NHS England

East of England Major Trauma Services

Public Health Needs Assessment 2023

Authors

Dr Esther Kwong
Specialised Commissioning Public Health Consultant,
Healthcare Public Health Team, NHS England

Dr Lauren Rixson
Healthcare Public Health Officer,
Healthcare Public Health Team, NHS England

Healthcare Public Health Team, NHS England – East of England
Victoria House, Capital Park, Fulbourn, Cambridge, CB21 5XB
Contact: england.eoehealthcarepublichealth@nhs.net

Professor Feryal Erhun
Professor of Operations & Technology Management

Professor Houyuan Jiang
Professor of Management Science

Mr Zidong Liu
PhD Candidate, University of Cambridge

University of Cambridge Judge Business School,
University of Cambridge, Trumpington St, Cambridge CB2 1AG

Acknowledgements

Reviewers:

Mr Simon Griffith
Head of Acute Commissioning (Acting),
Specialised Commissioning Services Team, NHS England – East of England

Dr Corinna Pascuzzi
Clinical Director, East of England Trauma Network

Mr Matt Targett
Network Manager, East of England Trauma Network

Mrs Nnenna Ekeke
Public Health Specialist, Healthcare Public Health Team, NHS England

Published December 2023

Foreword

A decade has passed since the establishment of the Major Trauma Network in our region; the COVID-19 pandemic created acute supply pressures on our region's Major Trauma Centre and tested the resilience of the network, prompting an impetus to review the capacity of our major trauma services across the region. It is within this context that I am delighted my team in Healthcare Public Health, led by the Specialised Commissioning Public Health Consultant in the East of England, could provide the region with a review of major trauma services through a public health needs assessment lens.

This health needs assessment focuses on the needs of our population, highlights the increasing demand from population growth, and the rapidly shifting needs for major trauma services driven by the changing population demographics due to an ageing population. This report provides the intelligence and evidence base for us to understand needs, variation, service assets and gaps across the region, and sets out recommendations on how we can work collectively to progress in responding to the needs of our patients and populations.

I would like to sincerely thank Professor Feryal Erhun, Professor Houyuan Jiang and Mr Zidong Liu from Cambridge University Judge Business School for their collaboration in this project, in particular for building and contributing to the pioneering modelling work on capacity and demand assessment to support the ongoing development of major trauma services for our region.

I fully believe that the intelligence within this health needs assessment allows us to better understand the landscape of our major trauma services, areas of focus and the changes required.

This change requires our ongoing strong commitment across our region, six regional Integrated Care Systems and NHS England supporting Specialised commissioning, in the re-organisation and development of major trauma services for our population. I look forward to continuing to work collaboratively and providing Public Health leadership working with system leaders to support the continuing healthcare and public health improvements in major trauma.

Dr Aliko Ahmed
Regional Director of Public Health – East of England
NHS England / Office for Health Improvement and Disparities

Contents

Glossary of terms

Acronym	Description
AIS	Abbreviated Injury Scale – Based on each individual type of injury ranging from 1 to 6 (fatal) in severity.
ARIMA	Autoregressive Integrated Moving Average (time series)
CCI	Charlson Comorbidity Index
Core20	The Core20 principle suggests that the most deprived 20% of the national population should be targeted to reduce health care inequalities
Direct Admission	Care received from the first receiving hospital
ED	Emergency Department
EoE	East of England
GCS	Glasgow Coma Scale ranging from 3 to 15 (conscious)
GOS	Glasgow Outcome Scale
HES	Hospital Episode Statistics
ICB	Integrated Care Board: Bedfordshire, Luton, and Milton Keynes (BLMK), Cambridgeshire and Peterborough (C&P), Herts and West Essex (HWE), Mid and South Essex (MSE), Norfolk and Waveney (N&W), Suffolk and North East Essex (SNEE)
ICU	Intensive Care Unit
IQR	Interquartile Range
ISS	Injury Severity Score – 1–8 trauma, 9–15 severe trauma, > 15 major trauma
IMD	Index of Multiple Deprivation
LoS	Length of Stay in the hospital
LSOA	Lower layer Super Output Area (Geography)
MSOA	Middle layer Super Output Area (Geography)
MTC	Major Trauma Centre
ONS	Office for National Statistics
Ps	Probability of survival
Secondary Transfer	Movement from an initial treating hospital to a second hospital for care, usually the MTC.
ST	Specialist Trainee (doctor grade)
TARN	Trauma Audit and Research Network
TU	Trauma Unit
Ws	Standardised W score – Probability of survival that takes into account patient and injury characteristics

1
Executive summary

Key findings

Increasing and changing prevalence of major trauma:

- The number of major trauma patients has almost doubled in ten years and is projected to continue increasing, especially among persons aged over 75 years. This includes a doubling in the number of severe head injuries (Abbreviated Injury Scale ≥3).
- Low falls (falls less than two meters) are the most common cause of major trauma admissions and deaths, and their incidence has doubled over time.

Capacity challenges:

- The Major Trauma Centre (MTC) at Addenbrooke's Hospital reached its trauma bed occupancy capacity in 2018, and trauma units are increasingly treating more major trauma patients.
- Norfolk and Norwich Hospital receives the second largest count of major trauma patients after Addenbrooke's Hospital and the second largest count of transfers out of the MTC after Peterborough City Hospital.
- If Norfolk and Norwich Hospital is to be upgraded to a Major Trauma Centre, its trauma bed capacity would need to be doubled to meet a 60-minute patient direct admission catchment area.

Equity challenges:

- There is inequity of access to Major Trauma Centre services for the elderly, patients with low fall injuries, more deprived patients, and patients injured more than 35 minutes from the MTC. These patients are more likely to be treated in a Trauma Unit.
- The likelihood of receiving care related to Best Practice Tariff metrics decreases with patient age. Patients at Trauma Units are less likely to receive Consultant-led care.

Major Trauma[1] in the East of England[2]

ISS >15
35%

MEN
60%
40%
WOMEN

72
YEARS
was the median age

11%
of patients were Core 20
CORE20

Falls less than 2m accounted for **58%** of injuries

Half of injuries occurred at home

11%
were transported by air ambulance

Vehicles were involved in **half** of injuries in 18 to 44 year olds

45%
were treated at the Major Trauma Centre

21% of patients were secondary transfers

Half were received by a trauma team[3]

75%
with cognitive impairment[4] were scanned within 1 hour

Head injuries were the most frequent and severe injury

Median LoS was **11** DAYS

9% were discharged to rehabilitation

[1] Major trauma is defined as an Injury Severity Score (ISS) of at least 15.

[2] For the years 2017/18 to 2019/20
[3] At the Major Trauma Centre
[4] Glasgow Coma Scale (GCS) <13

NHS England

Key recommendations

Expand the capacity of the major trauma network:

- Establish a second Major Trauma Centre (MTC) to complement the current MTC capacity at Addenbrooke's Hospital.
- Focus on quality improvement and investment to meet major trauma quality and Best Practice Tariff standards at the potential second Major Trauma Centre, including access to a consultant led trauma team and timely CT (Computed Tomography) scans.

Ensure equitable access to high quality care:

- Improve equity of access to Major Trauma Centres for elderly patients, and those living in rural and deprived areas.
- Perform ongoing regular assessments of the distribution of major trauma patients who receive their care completely in Trauma Units and in relation to their equity of access to MTCs.
- Continue improvements in upskilling and increasing capacity of Trauma Units, particularly for those outside of the 60-minute coverage area of current and proposed MTCs.

Revamp major trauma care to meet the population's changing needs:

- Further equip trauma services for elderly trauma including associated patterns of injury and timely identification.
- Prioritise primary and secondary falls prevention for the planned phased upgrading and development of a second Major Trauma Centre.

Prevent trauma:

- Prioritise primary and secondary falls prevention within the East of England Trauma Network.
- Address the root causes of violent injury and trauma, which are more prevalent in younger and more deprived populations in our region.

Challenges for Major Trauma Care in the East of England

Increasing incidence of major trauma patients

Population growth of the elderly

Higher rate of low falls

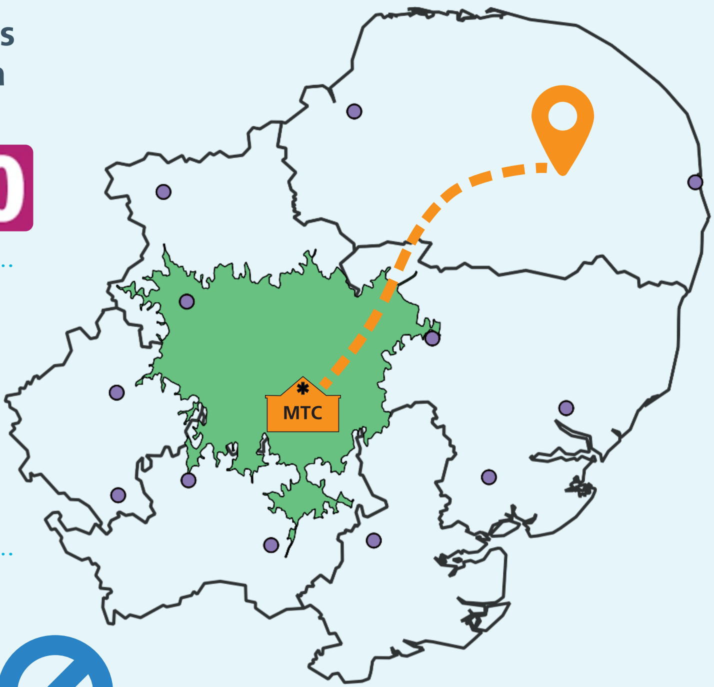
Increased counts of severe head injuries

Inequity of access to Major Trauma Centre services

CORE20

Only 3% of deprived patients are within 45 minutes of the MTC

Addenbrooke's Hospital (MTC) reached full trauma bed capacity in 2018



More patients are being treated entirely in Trauma Units

Elderly are the least likely to be transferred to the MTC

MTC = Major Trauma Centre

Suggestion
Expand the capacity of the East of England Trauma Network with a second Major Trauma Centre

\+

Focus on service quality and elderly trauma needs

Demand and capacity modelling for Norfolk and Norwich Hospital suggests **doubling its current trauma bed capacity to meet future patient demand**

Major trauma is defined as an Injury Severity Score (ISS) of at least 15.

NHS England

Introduction

2
Introduction

The Healthcare Public Health team, led by the Specialised Commissioning Public Health Consultant in NHS England working in collaboration with the University of Cambridge Judge Business School Healthcare group, conducted a review of the region's trauma services. This took the form of a public health needs assessment which includes a forecasted capacity and demand model to support the further development of East of England's regional trauma services.

The East of England Trauma Network and the regional major trauma re-organisation project oversight group, led by the Head of Acute Services for Specialised Commissioning at NHS England, East of England, shared a concern that the population's need for trauma services, especially that of major trauma services in the region may have outgrown capacity. The COVID-19 pandemic brought to the fore capacity and resilience issues affecting major trauma services in the East of England resulting in Norfolk and Norwich Hospital taking on a substantial major trauma workload to support the established Major Trauma Centre at Addenbrooke's Hospital in Cambridge. Subsequently, the Regional Executive Team of NHS England charged that the Specialised Commissioning team working in collaboration with the East of England Trauma Network form a Project Group to review current and future demand and capacity for major trauma in the East of England.

Our region's trauma network was established in 2012 as an 'inclusive model' to deliver trauma care across a network footprint that includes Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Suffolk, and Norfolk. Patients from the south of Essex, south Hertfordshire, and Milton Keynes flow into London and Thames Valley Trauma Networks. The network was established with Addenbrooke's Hospital as the region's single Major Trauma Centre (MTC) with other network hospitals as Trauma Units (TUs) (see full list of East of England Trauma Network hospitals, listed alphabetically).

The original configuration of East of England's Trauma Network was based on the modelling of major trauma activity undertaken in 2010 for a population of 5.7 million (Mackenzie et al, 2013[1]). Local data and activity levels from before 2010 were used to predict and plan resource capacity, and prevalence estimation. Trauma capacity for the MTC at Addenbrooke's Hospital at the time of inception was planned for 75 admitted inpatients.

The Trauma Audit Research Network (TARN) is a national audit programme which provides comprehensive data on the key performance indicators and activity associated with major trauma. A decade on since the establishment of the East of England regional Trauma Network, there is an opportunity to review trends through ten years of TARN data to establish an understanding of the changes in both clinical and population needs, as well as services capacity, assets, and service gaps. This provides the basis to forecast and model future trends on need, demand, and capacity to establish an ongoing, sustainable, and equitable major trauma service and trauma network for the region.

Aims of this report

The first part of this needs assessment will focus on four elements:

- needs in population trends
- needs of major trauma services in the region
- population demographics, and patient characteristics of this need
- understanding future changes to population trends.

The second part of this needs assessment considers three elements:

- an assessment of the assets
- identification of gaps of service capacity to date of the region's Trauma Network
- assessment of equity of access, and service performance as a proxy to the gaps and capacity constraints.

The third part presents the capacity and demand model for the proposal of a second Major Trauma Centre at Norfolk and Norwich Hospital, with an estimation of patient flows, service capacity and resource investment required. This is presented alongside a series of scenarios that evaluate the sensitivity of various predictions and contextual situations for the major trauma network in the region.

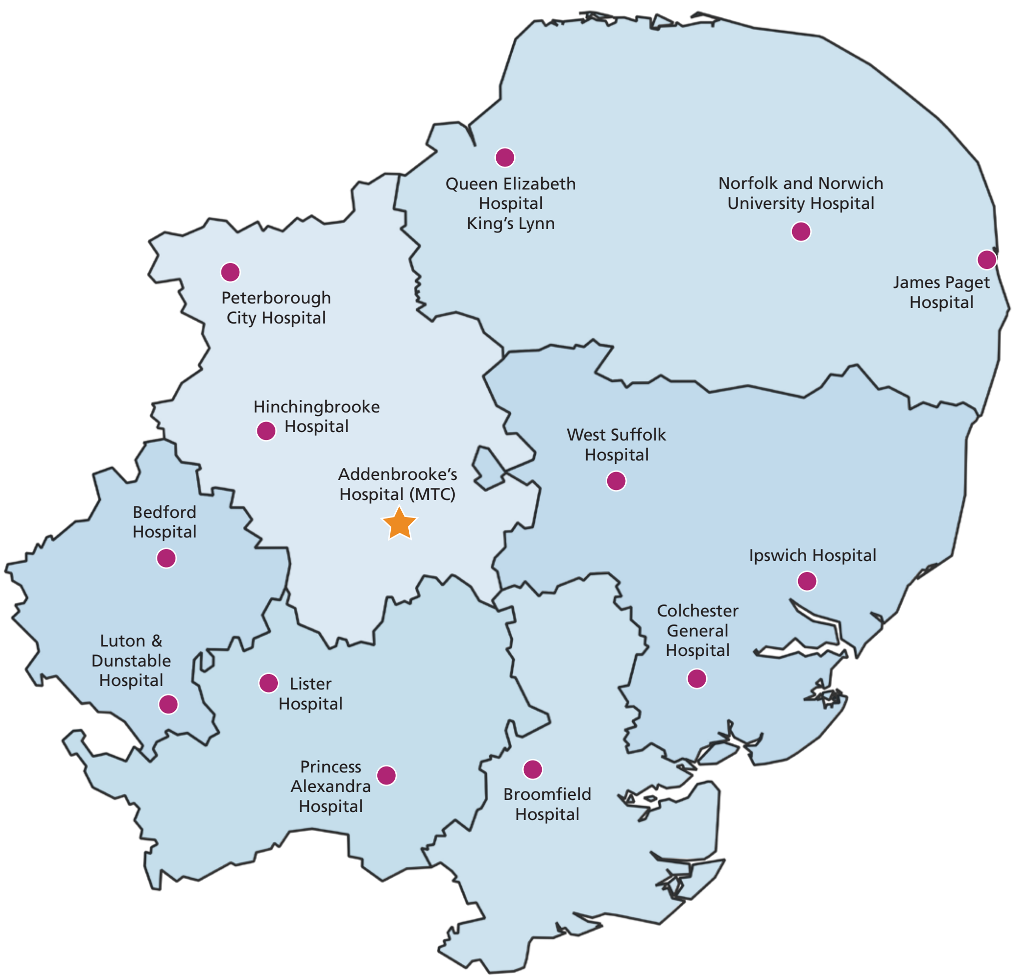
Part four summarises the overarching conclusions and recommendations from this health needs assessment.

