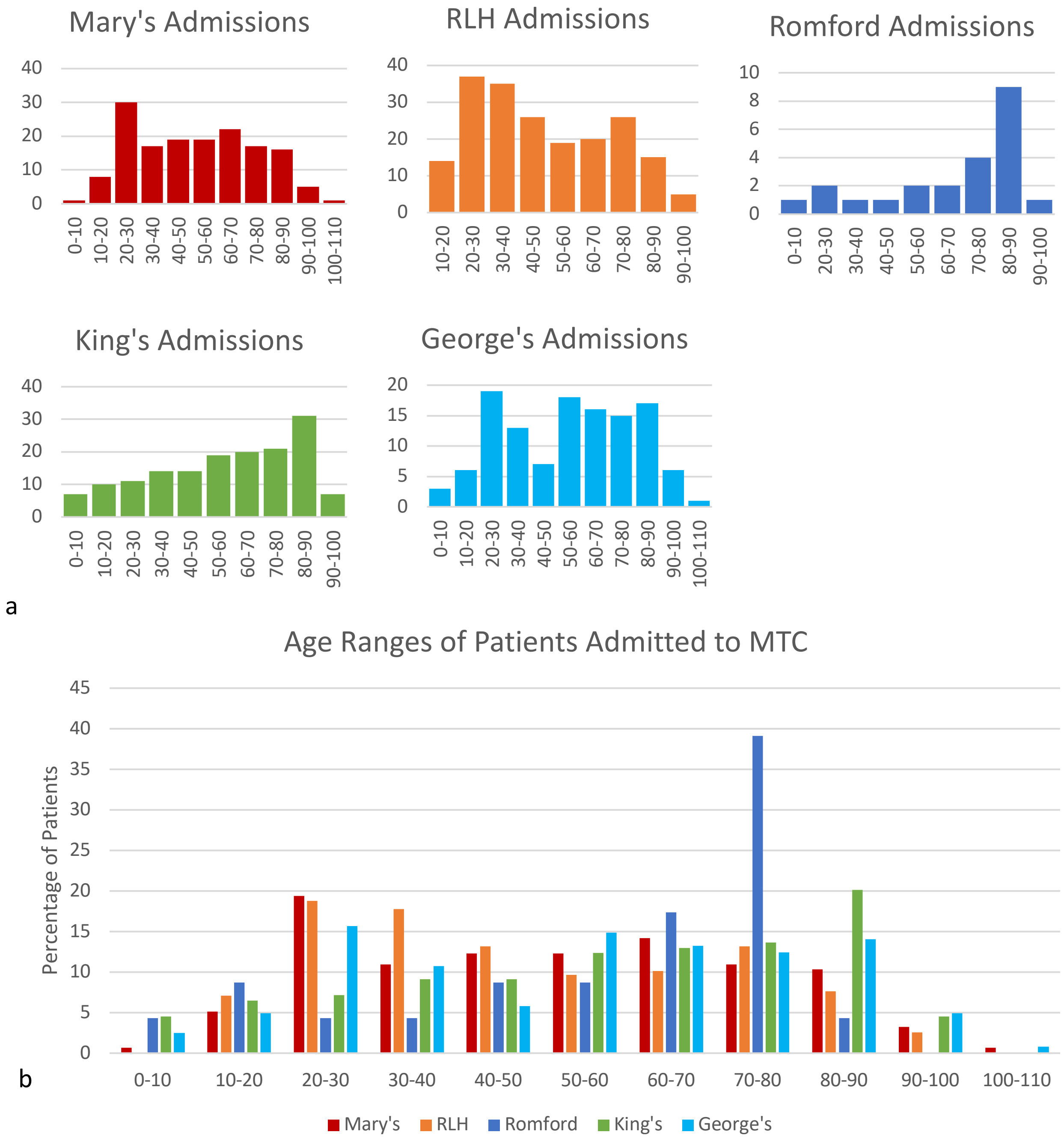

Figure 4) Age distributions of patients admitted to the MTC in each network (a) and combined (b). X axis are age ranges, Y axis are actual numbers of patients in a, percentages in b.

Mechanism of Injury:

Figures 4 and 5 demonstrate the mechanisms of injury leading to presentation at the Trauma Units and to the MTCs respectively.