[1] Mackenzie, R., S. Lewis, B.F. Matta. 2013. Trauma care organisation. A. Gullo, ed., Anaesthesia, Pharmacology, Intensive Care and Emergency A.P.I.C.E.: Proceedings of the 25th Annual Meeting – International Symposium on Critical Care Medicine, chap. 5. Springer, 49–71. doi:10.1007/978-88-470-5516-2 5.

East of England Trauma Network hospitals, listed alphabetically, and their location

- Bedfordshire Hospitals NHS Foundation Trust
  - Bedford Hospital
  - Luton & Dunstable Hospital
- Cambridge University Hospitals NHS Foundation Trust
  - Addenbrooke's Hospital **(Major Trauma Centre)**
- East and North Hertfordshire NHS Trust
  - Lister Hospital
- East Suffolk and North Essex NHS Foundation Trust
  - Colchester General Hospital
  - Ipswich Hospital
- James Paget University Hospitals NHS Foundation Trust
  - James Paget Hospital
- Mid and South Essex NHS Foundation Trust
  - Broomfield Hospital
- Norfolk and Norwich University Hospitals NHS Foundation Trust
  - Norfolk & Norwich University Hospital
- North West Anglia NHS Foundation Trust
  - Hinchingbrooke Hospital (from 2015/16)
  - Peterborough City Hospital
- The Princess Alexandra NHS Trust
  - Princess Alexandra Hospital
- The Queen Elizabeth Hospital King's Lynn NHS Trust
  - Queen Elizabeth Hospital King's Lynn
- West Suffolk Hospital NHS Trust
  - West Suffolk Hospital

Figure 2.1 *Major Trauma Centre (Addenbrooke's), Trauma Units, and the East of England Trauma Network within six Integrated Care Board (ICB) areas in the East of England*



3
Methods and data quality

This health needs assessment uses ten years of the TARN database as its source of patient level trauma episode data. Variables are taken from the TARN Performance Review Indicators extract and TARN Analytics Power BI (University of Manchester).

TARN uses a retrospective analysis of Hospital Episode Statistics (HES) to determine if a case meets the criteria to be defined as trauma (See TARN Inclusion Criteria in Appendix 1). TARN assigns patients with an Abbreviated Injury Scale (AIS) for each injured body region. The detailed recording of all injuries is used to determine patient Injury Severity Score (ISS) and probability of survival (Ps). Therefore, a patient's ISS is assigned after discharge. The ISS is calculated as the addition of the squared numbers of the three most injured body regions by their AIS code, ranging from 1 to 75.

The retrospective nature of TARN data means that trauma episodes can be missed for submission to the database (coverage). This is in addition to missing data caused by fields not being completed. These missing data are monitored by TARN and described by hospital and year in Appendix 2. Data in this report is not adjusted for missing data.

Inclusion criteria for this health needs assessment

- Attended East of England trauma hospitals
- Date of admission between April 2012/13 and March 2021/22 (NHS fiscal years)
- Trauma patients over 18 years of age
- ISS greater than 15 (major trauma) included in all parts
- ISS 9 to 15 (severe trauma) included in Part One and Part Three
- ISS 1 to 8 included in Part One and Part Three
- Deaths of patients occurring in hospital (pre-hospital deaths are not collected by TARN)

Part One of this health needs assessment is based on individual patients, using their unique ID numbers to avoid double counting characteristics. This part includes only trauma episodes from residents of the East of England based on the commissioning region defined by the NHS Organisational Data Service (ODS)[1]. Part One includes ARIMA time series analysis to estimate future trauma patient demand.

Part Two and Part Three include all patients using East of England trauma services including visitors and out of region residents. In this part, counts may feature the same patient more than once if they have visited more than one hospital during an episode of trauma. Part Two includes forecasting models to estimate future trauma bed occupancy. Part Three involves a scenario analysis to estimate the future patient demand and bed occupancy of Norfolk and Norwich Hospital if it were to become a Major Trauma Centre. Further analytical technical details are provided in the appendices.

Unless stated or representing data over time, pooled data refer to the fiscal years 2017/18, 2018/19 and 2019/20. This was chosen to account for improvements in data quality over time, to avoid outliers that may have been due to COVID-19 (2020/21), and to best represent recent circumstances rather than an average across ten years. Data may not add up to 100% due to rounding. Unless stated, findings refer to major trauma only (ISS >15).

Patient residential Index of Multiple Deprivation Score (IMD) was determined using their postcode data to estimate their residential Lower layer Super Output Area (LSOA) location using linkage provided by Open Data Communities.[2]

1 ODS postcode files. https://digital.nhs.uk/services/organisation-data-service/file-downloads/ods-postcode-files

2 English indices of deprivation 2019. https://imd-by-postcode.opendatacommunities.org/imd/2019

Patient selection flow diagrams

An individual patient can have multiple submissions to TARN depending on how many hospitals they attend as part of their trauma episode. Patients can have multiple trauma episodes but are counted as new patients in this analysis. Figure 3.1 presents the TARN patient selection included for the descriptive data in Part One and Part Two. Figure 3.1 shows a similar selection criterion for Part Three, time series analysis (Part One) and bed occupancy forecasting (Part Two), except patients are further excluded if they are missing hospital submissions as part of their trauma episode.

Figure 3.1 *Flow diagram for Part One and Two using TARN data submissions*

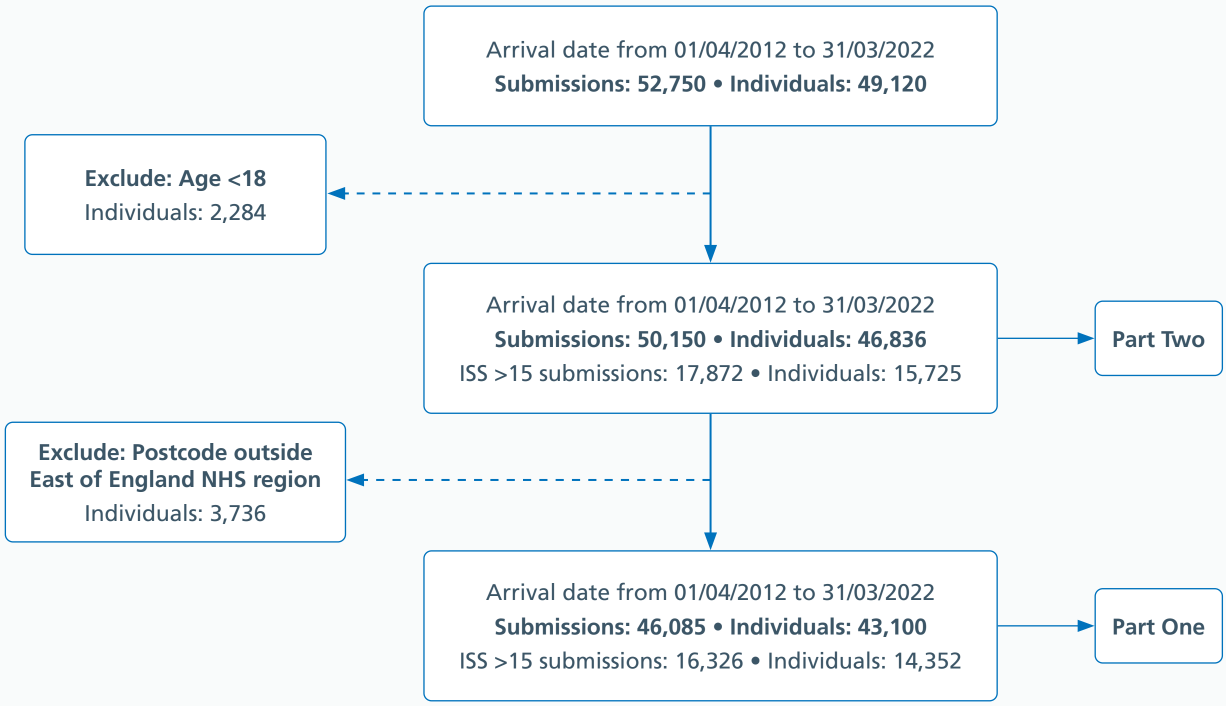
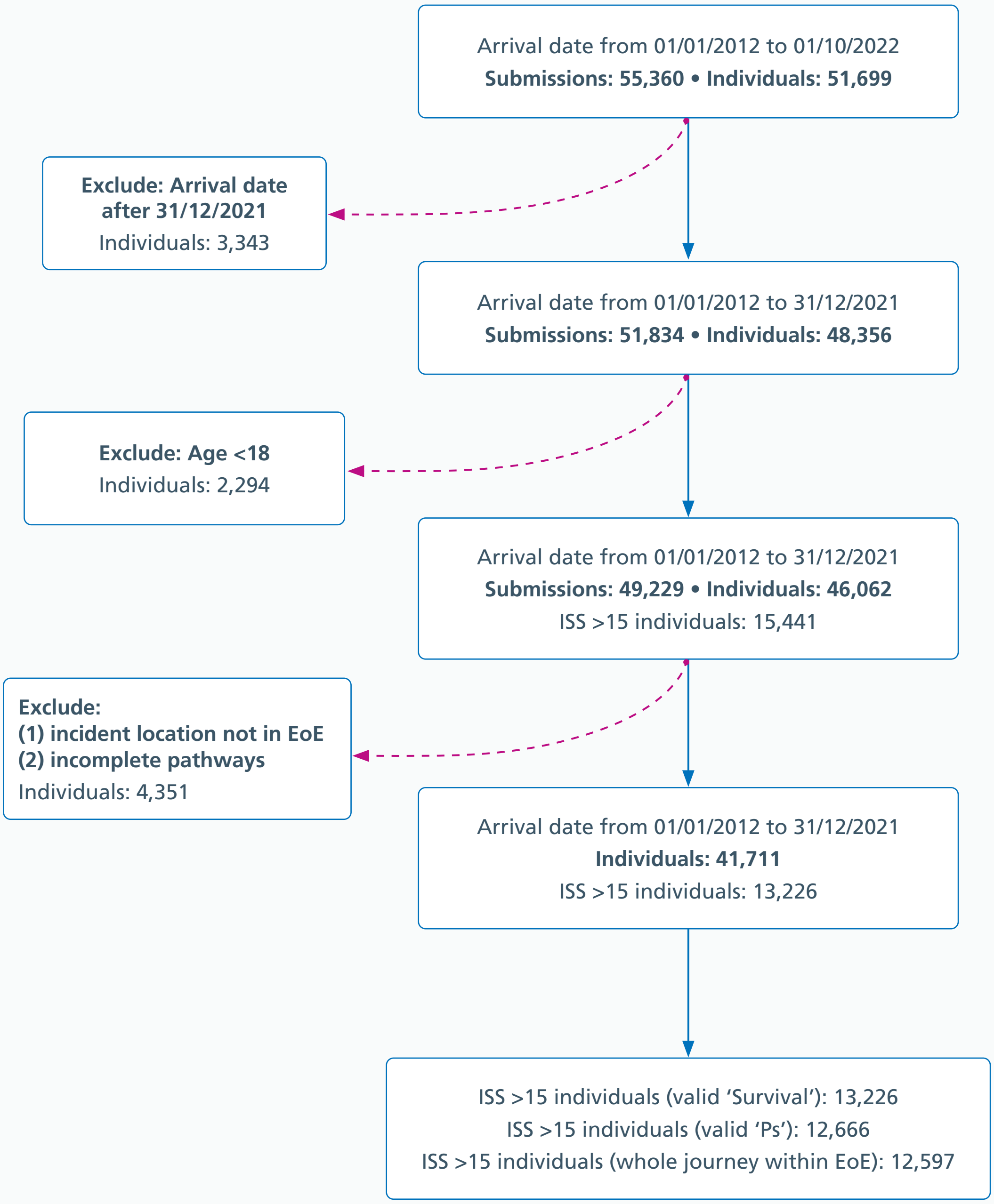


Figure 3.2 *Flow diagram for Part Three and forecast models – Ten years of TARN data from the beginning of 2012 to the end of 2021. Some analysis (e.g., occupancy levels) is based on submissions and others (e.g., pathways) on individual records.*



PART ONE

Population needs

Part One focuses on the characteristics of major trauma patients that reside within the East of England region and attended East of England trauma hospitals. This includes their demographics, residence location, injury mechanisms and body regions of injury. This part also includes a description of the population catchment of each hospital within the East of England Trauma Network.

4
East of England region population overview

This section introduces the general East of England population including factors of age, sex, location of residence and area deprivation. It also considers the changing age structure of the population over time and future population growth.

Age structure

The latest census reports that the East of England region is home to 6,621,000 people (ONS Census 2021)[1]. The largest counts of people are in the counties of Essex and Hertfordshire. Figure 4.1 shows the age structure for the East of England where the highest proportions of persons are between the ages of 30 and 59 years. This age distribution is not equally dispersed across the region. Figure 4.2 shows that adults over 65 years tend to live in areas of lower population density such as Norfolk and East Suffolk but also in cities such as Southend-on-Sea.

[1] First results from Census 2021 in England and Wales. https://www.ons.gov.uk/releases/initialfindingsfromthe2021censusinenglandandwales

Figure 4.1 *Population pyramid for East of England (ONS Census 2021)*

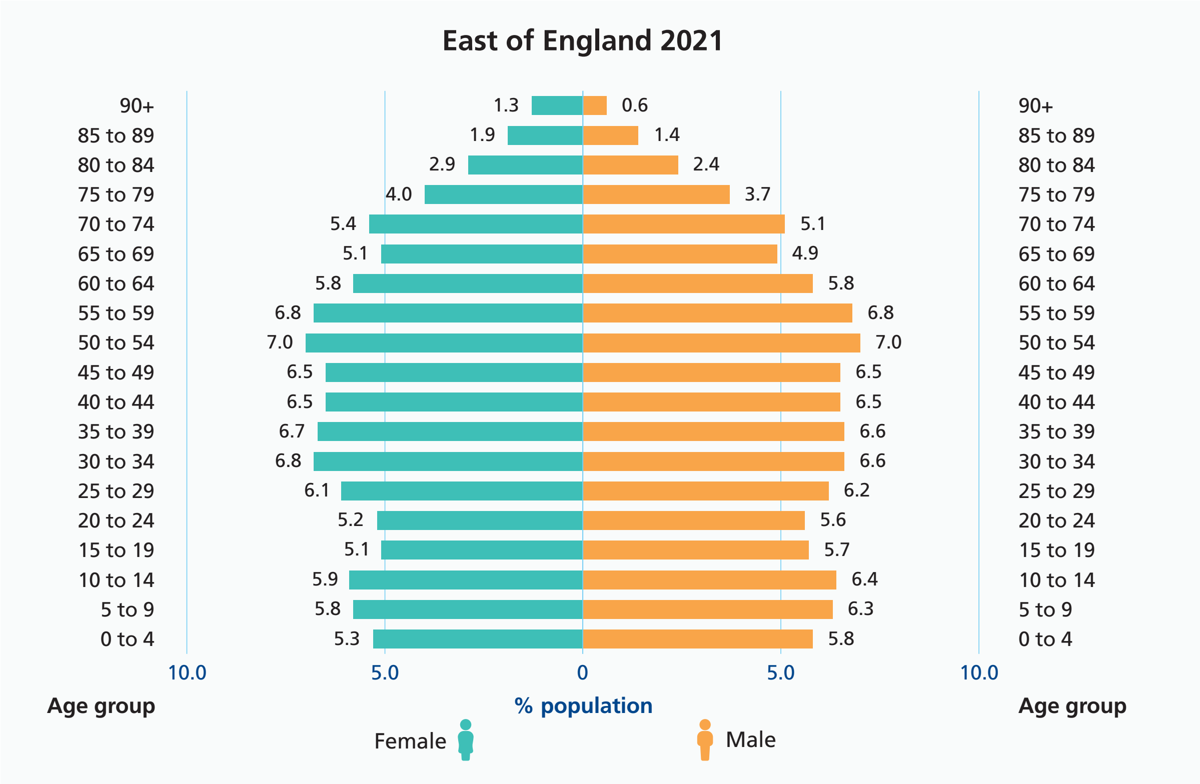
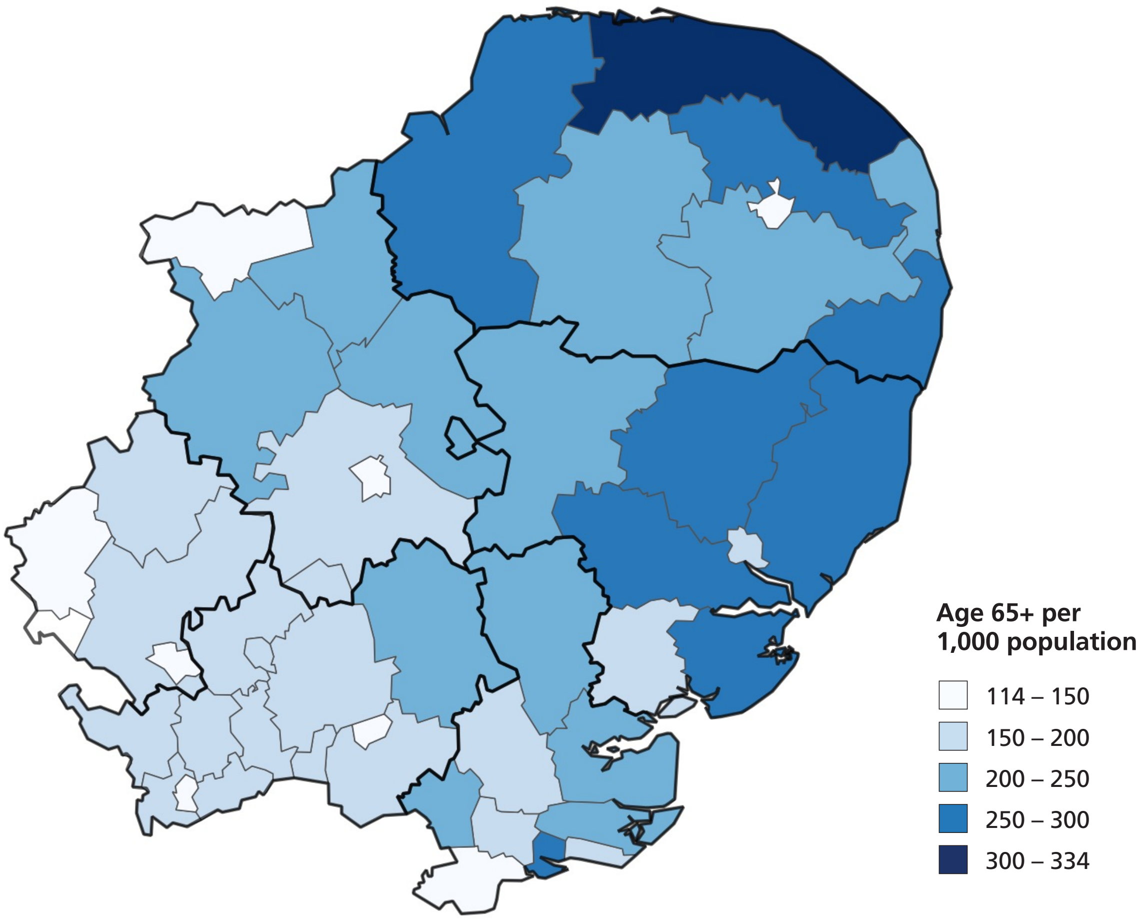


Figure 4.2 *Count of persons aged 65+ per 1,000 population by Local Authority Districts (ONS Census 2021)*



Change in population size over time

The most recent census in 2021 suggests an overall growth of 8.3% in the region since 2011 (Table 4.1). The largest growth was observed in Bedford (+17.7%) and Peterborough (+17.5%). Growth has been larger for the population aged over 65 years in all local authorities with the largest growth in those aged 70–74 years.

Table 4.1 Census population data in 2011 and 2021 for Upper Tier East Local Authorities[2] *(Using ONS defined age boundaries)*

	All ages				
	2011	**2021**	**% change all ages**	**% change 15–64**	**% change 65+**
East of England (Region)*	5,846,965	6,334,500	8.3	4.9	19.3
Bedford	157,479	185,300	17.7	14.6	22.6
Central Bedfordshire	254,381	294,200	15.7	10.8	28.0
Luton	203,201	225,300	10.9	10.0	10.4
Milton Keynes	248,821	287,000	15.3	11.0	35.8
Cambridgeshire	621,210	678,600	9.2	5.7	23.2
Peterborough	183,631	215,700	17.5	13.5	20.6
Southend-on-Sea	173,658	180,700	4.1	1.6	11.3
Thurrock	157,705	176,000	11.6	8.5	17.7
Essex	1,393,587	1,503,300	7.9	3.9	19.3
Hertfordshire	1,116,062	1,198,800	7.4	4.8	16.1
Norfolk	857,888	916,200	6.8	2.6	18.9
Suffolk	728,163	760,300	4.4	0.0	21.0

*Excludes Milton Keynes due to ONS census geography

The most recent population projection data from the ONS expects to see the East of England population grow by 4.2% between 2021 and 2031. This is half the rate of the previous ten years. Table 4.2 shows this growth is likely to vary by area, with the largest growth in Thurrock (+8.0%). It is estimated that the most growth will be in adults over 75 years, particularly in the local authorities of Milton Keynes, Bedfordshire, Suffolk, and Peterborough. Figure 4.3 shows that regional growth in older women is likely to be higher than in men.

[2] How the population changed where you live: ONS Census 2021. https://www.ons.gov.uk/visualisations/censuspopulationchange

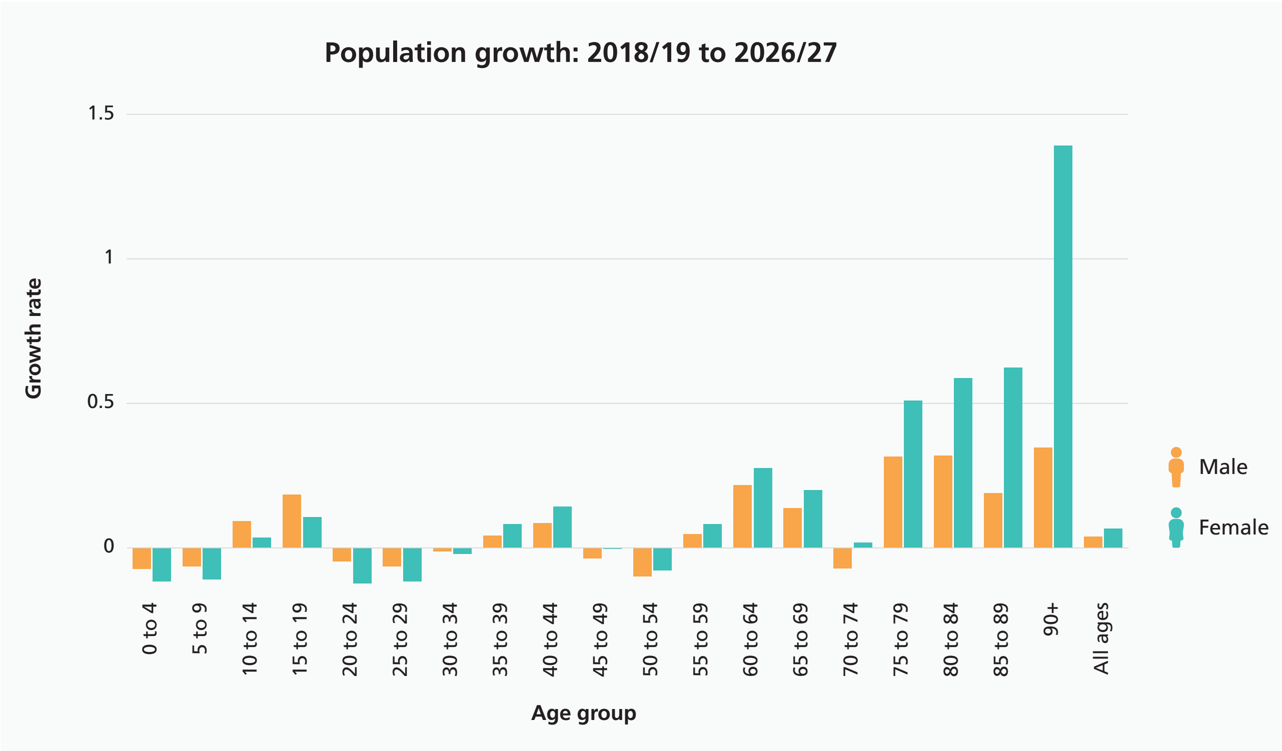
Table 4.2 *Population projection by Upper Tier Local Authorities (ONS Census 2018)*[3]

			Predicted 10-year change 2021 to 2031			
	2021	**2031**	**% change all ages**	**% change 16–44**	**% change 45–74**	**% change 75+**
East (Region)*	6,312,979	6,580,494	4.2	2.7	4.9	26.3
Bedford	176,212	187,287	6.3	2.5	9.7	29.9
Cambridgeshire	660,675	682,536	3.3	1.9	3.4	29.4
Central Bedfordshire	293,042	313,030	6.8	3.9	8.4	35.2
Essex	1,507,862	1,587,577	5.3	5.1	3.7	24.7
Hertfordshire	1,196,507	1,218,231	1.8	-0.8	5.6	21.8
Luton	212,478	204,718	-3.7	-7.5	7.3	14.1
Milton Keynes	272,467	277,872	2.0	-2.7	8.7	47.3
Norfolk	924,146	979,102	5.9	5.8	4.0	26.9
Peterborough	207,890	222,079	6.8	4.9	12.4	31.3
Southend-on-Sea	186,062	195,875	5.3	3.0	8.5	22.9
Suffolk	769,544	797,274	3.6	1.7	1.6	30.3
Thurrock	178,563	192,786	8.0	7.0	12.4	25.6

Note that the 2018 (latest) projection data does not consider the impact of the COVID-19 pandemic or 2021 Census.

*Excludes Milton Keynes due to ONS census geography

Figure 4.3 *Projected percentage change (growth) in the East of England population by age group and sex for seven years (ONS Census 2018)*

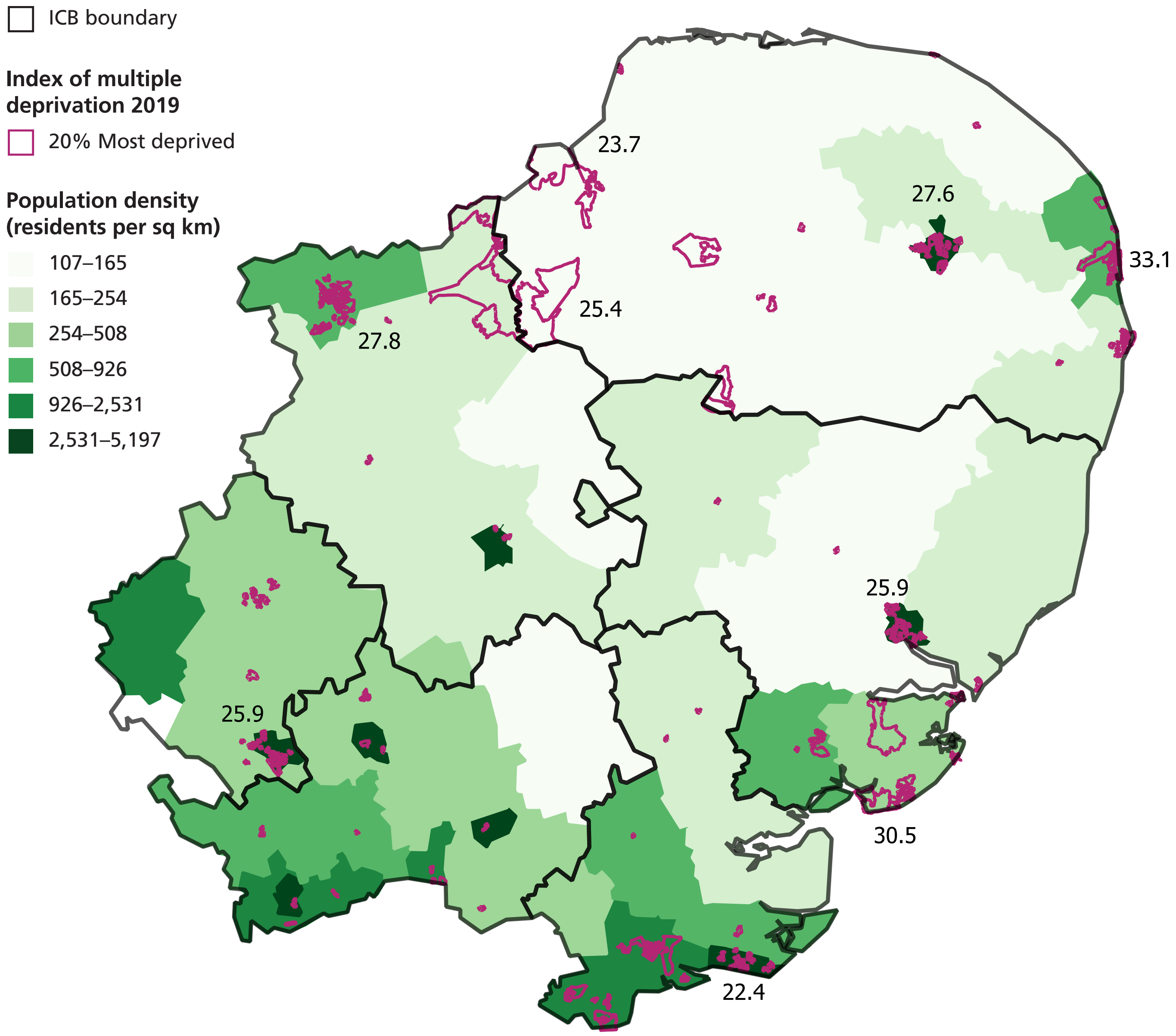


[3] Population projections for local authorities. https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/localauthoritiesinenglandtable2

Area deprivation (Core20)

Patients can be classified as deprived of a range of resources by their residential Index of Multiple Deprivation (IMD) score. Figure 4.4 shows that the 20% most deprived neighbourhoods by IMD 2019 are found in both rural and urban areas. Deprivation can concentrate in towns and cities such as Norwich, Peterborough, Ipswich, and Luton. Deprived areas are also found in locations along the coast such as Clacton-on-Sea and Great Yarmouth and rural areas such as Fenland. Great Yarmouth is the most deprived area in the region, followed by Tendring, Peterborough and Norwich.

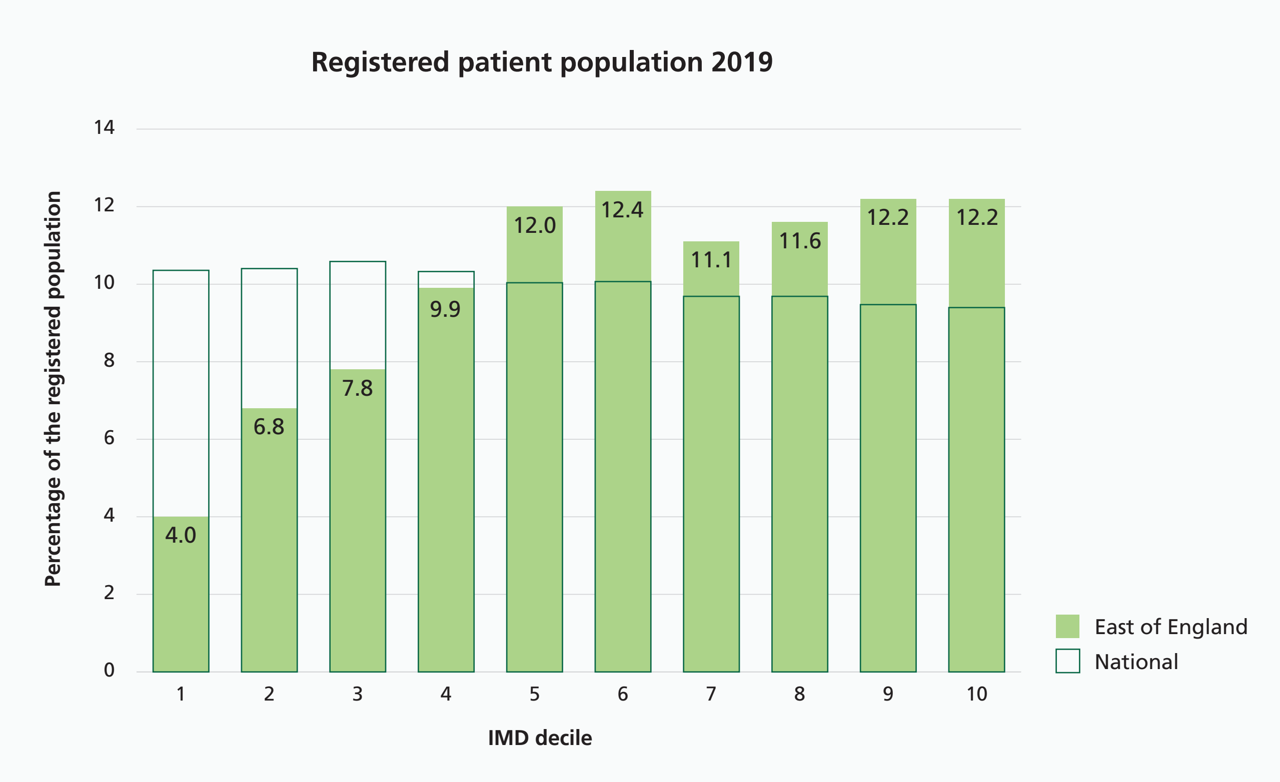
Figure 4.4 Population density by Local Authority Districts (ONS Census 2021[4]) with 20% most deprived areas. IMD scores for areas above the English average (21.7) labelled (higher score means greater deprivation).