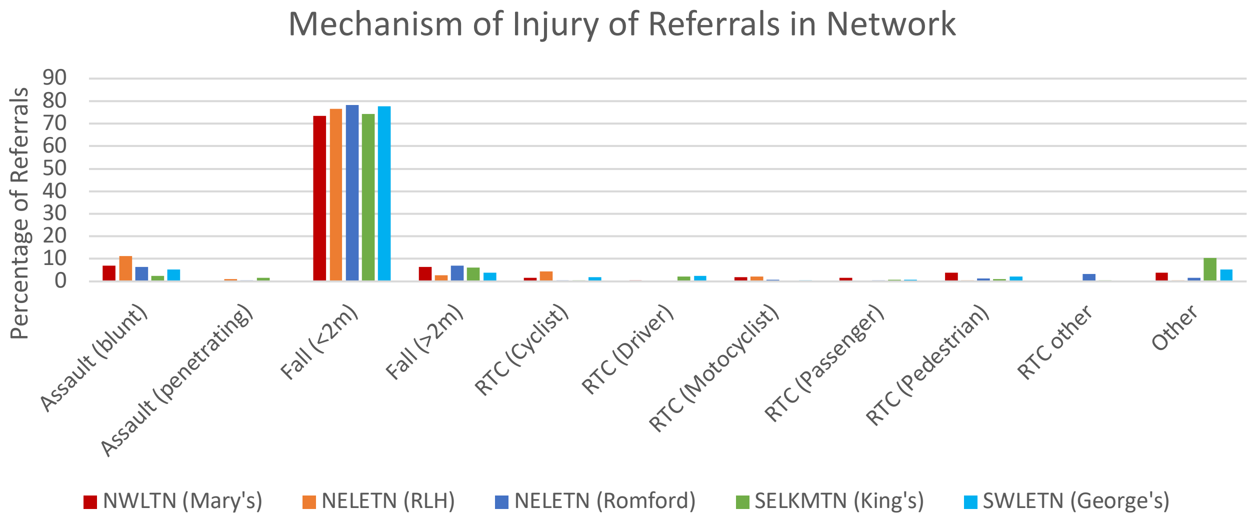

Figure 4) Mechanism of Injury in those presenting to the Trauma Units in each network (expressed as a percentage).

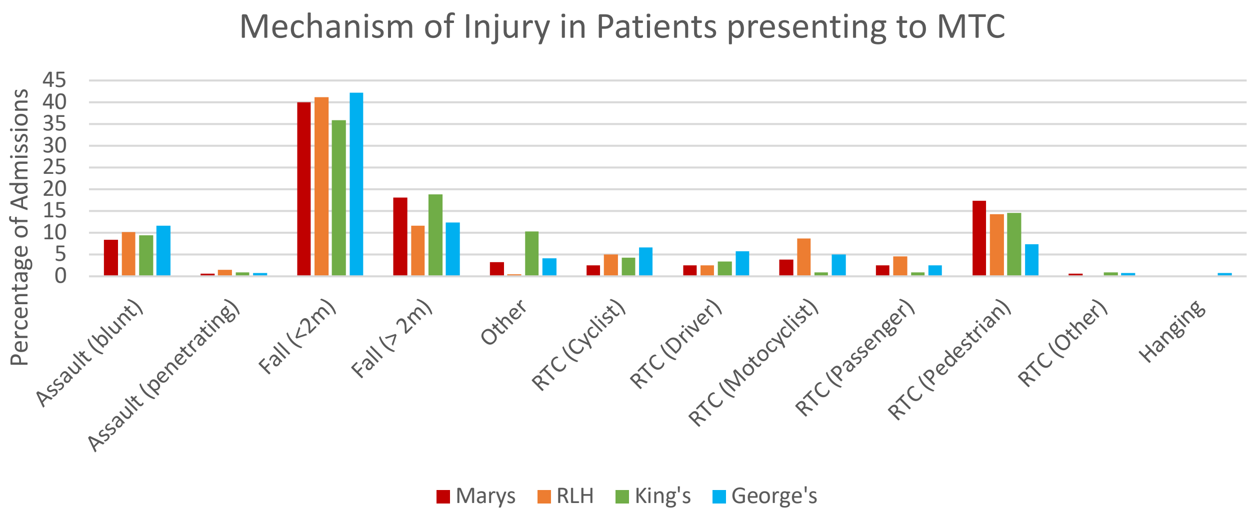

Figure 5) Mechanism of Injury in those presenting to the Major Trauma Centres (no data on Mechanism of injury supplied for Romford inpatients).