[4] How the population changed where you live: ONS Census 2021. https://www.ons.gov.uk/visualisations/censuspopulationchange

The national registered patient population is equally distributed across ten IMD deciles. In the East of England, there are fewer residents in the bottom four deciles (most deprived) and higher counts in deciles 5 to 10 (Figure 4.5). Finding more residents in the less deprived deciles is also the trend at the ICB level, except for in Norfolk and Waveney where there are more residents in deciles 4 to 6.

Figure 4.5 *Registered patient population by IMD 2019 deciles (July 2022), national and East of England.*[5]



5 NHS England registered population demographics tool (internal).

5 Characteristics of the trauma patient population in the East of England

This section introduces our TARN patient cohort for this public health needs assessment. Trauma patients from the East of England are reviewed for their Injury Severity Score (ISS) by demographics. Major trauma is defined as an ISS with a score greater than 15 and severe trauma as an ISS between 9 and 15. Trauma, as ISS 1 to 8, is initially included to assess the overall burden of trauma. Severe trauma is considered in this part due to the potential for this ISS band to receive services from the Major Trauma Centre in the future.

Trauma by injury severity

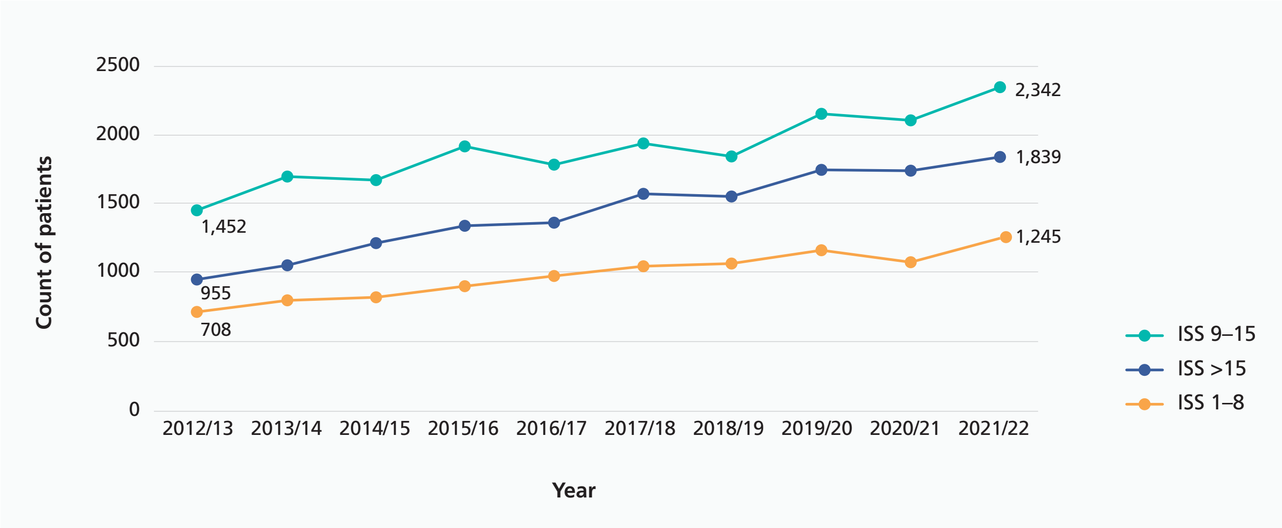
For the fiscal years 2017/18 to 2019/20, there were 14,084 living patients, from the East of England region, admitted to the East of England Trauma Network hospitals with any trauma. Of these, 35% of patients were impacted by major trauma, 42% by severe trauma and 23% by trauma with an ISS 1–8. This makes severe trauma the most common trauma severity category.

Figure 5.1 shows that the count of trauma patient population in the East of England has been increasing since 2012/13 and is now at its highest count. The total number of trauma patients has increased for all severity types with the count of major trauma almost double in 2020/21 what it was in 2011/12. However, the proportions of trauma by severity have stayed the same over time, with <5% change.

As a crude rate, major trauma has significantly increased from 20.6 per 100k in 2012 to 35.3 per 100k East of England population (age 18+ years) in 2020. Growth was slower from 2015 onwards (28.1 per 100k) compared to previous years. This may be related to the improvement in data coverage over time (see Appendix 2).

In 2020/21, the impact of COVID-19 lockdown had a minor impact on patient counts. There were 131 fewer trauma patients than the previous year, with 64% of these patients with injuries of ISS 1–8. The largest growth in all trauma patients occurred in 2019/20 where there were 601 more patients than the previous year.

Figure 5.1 Number of trauma patients over time by ISS (n=43,100)

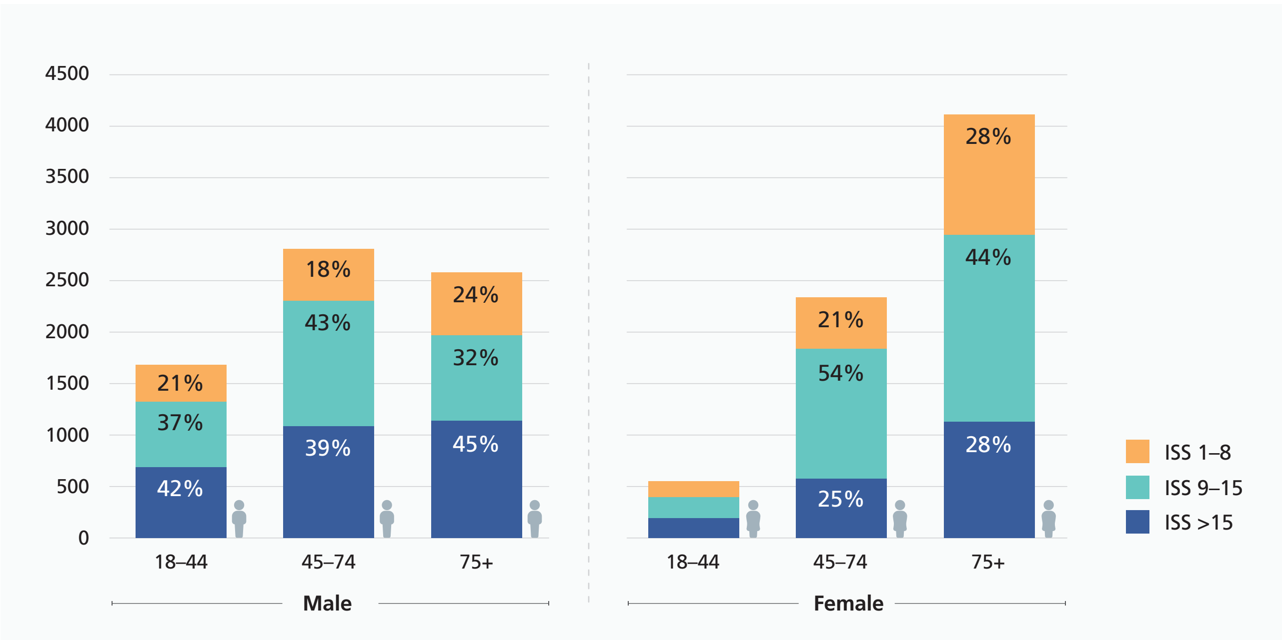


Trauma severity by demographics

Age and sex

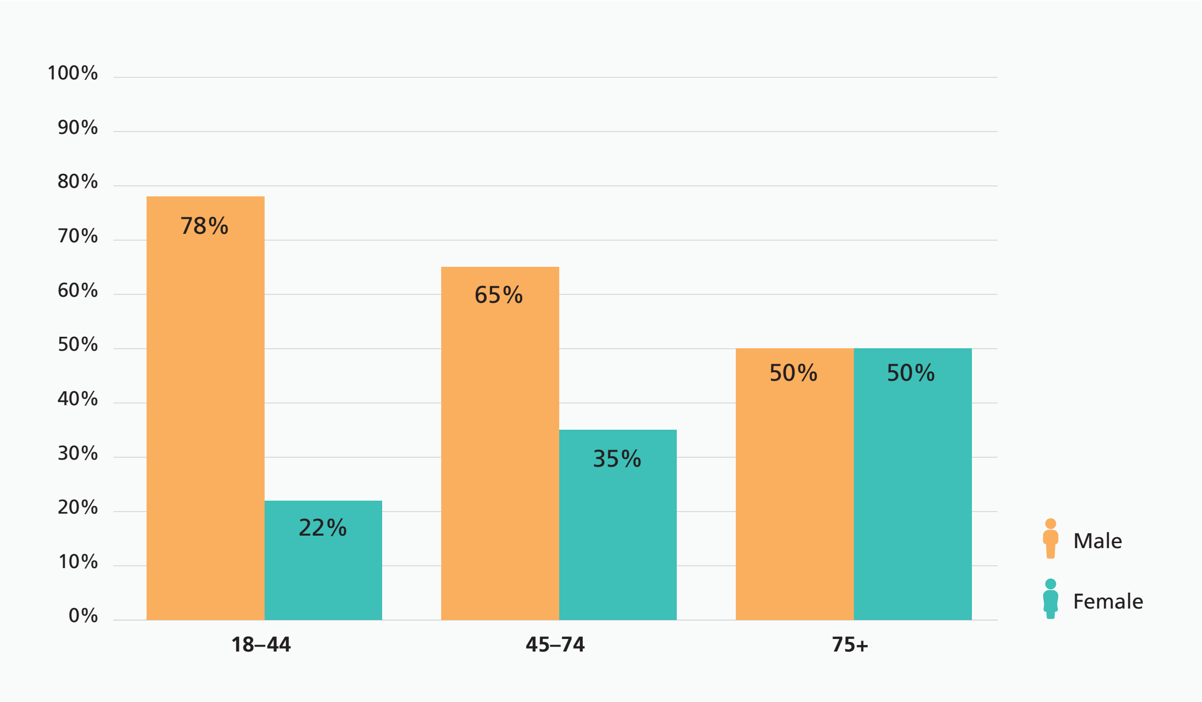
Figure 5.2 shows that the number of trauma patients and the severity of injury suffered varies between men and women of the same age groups. Comparing counts, women over 75 years have the highest count of all trauma and women aged 18–44 years have the lowest. Men aged 18–44 years have three times more trauma patients compared to women of the same age. Proportionally, men suffer from more major trauma and women suffer more severe trauma overall.

Figure 5.2 Count and proportion of trauma by ISS, split by age and sex (n=14,084), 2017/18 to 2019/20 pooled



When considering just major trauma, men suffer from a greater proportion of injuries at ages 18–44 years and 45–74 years compared to women (Figure 5.3). However, over the age of 75 years, the proportion of major trauma injuries affects men and women equally.

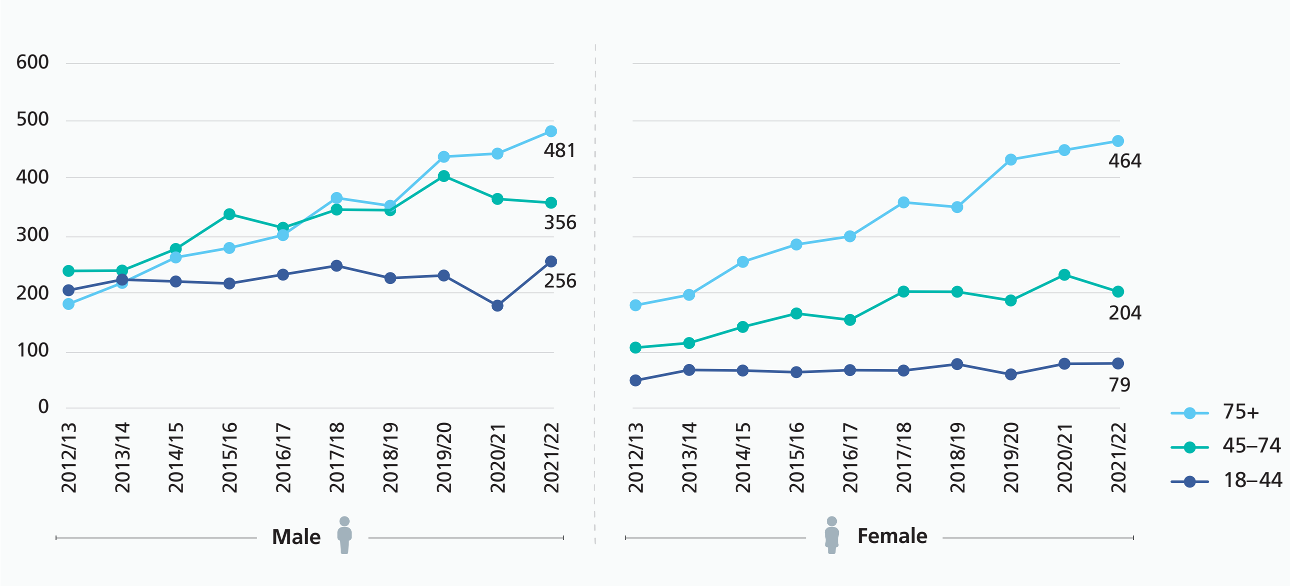
Figure 5.3 Proportion of major trauma patients by sex (n=4,876), 2017/18 to 2019/20 pooled



Over time, the count of major trauma patients increased in all age groups, but the most growth was seen in elderly patients (Figure 5.4). In 2012/13, the lowest counts in men were seen in the elderly and there were fewer differences in counts between age groups. Yet by 2019/20, major trauma in elderly males had the largest count by age group.

This has resulted in the average patient age for major trauma increasing from 58 to 65 years in men and from 70 to 74 years in women. The proportion of elderly patients has increased from 37% in 2012/13 to 51% in 2021/22. Growth in counts was stronger in the earlier years of both male and female elderly growth (2012–2015).

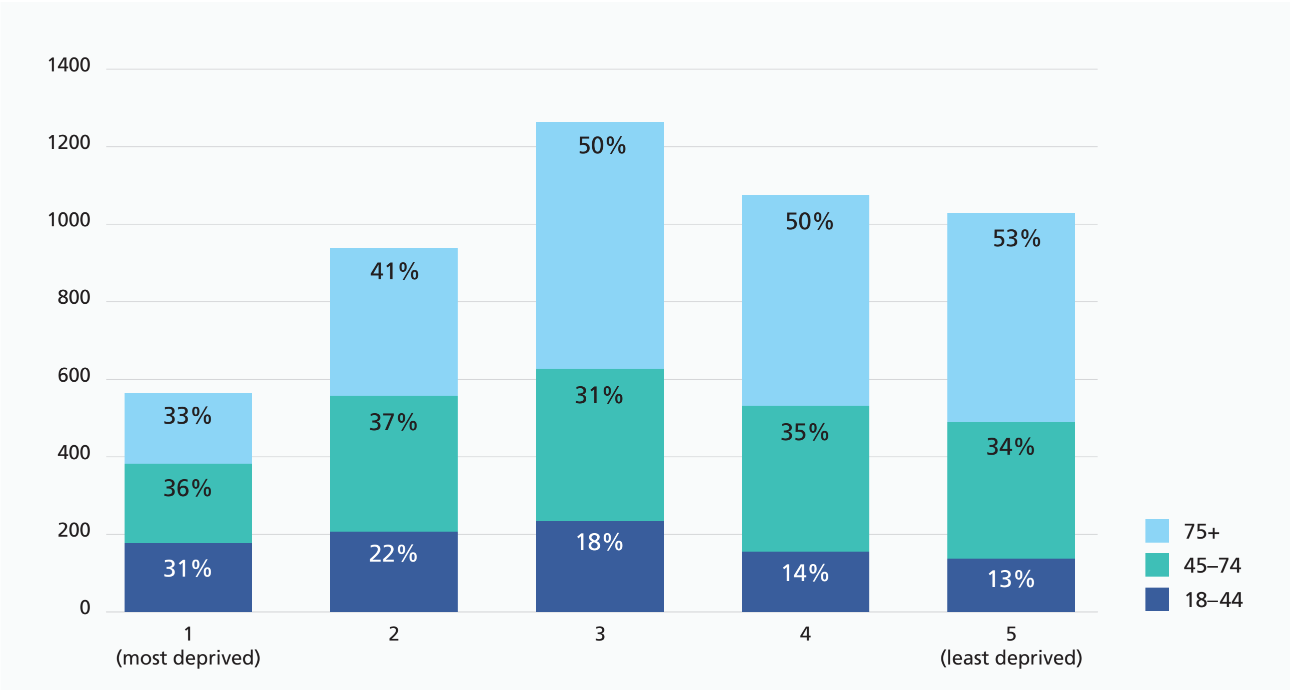
Figure 5.4 Count of major trauma patients over time by age group and sex (n=14,393)



Area deprivation

The distribution of major trauma patients by IMD quintile is in line with the East of England population distribution. There are slightly more patients in the third quintile and less patients from the least deprived quintile than would be expected. Figure 5.5 shows that in the most deprived quintile, there is an equal distribution of patients between age groups. As area deprivation decreases, the proportion of elderly patients increases.

Figure 5.5 Count and proportion of major trauma patients by IMD quintile and age (n=4,875), 2017/18 to 2019/20 pooled



Pre-existing medical conditions

TARN uses the Charlson Comorbidity Index (CCI) to adjust for patient comorbidities that may put them at higher risk of poor recovery or survival. For major trauma, 34% had no pre-existing conditions, 57% had a CCI score between 1 to 10 and 5% had severe comorbidities with a score of 11 or more (Figure 5.6). Major trauma patients were more likely to have a higher CCI score compared to severe trauma. The number of comorbidities increase with age with 77% of elderly major trauma patients having a CCI score above one (Figure 5.7).

Figure 5.6 *Charlson Comorbidity Index of major trauma patients by ISS (n=10,805), 2017/18 to 2019/20 pooled*

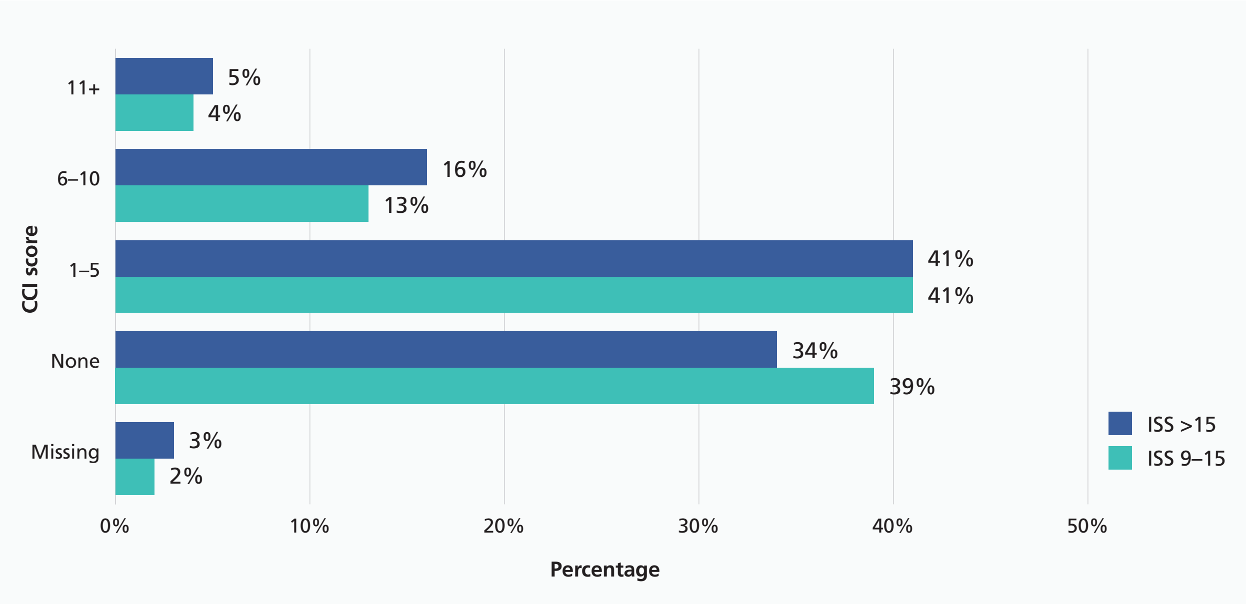
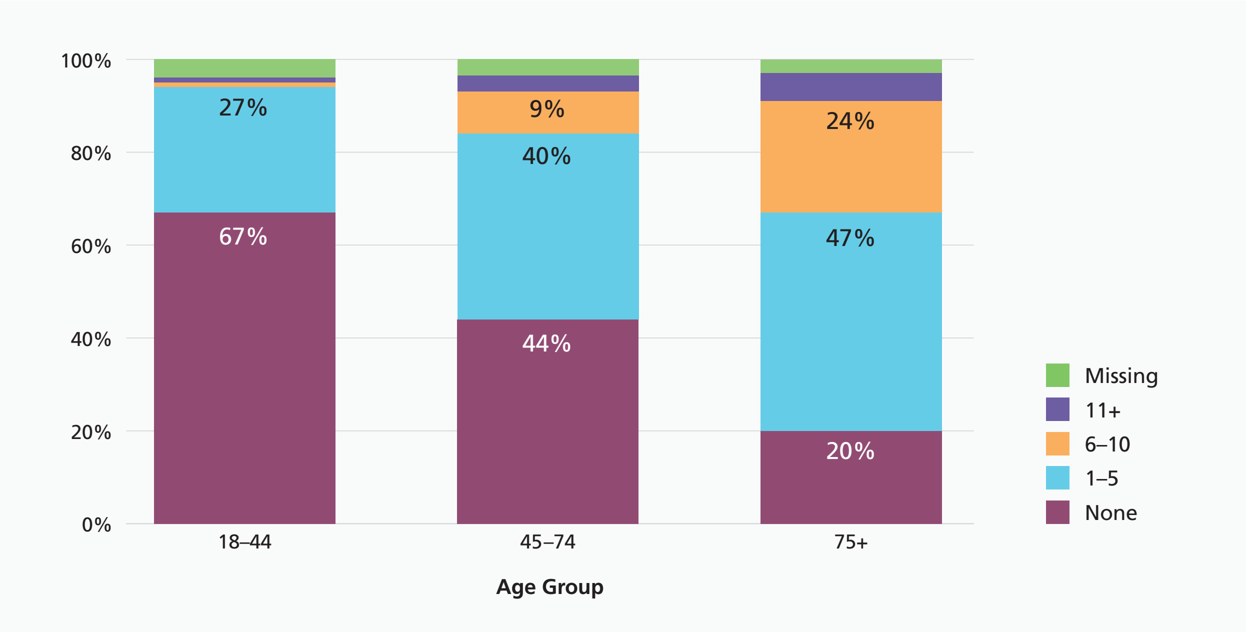


Figure 5.7 *CCI score by age in major trauma patients (n=4,875), 2017/18 to 2019/20 pooled*



Spatial location of residence

Within the East of England population, patients from Norfolk and Waveney (N&W) and Cambridgeshire and Peterborough (C&P) ICBs contribute to 44% of major trauma seen in East of England Trauma Network services. Lower proportions of patients from Mid and South Essex (MSE) and Bedfordshire, Luton, and Milton Keynes (BLMK) may be from their populations using neighbouring trauma network hospitals. The proportions between major and severe trauma by ICB are within a 3% difference.

Figure 5.8 *Proportion of major trauma patients attended East of England Trauma Network services by EoE ICB residence, 2017/18 to 2019/20 pooled.*

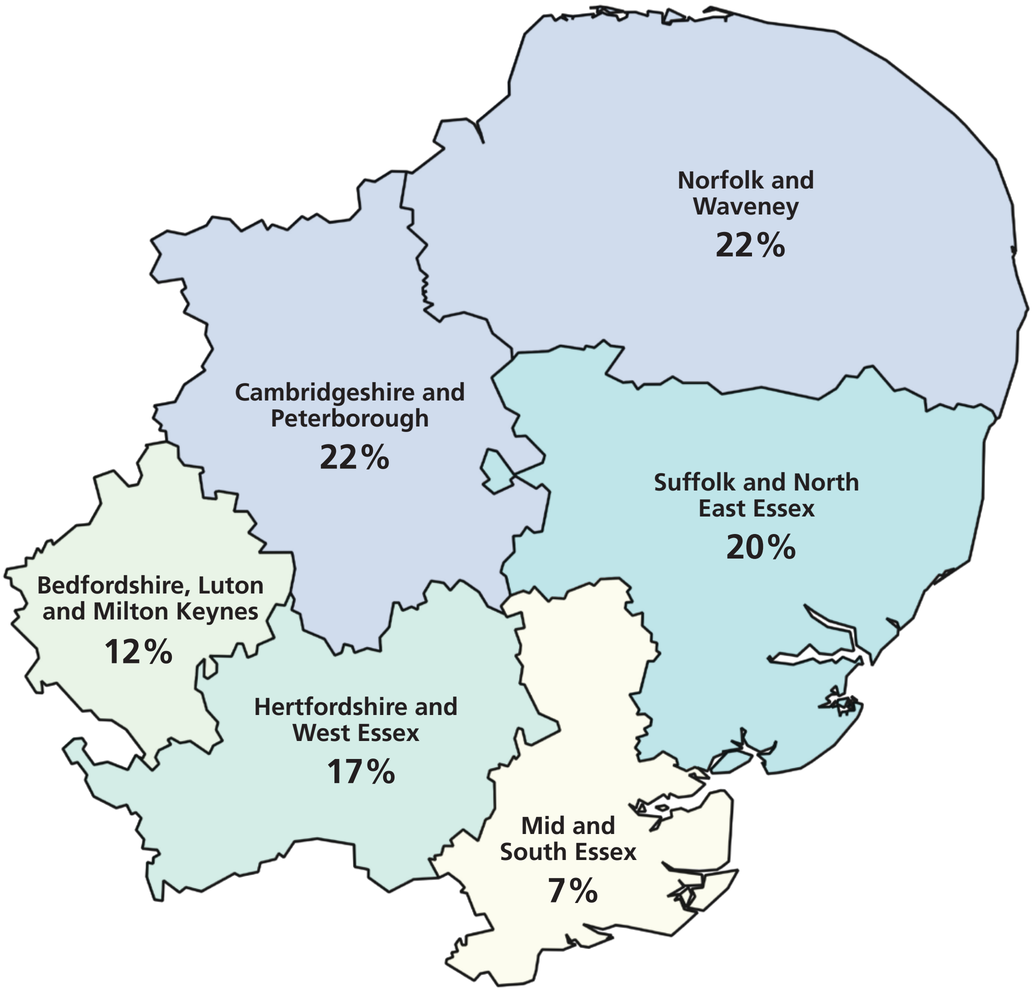
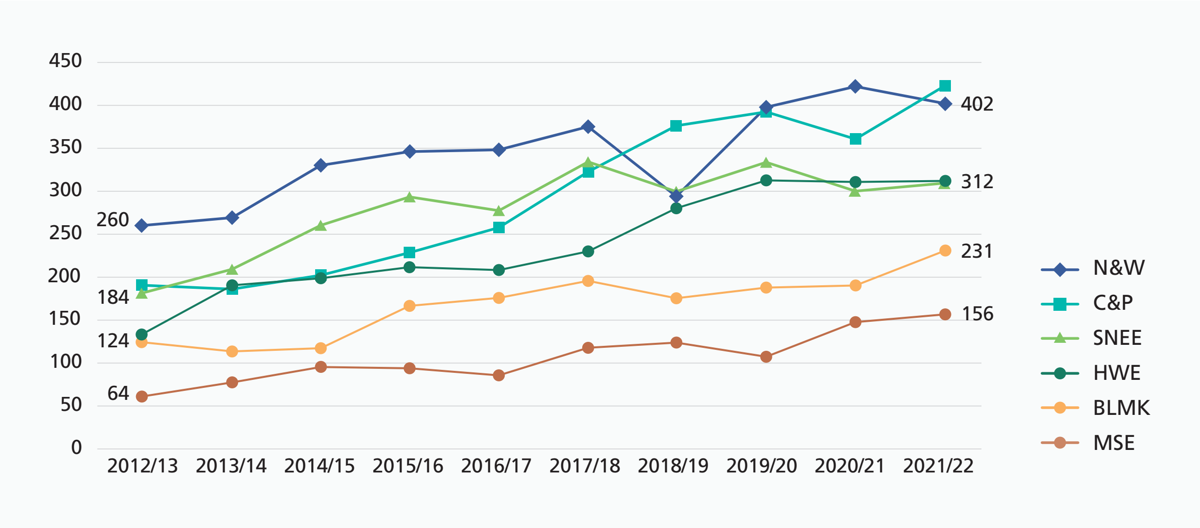


Figure 5.9 shows that the count of major trauma patients has increased across all ICBs. N&W had the highest count of major trauma patients in each year except 2018/19 and the most recent year. The unexpected drop in 2018/19 for N&W may be due to reduced data coverage for this year (see Appendix 2). Suffolk and North East Essex (SNEE) showed a significant growth in patient counts until 2015/16 after which there was only a slight increase overall. Coverage has been poor for Colchester Hospital since 2019/20 which may explain a recent plateau in SNEE counts. C&P showed the highest increase in counts over time compared to other ICBs.

Figure 5.9 Count of major trauma patients by ICB over time (n=14,351)



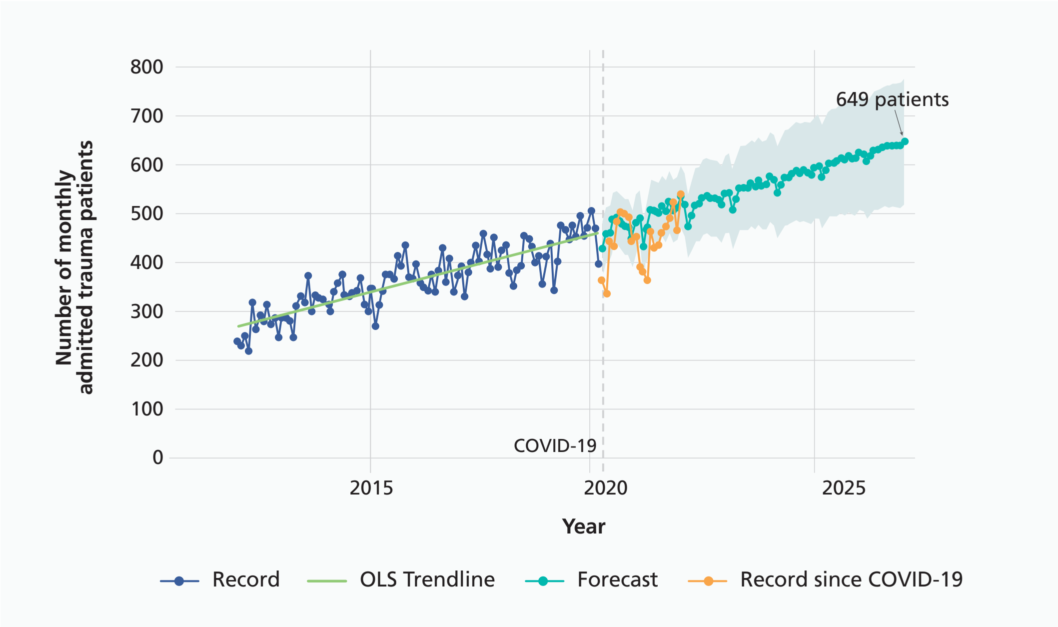
Estimating future patient demand in the East of England

The future population demand for trauma cases (all ISS) was estimated using ARIMA time series analysis modelling. This analysis uses historical trends, and seasonality to predict future outcomes. Figure 5.10a shows the historical number of monthly admitted trauma patients in blue between 2012 and 2020 and predicted number of monthly admitted trauma patients in green between 2020 and 2027. The shaded area represents the range of the estimate based on reference interval. The orange shows the monthly admissions during COVID-19 years. This historical data from COVID-19 years was not used in the prediction due to the impact of lockdowns reducing patient counts. The model was checked for robustness by comparing with a triple-exponential smoothing model which is available in Appendix 3.