Polytrauma vs Isolated Head Injury:

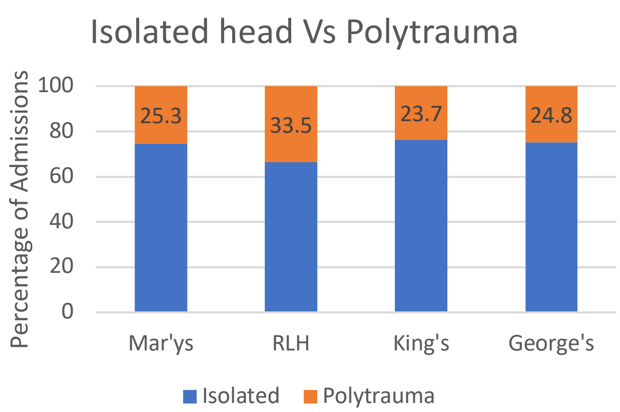

Figure 6 demonstrates the comparisons of isolated and polytrauma patients admitted to the MTCs.

Figure 6) the volume of isolated vs polytrauma at MTCs (expressed as percentage)

Mode of Arrival:

The mode of arrival was most commonly ambulance service, especially in TUs. In MTCs, HEMS services also made up a significant proportion of transport services. This however is highly subjected to reporting bias.

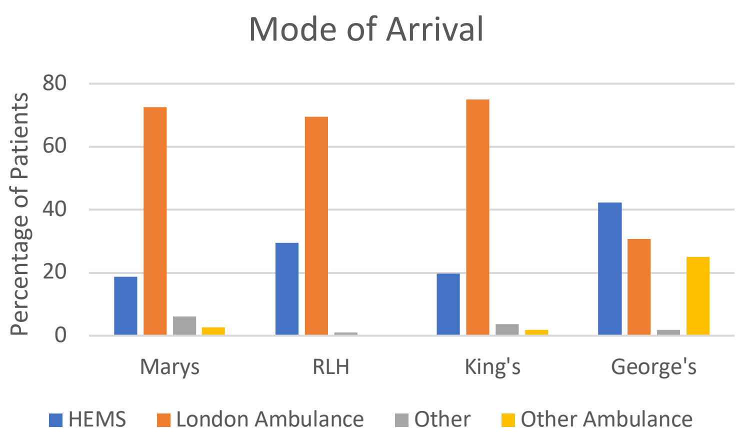

Figure 7) Mode of arrival at respective MTCs. Note, Romford did not record mode of arrival for admitted patients. Additionally, there is probably reporting bias as numbers reported vary (n= Mary's 149, RLH 197, King's 112, George's 52).

Transfers:

Transfer rate from TU to MTC varies significantly, but there are many reasons for this. Raw figures reported are: Mary's 23/204, RLH: 13/175, Romford: 33/243, Kings: 33/352, George's: 8/283.

Admitting Teams at Trauma Units:

Recorded admitting team at the time of referral was often "Emergency medicine" or "CDU". Attempts were made to go back to TUs to establish if patient care was then subsequently transferred to an inpatient team. As can be seen, there is a wide variation in specialists even within network who care for TBI patients.

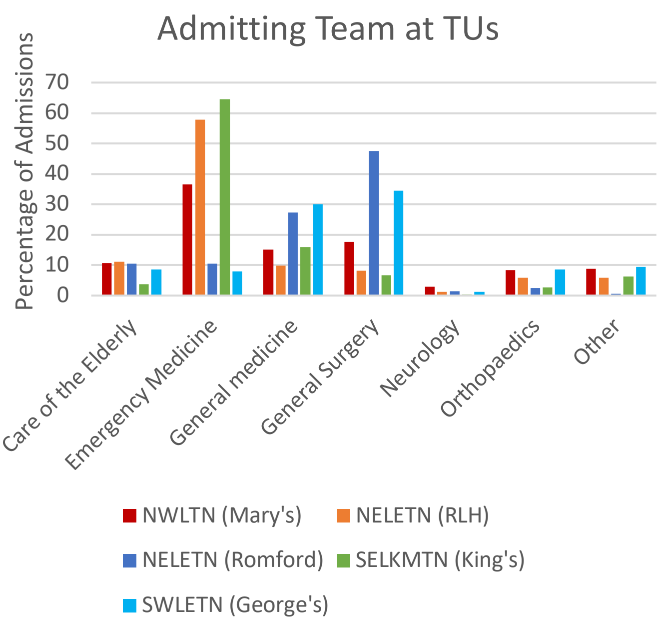

Figure 8) Reported admitting team for each network. Emergency medicine includes CDU admissions for overnight observations.