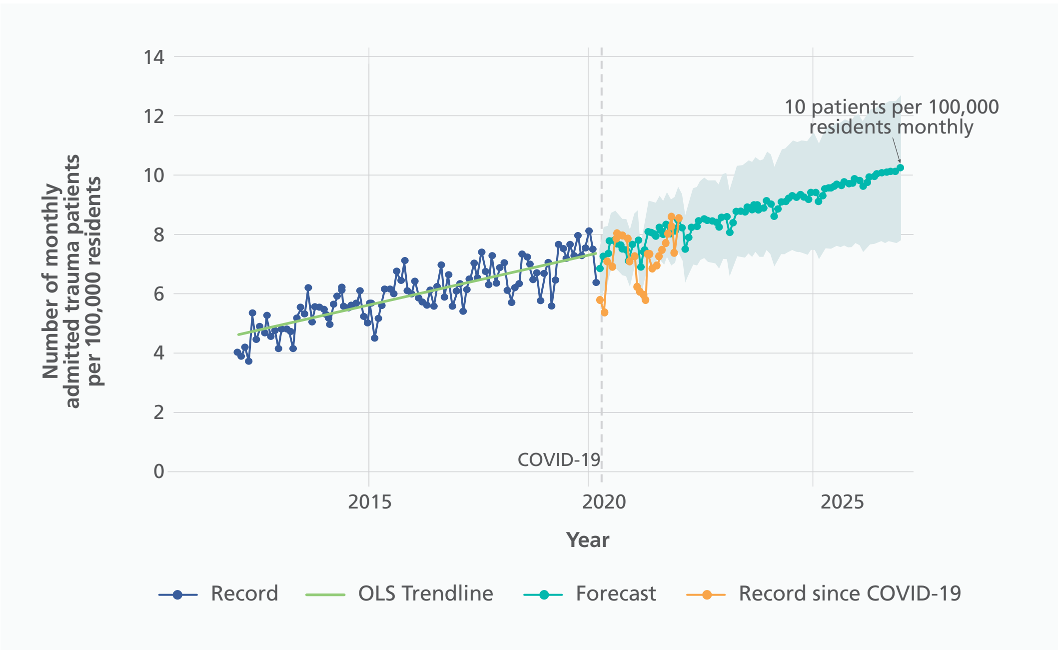
Figure 5.10a shows that the predicted number of monthly admitted trauma patients from March 2020 to December 2026 steadily increases, reaching 649 patients in that month. This equates to approximately 7,606 (reference range of 6,132 to 9,080) trauma patients annually in 2026, which represents a one-third increase in the number of trauma patients from March 2020 to December 2026.

Figure 5.10 Forecast for the number of monthly admitted trauma patients (all ISS) in the East of England region using time series analysis (ARIMA) by a) count and b) crude rate.

a



b



OLS Trendline is based on the ordinary least squares (OLS) regression fit.

6
Major trauma injuries in the East of England population

This section considers the mechanisms and types of injuries associated with major (ISS >15) and severe trauma (ISS 9–15). Injury mechanisms are broken down by patient demographics and change over time. This section ends with a review of the characteristics of severe head injuries.

Trauma by mechanism of injury

Falls less than two meters (also known as low falls) are the most common cause of major and severe trauma (Figure 6.1). This is followed by vehicle incidents and falls of more than two meters. Low falls contribute more to the burden of severe trauma (71%) compared to major trauma (58%). Vehicle incidents and falls more than two meters (also known as high falls) contribute more to major trauma compared to severe trauma. All other causes including blows and stabbing are less than 7% of all major trauma.

Figure 6.1 *Mechanism of injury by ISS (n=10,805), 2017/18 to 2019/20 pooled*

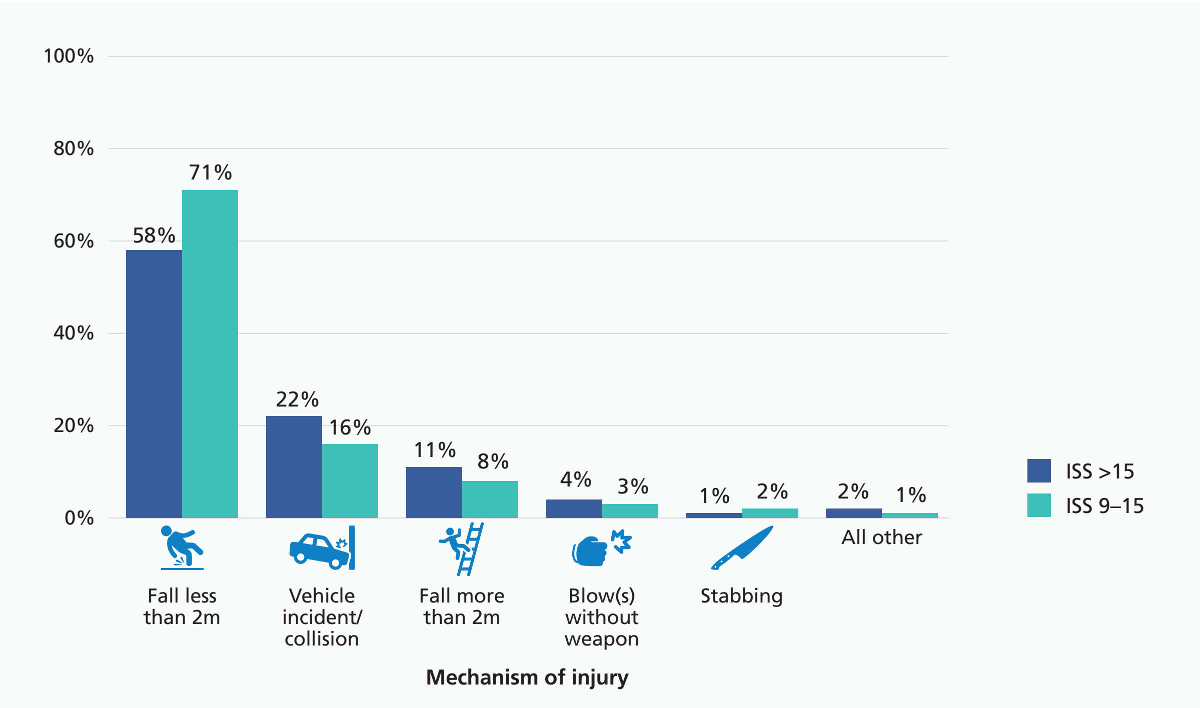


Figure 6.2 shows that the count of patients having a major or severe trauma due to low falls has increased over time. Proportionally, low falls have increased from 47% to 63% of all major trauma and from 69% to 76% of all severe trauma. Vehicle incidents, high falls, and other causes have also slightly increased in count but not at the same rate as low falls.

Figure 6.2 Count of mechanism of trauma over time by ISS (n=14,393)

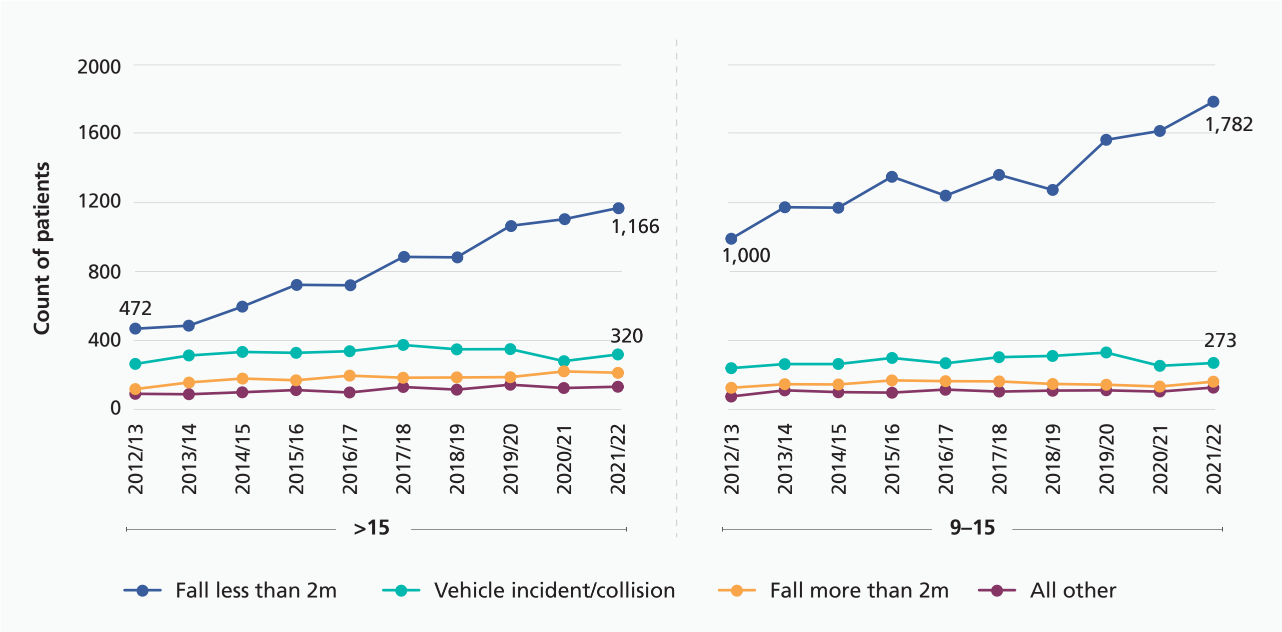
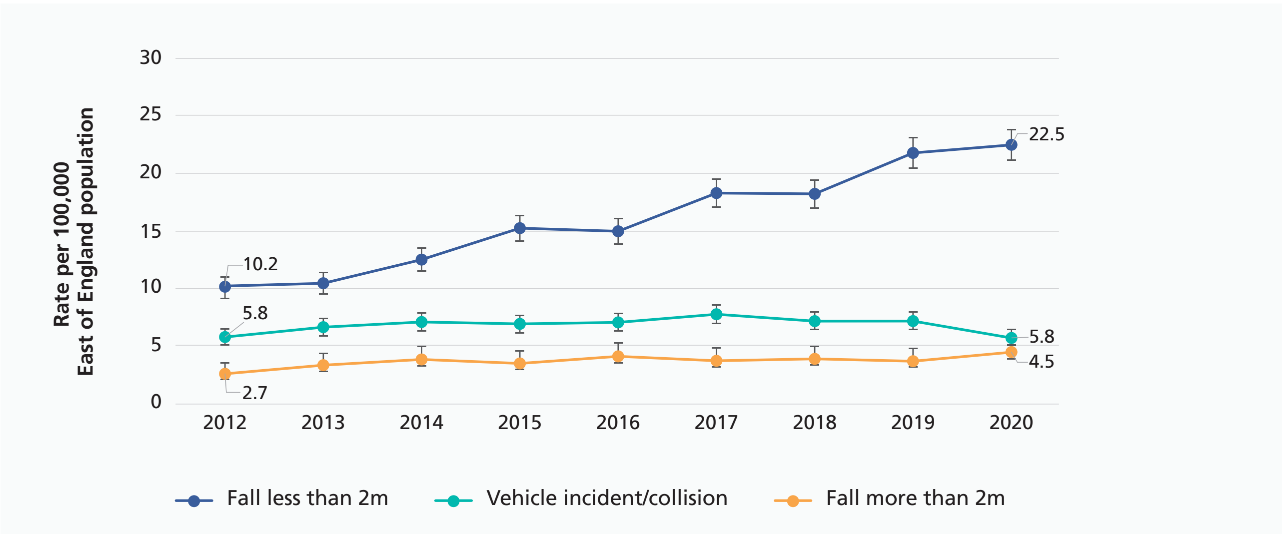


Figure 6.3 shows that the rate of low falls as the mechanism of major trauma has statistically significantly doubled from 10.2 in 2012 to 22.5 per 100k persons in 2020. Vehicle incidents have remained stable over time at 5.8 per 100k persons. Given the 8% population growth in the East of England over the past ten years, this suggests that the rise in low falls has increased beyond population growth for the region. Note this crude rate does not consider changes in population age structure over time.

Figure 6.3 Crude rate per 100k of major trauma mechanisms for East of England (18+ years) population over time

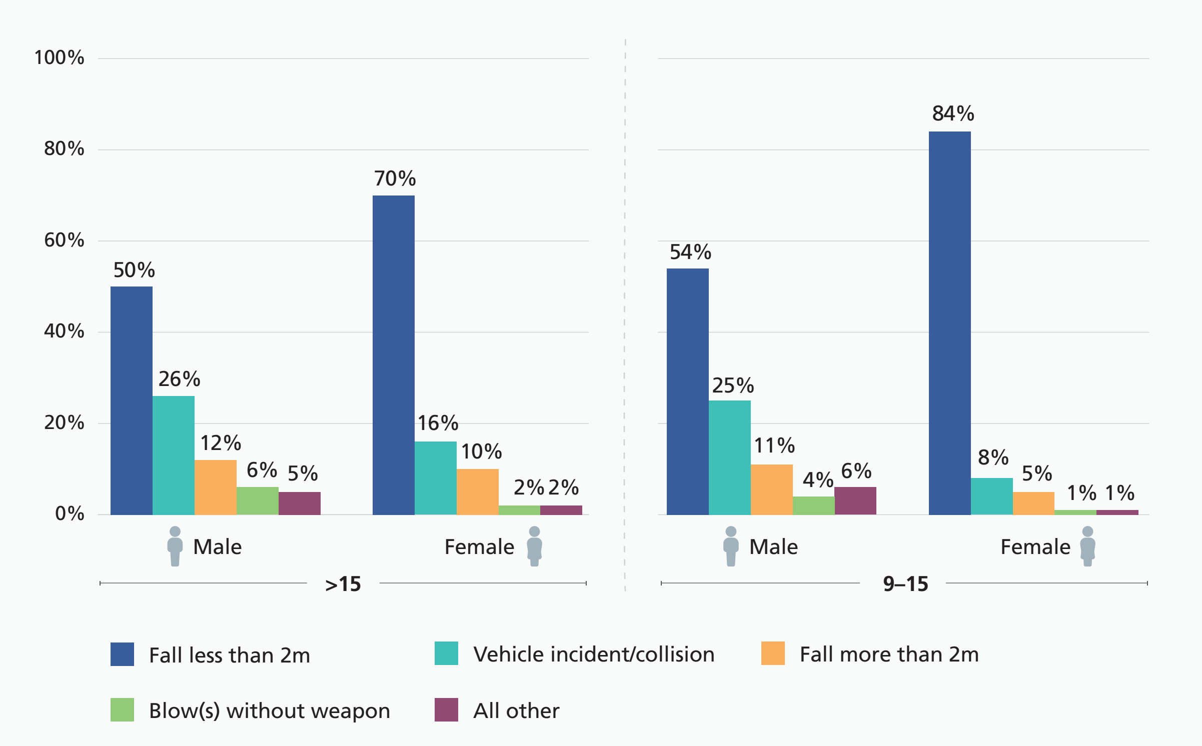


By demographics

Sex

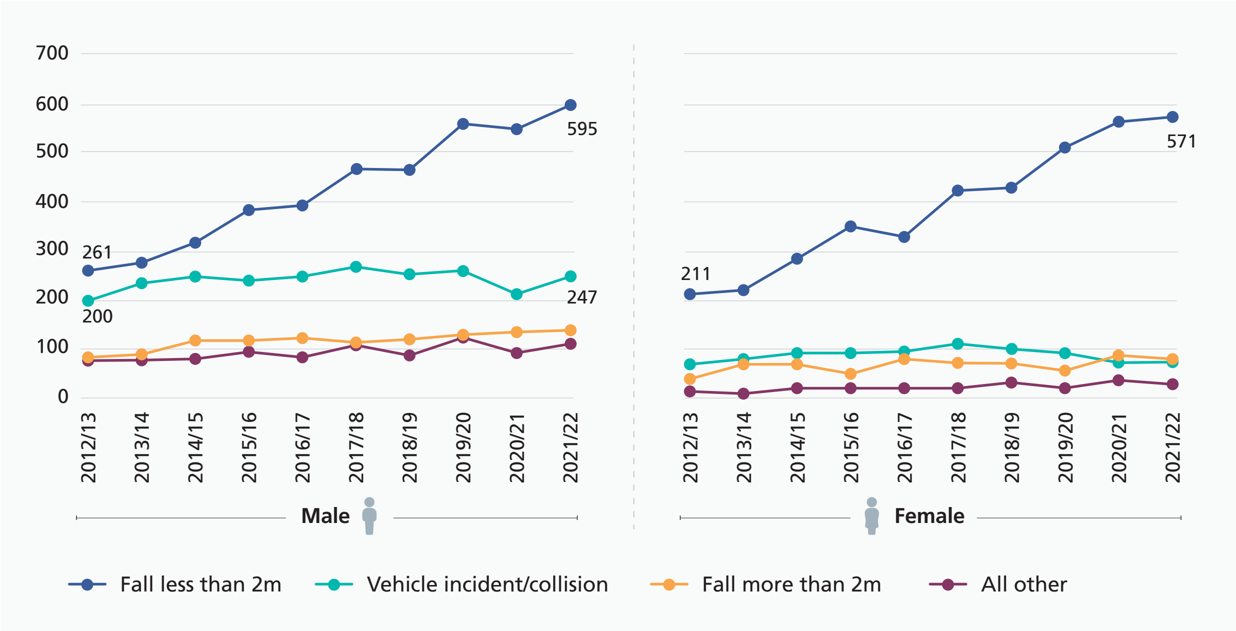
Trauma injury mechanisms vary between men and women (Figure 6.4). Women are more likely to experience major or severe trauma by low falls. However, men are more likely to experience all other injury mechanisms. Only half of major trauma injuries in men are due to low falls compared to 70% in women. In women, vehicle incidents and high falls are twice as likely for major trauma compared to severe trauma. In men, the proportions of injury mechanism for major and severe trauma are similar.