Anticoagulation:

Figures 9 and 10 demonstrate the numbers of patients on anti-platelet agents or anticoagulated admitted across the network and admitted to the MTCs.

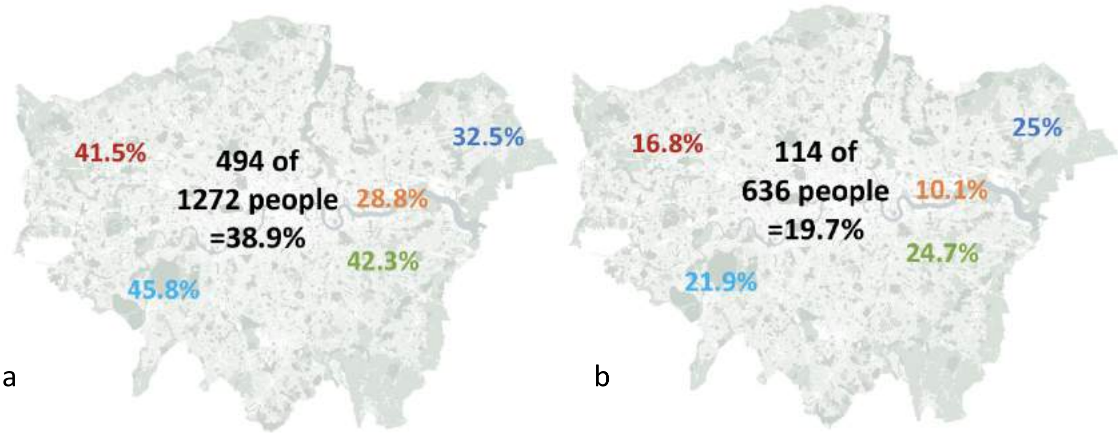

Figure 9) Graphical representation of number of patients a) referred in network on anti-platelet / anticoagulation agents and b) admitted to MTC on anti-platelet / anticoagulation agents.

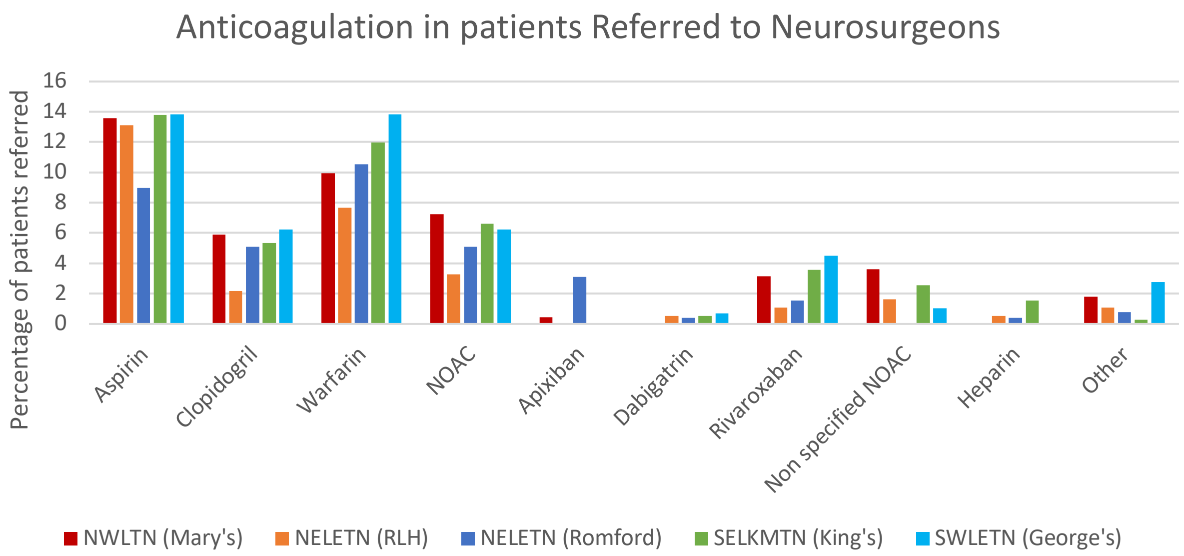

Figure 10) Percentage of patients on anti-platelet and anticoagulation agents broken down by agent type within network.

Length of Stay

Predicted Length of stay:

The quality of data on reported length of stay varied considerably across the networks. Neurosurgical units were asked to predict how long they envisaged a patient referred to them, but not transferred to them, would stay in their TU before returning home. Only Romford provided comprehensive data for most of their referred patients. Figure 11 is a graph comparing predicted length of stay in the TU (at the time of referral to the Romford) and actual length of stay.

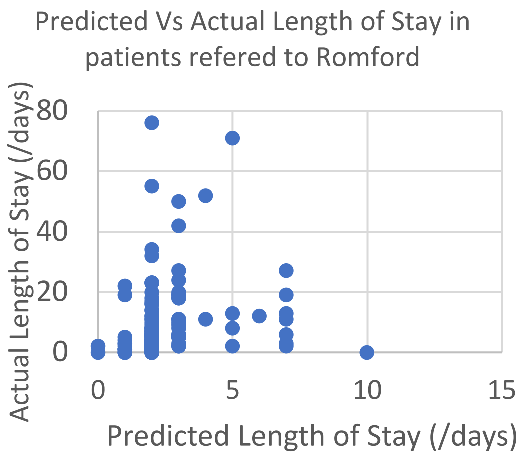

Figure 11 demonstrates predicted vs actual length of stay from referrals made within NELETN (Romford)

Actual Length of Stay:

Figure 12 demonstrates Length of stay for all patients reported (data for n=722) across the trauma networks at TUs that there seems to be two groups of patients, a group that stay a relatively short period (<1 week) in hospital, and a group, usually elder who stay for many weeks.

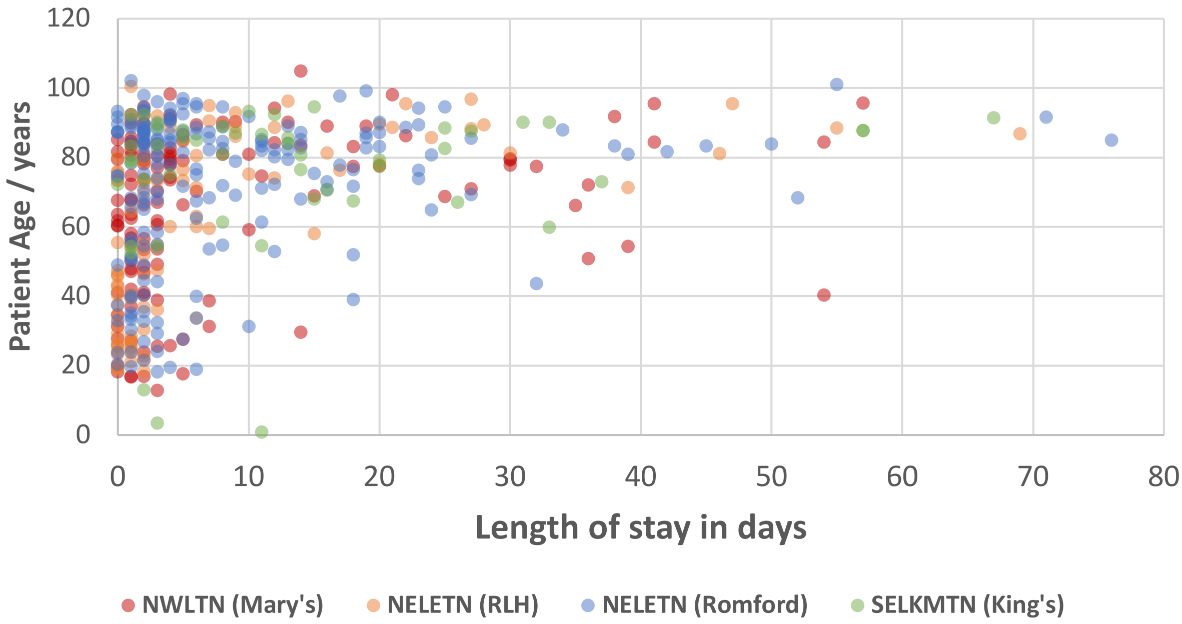

Figure 12) Demonstrates length of stay at TU with age (n = 722). A small number of patients were still inpatients beyond 3 months. They have been omitted from this graph to more clearly see the spread of patients over 3 months.