Figure 6.4 *Mechanism of injury by sex and ISS (n=10,805), 2017/18 to 2019/20 pooled*



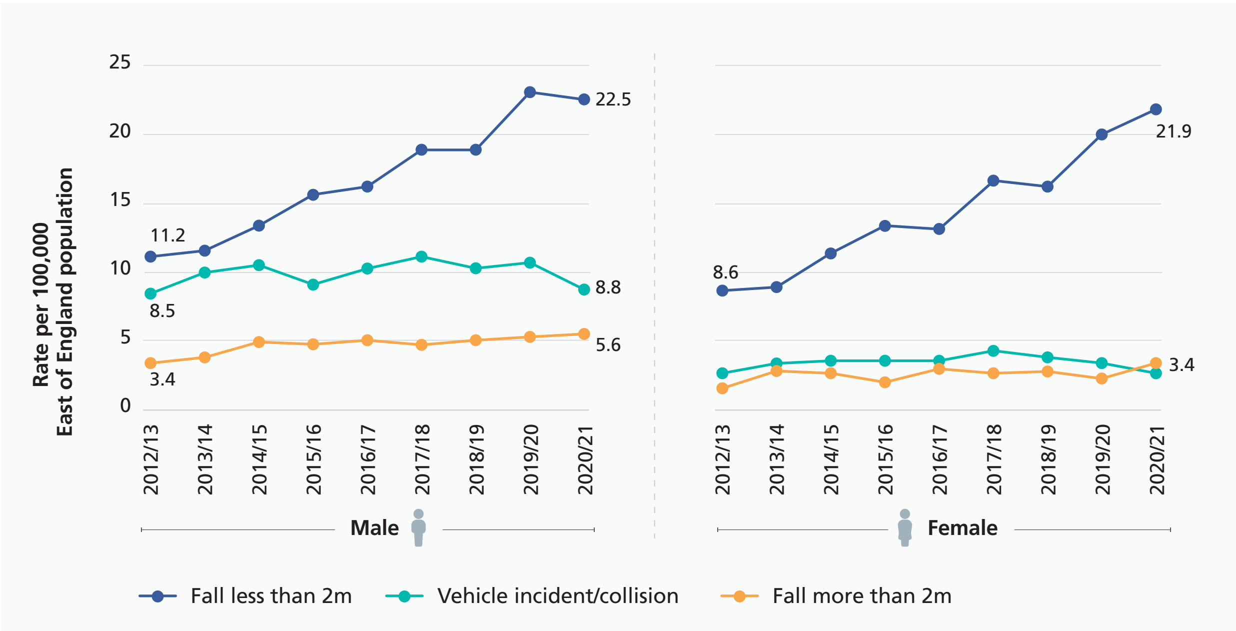
The count of major trauma low falls is slightly higher in men for 2021/22 compared to women (Figure 6.5). Proportionally, major trauma due to low falls has increased since 2012/13 from 41% to 54% in men and from 58% to 76% in women. Over the same time, vehicle incidents have proportionally halved from 32% to 22% in men and 21% to 10% in women.

Figure 6.5 Count of mechanism of trauma by sex over time (n=14,393)



This can be observed as a change in rate with low falls in men now at 22.5 per 100k and in women at 21.9 per 100k (Figure 6.6). The rate of vehicle incidents has stayed the same in both men and women.

Figure 6.6 Crude rate per 100k of major trauma mechanisms for East of England (18+ years) population over time by sex



Age

The main injury mechanism of major trauma changes with age (Figure 6.7). Vehicle incidents are the main cause of injury for patients aged 18 to 44 years, accounting for about half of their major trauma. This age group experiences more blows and stabbing injuries than any other age group, accounting for up to 20% of their injuries. In middle age, vehicle incidents decline to less than a third of their injuries. However, there are proportionally more high falls in middle age (16%) compared to the younger age group (12%). Over the age of 75 years, low falls are the cause of 85% of their major trauma. There is a similar trend for severe trauma, except there are proportionally more low falls in middle age compared to major trauma.

Over time, low falls have proportionally increased across all age groups. The largest increase was observed in persons aged 45–74 years with low falls accounting for half of their major trauma in 2021/22. Vehicle incidents have decreased by about 10% in both younger and middle age groups and were at their lowest proportion in those aged over 45 and 75 years in the COVID-19 pandemic year (2020/21) at 21% and 3%, respectively. Violent injuries from blows and stabbings in those aged 18–44 years have been variable but currently at their lowest at 11%. The elderly experienced the smallest amount of change in their injury mechanisms over time with an already high burden by low falls.

Figure 6.7 Proportion of major trauma by mechanism and age group over time (n=7,563)

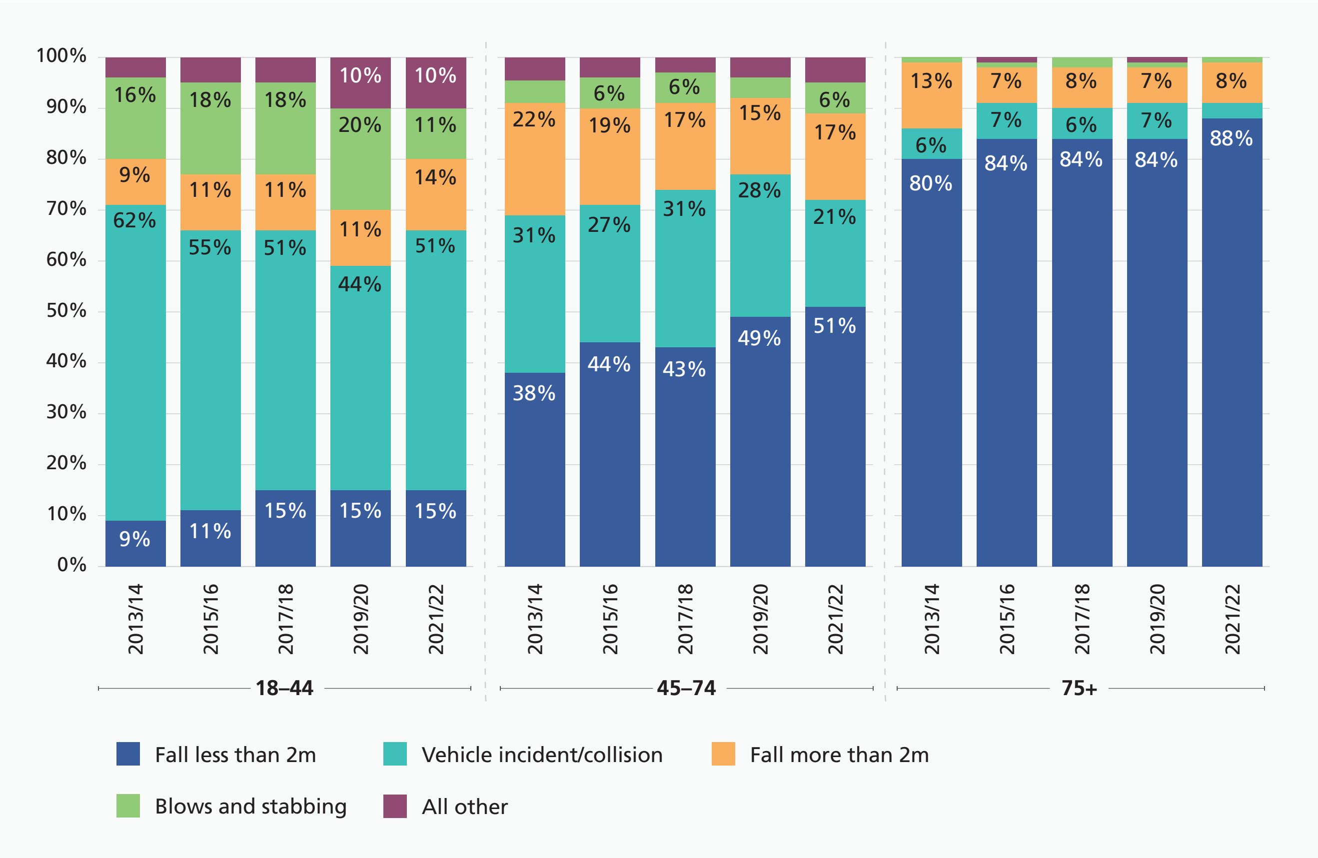


Table 6.1 shows the large difference in the rates of falls less than two meters by age group. All age groups have seen a doubling in the rate of low falls over time since the early years of the East of England Trauma Network. This is a statistically significant change in patients aged 45+ and 75+ years. There may be multiple reasons for this increase such as an increased identification rate in major trauma from low falls, or increased population fragility impacting low fall outcomes.

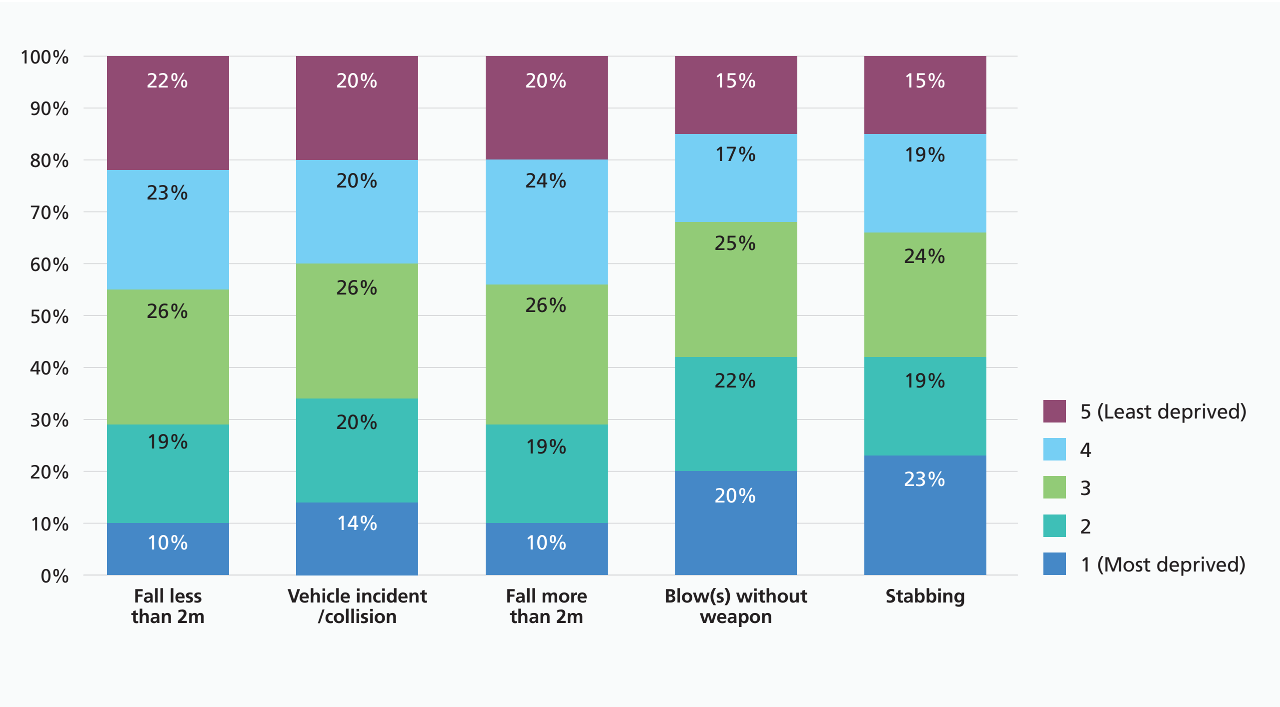
Table 6.1 Crude rate per 100k of East of England population by age group for major trauma falls less than two meters over time.

Falls less than 2 meters	Rate per 100k		
Year	**18–44**	**45–74**	**75+**
2012/13	0.8	7.3	59.6
2013/14	1.2	6.4	64.1
2014/15	1.3	6.9	79.1
2015/16	1.6	10.1	88.8
2016/17	1.8	9.2	89.1
2017/18	2.3	10.4	110.1
2018/19	2.2	10.5	107.7
2019/20	2.1	12.7	126.6
2020/21	1.8	12.6	132.4

Area deprivation

There was a higher proportion of patients from the most deprived quintile in those who suffered injuries by blows or stabbings compared to other mechanisms (Figure 6.8). The proportion of patients in all other quintiles did not greatly differ across injury mechanisms.

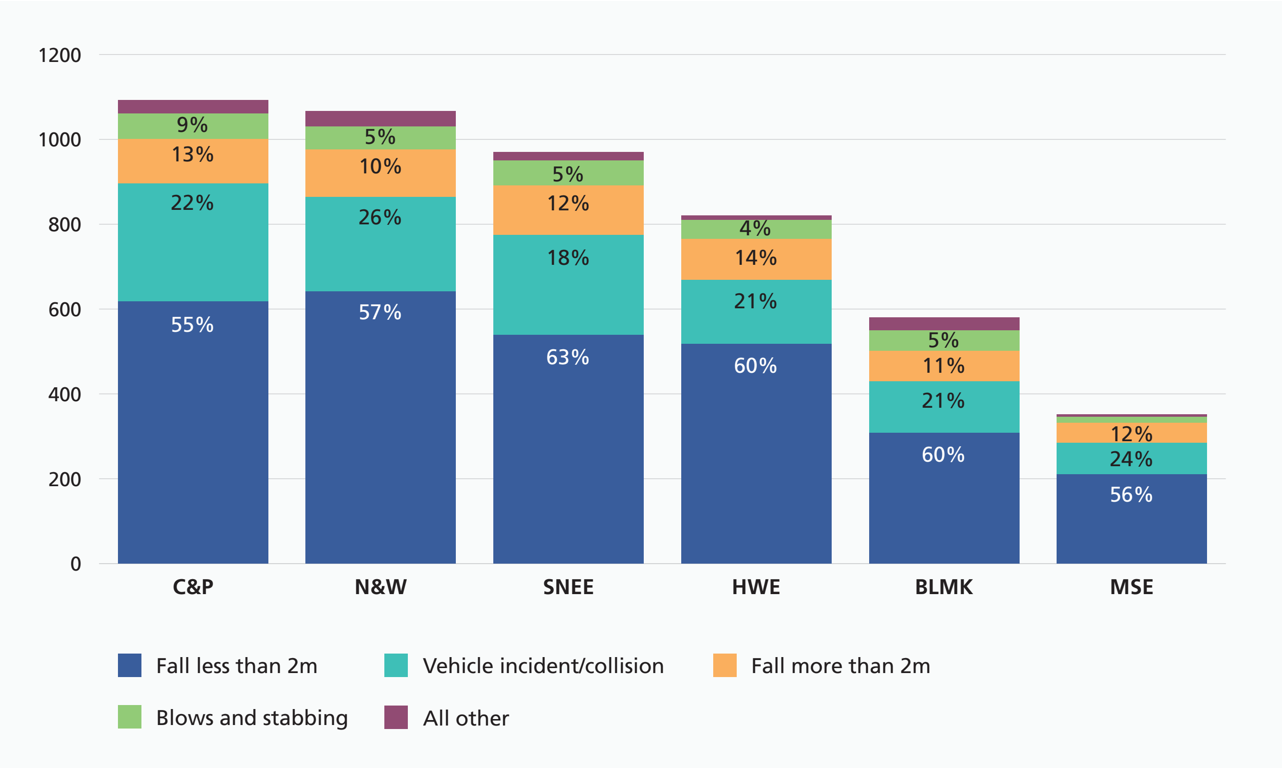
Figure 6.8 Mechanism of injury by patient IMD quintile for major trauma (n=4,753), 2017/18 to 2019/20 pooled



Integrated Care Board (ICB)

Figure 6.9 shows that the proportion of injury mechanisms across ICBs was similar with no more than an 8% difference. The proportion of low falls was highest in residents from SNEE at 63% and lowest in C&P at 55%. Vehicle incidents were highest in residents from N&W at 26% and violent injuries (blows, stabbing, shooting) highest in C&P at 9%.