Reasons for delay in discharge:

There were no set fields for reasons for delay in discharge or transfer onto rehab / further treatment. As a result, this data was poorly captured. However, common reasons cited were awaiting social care, rehab and nursing home placement. Reasons for delay from MTC transfer back to TU most commonly focused around bed availability at the local unit.

Documented Follow up:

Organisation of follow up was poorly captured, however the following recorded outpatient appointments for TU referred patients: Marys: 16/187 = 8.5%, Romford: 10/179 = 5.6%, RLH: not recorded, King's: 2/226 = 0.1%, George's: 6/155 = 3.9%. There are many factors influencing these numbers, most notably if it was recorded. However, some MTCs cover vast distances and it may well be more appropriate for follow up to be with local services than at the MTC.

Surgery:

The requirement for neurosurgery is relatively low, but there are many reasons that can affect that reported. These figures do not include ICP monitor insertion. Expressed as a percentage of reported TBI for each network, the number of operations performed are: St Mary's: 26/337 = 7.8%; Royal London: 38/361 = 10.5%; Queens' Romford: 18/244 = 7.3%; King's: 51/496 = 10.2%; St George's: 16/397 = 4%.

The above analysis has not focused on Great Ormond Street Hospital (GOSH). Three patients with TBI were admitted to GOSH during the period of study, while advice was given on a further 51.

Summary of Key Findings:

This analysis confirms that traumatic brain injury is a significant burden of disease outside of major trauma centres. Only 33% (n=664) of TBI patients in this study were under the care of neurosurgeons in an MTC.

The population falls into two main groups – a younger group who on the whole have a relatively short length of stay, and an older group whose length of stay is considerably longer than anticipated. This is in line with recent suggestions that major trauma can be considered as two diseases in relation to patient age and mechanism of injury [3].

Comparison with TARN national registry data is challenging. Patients with brain injuries who die early in ED may not be referred to neurosurgical services but will appear in TU TARN data. Equally patients perceived as having a 'medical' rather than trauma presentation who incidentally are found to have sustained a cerebral contusion may be discussed with the local neurosurgeon and appear in this report, but not on TARN. Despite this, comparing numbers in North West London with TARN suggests general similarity in volume of data captured.

In the elderly population, TBI may be an indicator of frailty and multiple co-morbidities resulting in a fall. It may be the signature injury in this population, in a similar manner to fractured neck of femur in the 1990's.

This study confirms that there is considerable diversity in teams looking after TBI patients in trauma units. Despite the advanced age of many patients in TUs with TBI, no more than 10% are admitted under the care of a physician specialising in elderly care. From this study, it is not possible to demonstrate the level of involvement of care of the elderly, for example, by orthogeriatricians when admitted under the orthopaedic services.

Anticoagulation:
This audit has demonstrated that nearly 40% of patients who sustain a TBI and are admitted to a TU are on an anti-platelet or anticoagulant of some description. See below for recommendations.

Surgery:
Neurosurgery is only required in 5-10% of cases. However, neuroscience centres bring expertise in neurocritical care and therapy specialists that has been demonstrated to be of benefit[4]. It could therefore be argued that more patients should be transferred to such specialist centres. This has to be balanced with the inconvenience of moving patients who do not need surgery further from home and away from local services that can probably be organised more rapidly locally.

Limitations of this study:
Data collection has proven difficult for certain aspects of this study and there has been different data collection completeness across London. As such, some of the objectives of this study cannot be answered with conclusive quantitative values. Where data quality is good, we believe that findings can be extrapolated across London as the underlying demographics of patients is similar.

Recommendations from Round Table Discussion:

Prevention:

In the UK, the predominant mechanism of TBI has historically been considered to be Road Traffic Collisions (RTCs), however, the main hospital burden of TBI in this audit appears to come from falls from standing in the elderly. Whilst public health measures to minimise RTCs should still be maximised, measures to prevent falls in the elderly could reduce this increasing problem.

This could be achieved in a number of ways – for example:

- Reduction of polypharmacy
- Home assessment and safety improvements (tacking down carpets, installation of banister etc) – some of this work is already being done by the third sector and utilising fire services through "fire as a health asset".
- Investigation into falls risks / frailty, with near miss falls warranting early assessment.
- Approaching organisations such as Transport for London to minimise risk of falls in their domain (e.g. escalators and stopping of buses).

Although TBI is a common condition with considerable morbidity / mortality, there is not the awareness of other diseases (stroke, cardiac arrest, cancer) and increased awareness, amongst the public (e.g. encouraging people not to cycle with earphones in), GPs, Commissioners, may help reduce incidence.

In this study we also requested reporting of "alcohol involvement" in each incident. The variability of documentation has meant we have not reported it quantitatively, however it is clearly a factor in many TBIs and should also be considered an area to target in prevention.

Anticoagulation:

In the 4-month audit, an average of 39% of TBI patients were on an anti-coagulant or anti-platelet agents. The risk of stroke needs to be balanced with their risk of falls. Some new anticoagulants (Direct Oral Anticoagulants, DOACs) do not have easily available reversal agents. Falls resulting in TBI in these groups can be very difficult to treat. Clear protocols for rapid reversal of anticoagulation need to be in place.

- Current guidelines for prescribing anticoagulation utilise the CHAD score. This in itself does not factor risk of falls.
- Aspirin – There is controversy over platelet administration as a treatment in this group. The Patch study implies platelets are of little benefit (and maybe harm) in patients who have had haemorrhagic stroke[5], but does this also apply to trauma?
- Warfarin – The rapid reversal of warfarin with Prothrombin Complex Concentrate (PCC) is now common place for advanced pre-hospital care services (such as air ambulance services) but is not routine for most land based services. There can also be delays in administration in hospital. This is probably the most effective "neuroprotectant drug" in warfarinised patients.
- DOACs – Reversal agents exist for dabigatran and rivaroxaban, but availability is limited.

See appendix 2 for proposed Management of Anticoagulated TBI patient guidance.

Elderly TBI:

Over 70% of patients in this audit are over the age of 70. Many of these patients are on anticoagulants (see above) and many are managed within the trauma unit. In this group of patients, a relatively minor TBI can convert someone from living independently to requiring significant or even full-time care. As can be seen from figure 12, these patients may spend in the order of months awaiting care packages or nursing home placement.

The London Major Trauma System have provided clinical guidance for the management of major trauma in the elderly[6]. More recently, consensus guidance has been provided about the management of perceived devastating brain injuries from critical acre, emergency medicine and neurosurgery societies. This has particular relevance in the elderly when co-morbidities need to be factored into decision planning[7].

The use of frailty scores may help guide identification of patients at risk of falls. This is due to become part of best practice for trauma patients.

In some Major Trauma Centres, elderly patients are co-managed with specific trauma Care of the Elderly physicians. This is similar to the orthgeriatrician model. The round table groups felt this was a more optimal model of care for the complex needs of elderly patients. A key recommendation from this and from the London Major Trauma Systems guidance is that involvement of care of the elderly should become standard part of management.

Joint TU/MTC Care:

Previous studies have demonstrated survival benefit when severe TBI patients are transferred to a neurosciences centre[4]. However, the majority of patients with neurotrauma injuries that would not benefit from neurosurgery, are still being managed in local trauma units. The transfer of patients has to be balanced with the inconvenience to families, the risks of transfer and the resource implications for Major Trauma Centres. Additionally, local trauma units are better placed to arrange rehabilitation / packages of care in their region. For these reasons, it is highly appropriate that patients are managed locally.

There is not however consistency in who is actually providing that care. Figure 8 demonstrates a breadth from general medicine to surgical specialities, especially general and orthopaedic. Usually these doctors have not been trained, nor do they have a specific interest in brain injury.

Assignment of a lead for local neurotrauma and closer working between TU and MTC teams could improve inconsistencies in local management. Remote teleconferencing has been suggested as an optimal mechanism for doing this and St Mary's and King's have plans to pilot this in the coming months with virtual MDTs enabling specialist therapist advice.

Follow Up:

One of the outputs from this study was to assess how many patients were offered follow up appointments in a head injury clinic at the MTC. This number was difficult to capture as it relied on it being documented, but it appears to be extremely low (~10%). Whilst this may look like poor service, on discussion it is probably appropriate. Many of these patients are elderly and will not get an additional neurosurgical intervention and traveling to an MTC has considerable inconvenience. However, highlighting of patients that may benefit could be enhanced with closer working between teams. Younger patients who have ongoing cognitive effects from TBI should be seen in MTC led TBI clinics as these offer access to additional services. The role of out-reach clinics especially for TIs that have a high TBI incidence should be considered.

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Additionally, over 100 people attended and contributed to the round table discussions held at the Royal Geographical Society on 16th November 2017.

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Appendix:

Appendix 1: Pattern of Brain Injury as reported by AIS across TU referrals (data from

ASDH	1
ASDH tiny; <0.6cm thick ([includes tentorial (subdural) blood one or both sides) 3	94
ASDH: bilateral (at least one side >1cm thick) 5	14
ASDH: large; massive; extensive; >50cc 5	59
ASDH: small bilateral [both sides 0.6-1cm thick] 4	23
ASDH: small; moderate; <50cc 4	132
ASDN Extensive	1
Brainstem compression [includes transtentorial (uncal) or cerebellar tonsillar herniation] 5	1
Brainstem injury involving hemorrhage 5	1
Cerebellar ASDH Large 5	1
Cerebellar ASDH Small / Medium 4	7
Cerebellar ASDH Tiny 2	2
Cerebellar contusion Large 5	1
Cerebellar contusion Small / Medium 4	3
Cerebellar contusion Tiny 2	3
Cerebellar EDH Small / Medium 4	1
Cerebral contusion but NFS: multiple, bilateral 3	3
Cerebral contusion but NFS: multiple, same side 3	5
Cerebral contusion extensive; massive; total volume >50cc: multiple, bilateral 5	1
Cerebral contusion large; deep; 30-50cc: multiple, bilateral 4	3
Cerebral contusion large; deep; 30-50cc: single 4	6
Cerebral contusion NFS: single 3	2
Cerebral contusion small; superficial; <30cc: multiple, bilateral 3	18
Cerebral contusion small; superficial; <30cc: single 3	45
Cerebral contusion tiny (<1cm) 2	26
Cerebral contusion tiny (<1cm): multiple, bilateral 2	6
Cerebral contusion tiny (<1cm): multiple, same side 2	6
Cerebral contusions extensive; massive; total volume >50cc: multiple, same side 5	3
Cerebral contusions large; deep; 30-50cc: multiple, same side 4	3
Cerebral contusions small; superficial; <30cc: multiple, same side 3	24
Crush injury (Must involve massive destruction of skull, brain and intracranial contents.) 6	1
DAI confined to white matter or basal ganglia 4	1
EDH: large; massive; extensive 5	3
EDH: small; moderate; <50cc 4	7
EDH: Tiny <0.6cm thick 2	7
ICH: large; >30cc 5	5
ICH: small; <30cc 4	6
ICH: tiny; single or multiple <1cm diameter 2	5
Skull fracture: BOS without CSF leak 3	15
Skull fracture: closed; simple; undisplaced; diastatic; linear 2	53
Skull fracture: comminuted; compound but dura intact; depressed <2cm; displaced 3	7
Skull fracture: complex; open with torn, exposed or loss of brain tissue 4	2
Small contusion	1
subarachnoid hemorrhage (not associated with coma >6 hours) 2	111
(blank)	
Grand Total	**719**

Appendix 2: Management of Anticoagulated TBI Patients.

Traumatic Brain Injury in Anticoagulated patients

All patients should have a CT scan, however, if they have a reduced level of consciousness and are known to be on an easily reversible anticoagulant (e.g. warfarin), this can be reversed by pre-hospital services / in ED prior to CT to minimise evolving clot.

What Anticoagulant are they on?	Warfarin	Aspirin / Clopidogril	DOAC
Suggested Management*:	Nearside INR if possible and reverse with: Fresh Frozen Plasma / Prothrombin Complex Concentrate +/- Vitamin K	Consider platelets	Consider FFP / Prothombin Complex Concentrate If available consider: For Dibigatrin: Idarucizumab For Rivoxaban: Andexant alfa

*The degree of reversal sometimes requires balance between likelihood of progression (small amount of subarachnoid haemorrhage vs expanding haematoma) and risks of underlying reason for anticoagulation (e.g. metal heart valve).