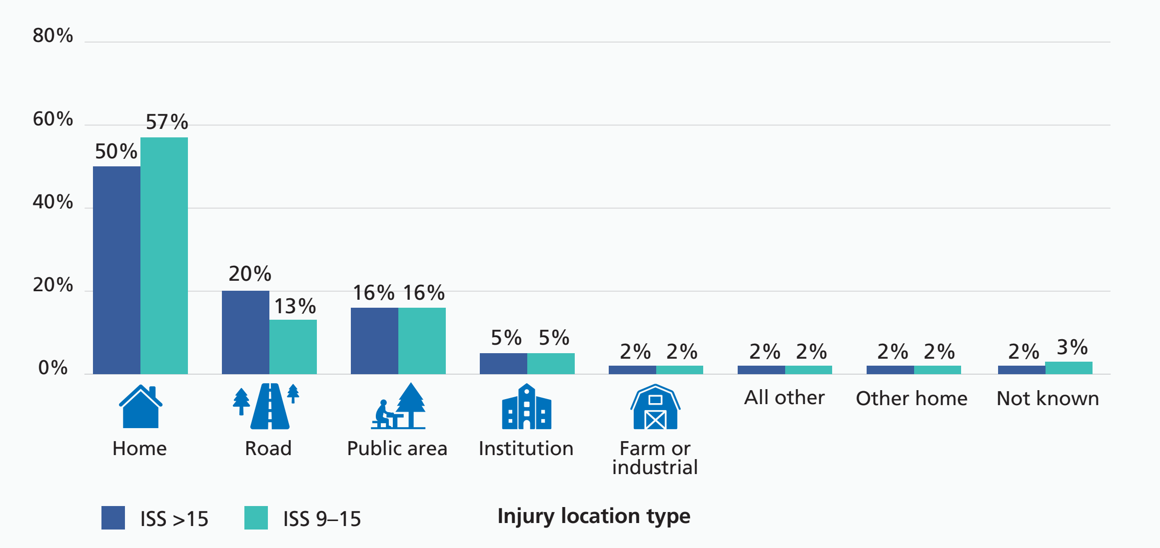
Figure 6.9 Proportion of major trauma injury mechanism by patient residential ICB (n=4,866), 2017/18 to 2019/20 pooled



Place of injury

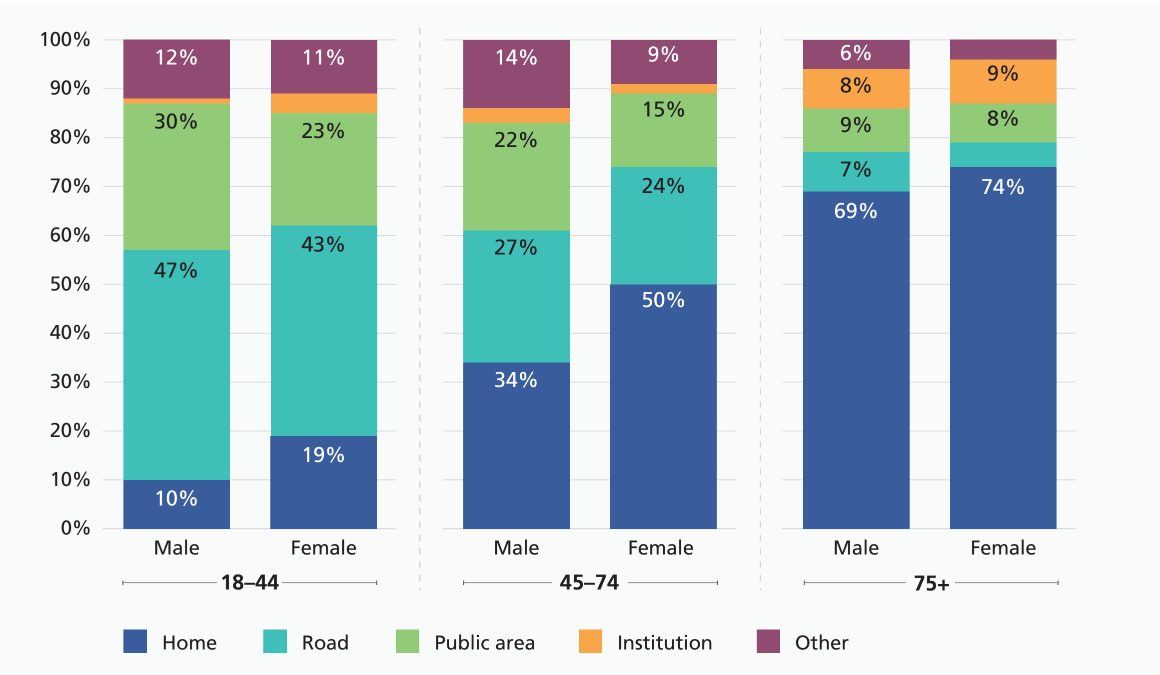
Half of major trauma injuries occurred at home, followed by 20% on a road and 16% in a public area (Figure 6.10). The proportions occurring for severe trauma were higher at home and lower for on a road. Falls below two meters were most likely at home (80%) or at institutions (94%) but half of public area injuries were due to other causes. Almost all vehicle incidents were located on a road (96%).

Figure 6.10 Injury location by place and ISS (n=10,805), 2017/18 to 2019/20 pooled



Men were more likely to have a major trauma on the road or in a public place compared to women (Figure 6.11). Major trauma occurring at home increased with age from 12% in patients aged 18–44 years to 71% in the elderly. Institution based incidents only occurred above 5% in patients aged 75+ years. Major trauma patients residing in more deprived areas were more likely to have an incident in a public area or road. Less deprived patients were more likely to have an injury at home.

Figure 6.11 Injury location for major trauma by sex and age group (n=5,556), 2017/18 to 2019/20 pooled



Injury type

Number of body regions injured

Half of major trauma patients injured two or more regions of their body (Table 6.2). In comparison, 75% of severe trauma patients had just one area injured. Major trauma patients between the ages of 18 and 64 were more likely to have two or more areas injured compared to older age groups.

***Table 6.2** Number of body regions injured by ISS (n=10,805), 2017/18 to 2019/20 pooled*

Number of regions injured	>15		9–15	
	n patients	%	n patients	%
1	2,402	49.3%	4,451	75.1%
2	1,260	25.8%	1,101	18.6%
3	651	13.4%	317	5.3%
4	317	6.5%	53	0.9%
5	165	3.4%	7	0.1%
6	67	1.4%		
7	11	0.2%		
8	3	0.1%		
Total	**4,876**		**5,929**	

Most frequently and most severely injured body regions

Head injuries were the most frequently injured body region for major trauma patients (36% of all injuries), followed by chest (17%) and limb injuries (14%) (Table 6.3). In severe trauma, limb injuries were the most frequently injured region (47%) followed by chest (17%) and spinal injuries (14%).

Head injuries were the most severely injured region for 62% of major trauma patients but only 7% of severe trauma patients. The proportion of head injuries as the most severely injured region in major trauma increases with age from 43% in patients aged 18–44 to 77% in the elderly as the proportion of other all injured areas reduced.

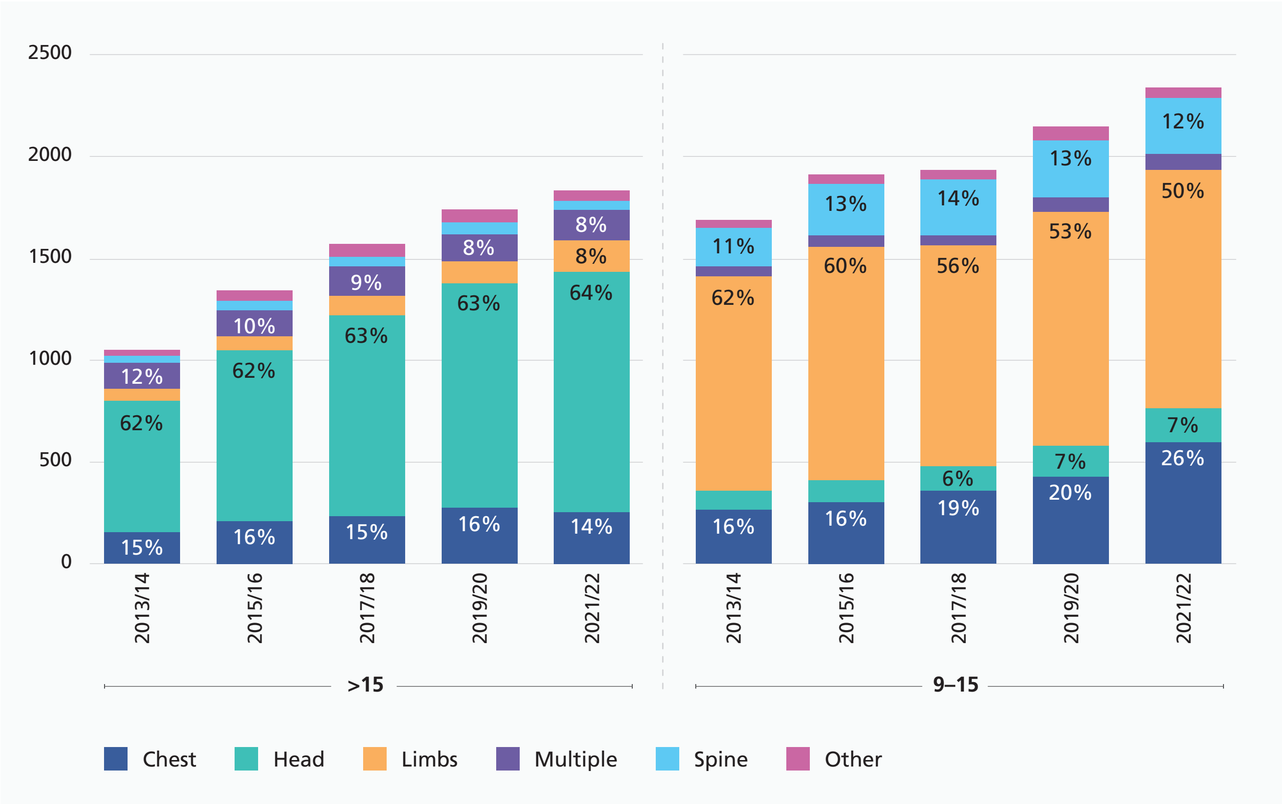
Table 6.3 Total number of injuries and patient proportion of most severely injured body region by ISS, 2017/18 to 2019/20 pooled.*

ISS	>15			9–15		
	n injuries	%	Most severely injured region	n injuries	%	Most severely injured region
Head	3,414	36.1	62.3%	687	8.8	6.8%
Chest	1,608	17.0	15.5%	1,357	17.3	19.8%
Limbs	1,295	13.7	0.3%	3,718	47.4	54.6%
Spine	991	10.5	3.4%	1,131	14.4	13.3%
Face	768	8.1	0%	335	4.3	0.1%
Pelvis	561	5.9	5.8%	234	3.0	0%
Abdomen	470	5.0	1.9%	212	2.7	2.2%
Other	363	3.8	1.7%	177	2.3	0.4%
Total	**9,470**			**7,851**		

*Does not include multiple most severe body regions

The proportion of the most severely injured body region has remained mostly stable over time for major trauma (Figure 6.12). For severe trauma, there has been a proportional reduction in limb injuries from 62% to 50% as chest injuries increased.

Figure 6.12 Most severely injured body region by ISS over time (n=17,612)



Head injuries

The severity of head injuries can be classified by their Abbreviated Injury Scale (AIS) and Glasgow Coma Scale (GCS). For patients with an AIS ≥3, 75% were classified as mild GCS impairment (>12), 10% as moderate impairment (9–12) and 15% as severe impairment (<9). The likelihood of severe GCS impairment reduces with age from 33% in patients aged 18–44 years to 8% in elderly patients (Figure 6.13). Men aged 18–44 years were more prone to head injuries with a GCS of <9 compared to women of the same age group. Figure 6.14 shows that almost a third of vehicle incidents are likely to result in severe GCS impairment. In contrast, only 9% of patients with falls less than two meters resulted in severe impairment.

***Figure 6.13** GCS by age and sex in patients with severe head injury (AIS ≥3) (n=3,067), 2017/18 to 2019/20 pooled*

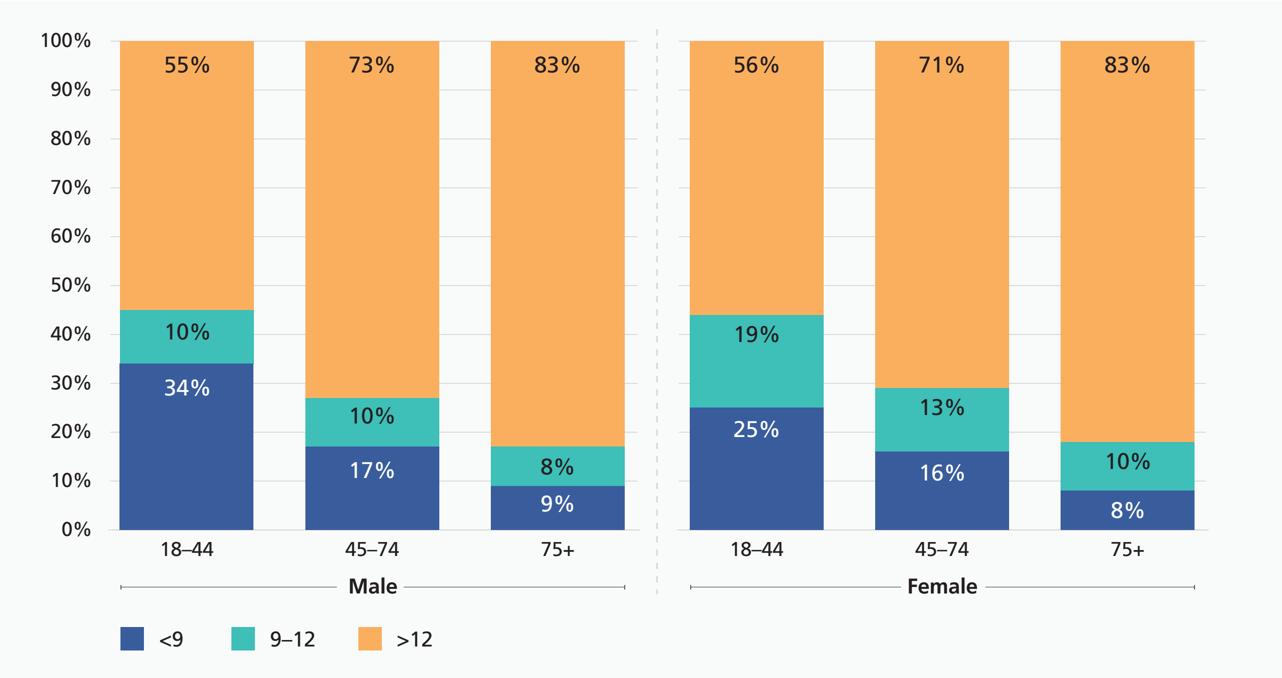
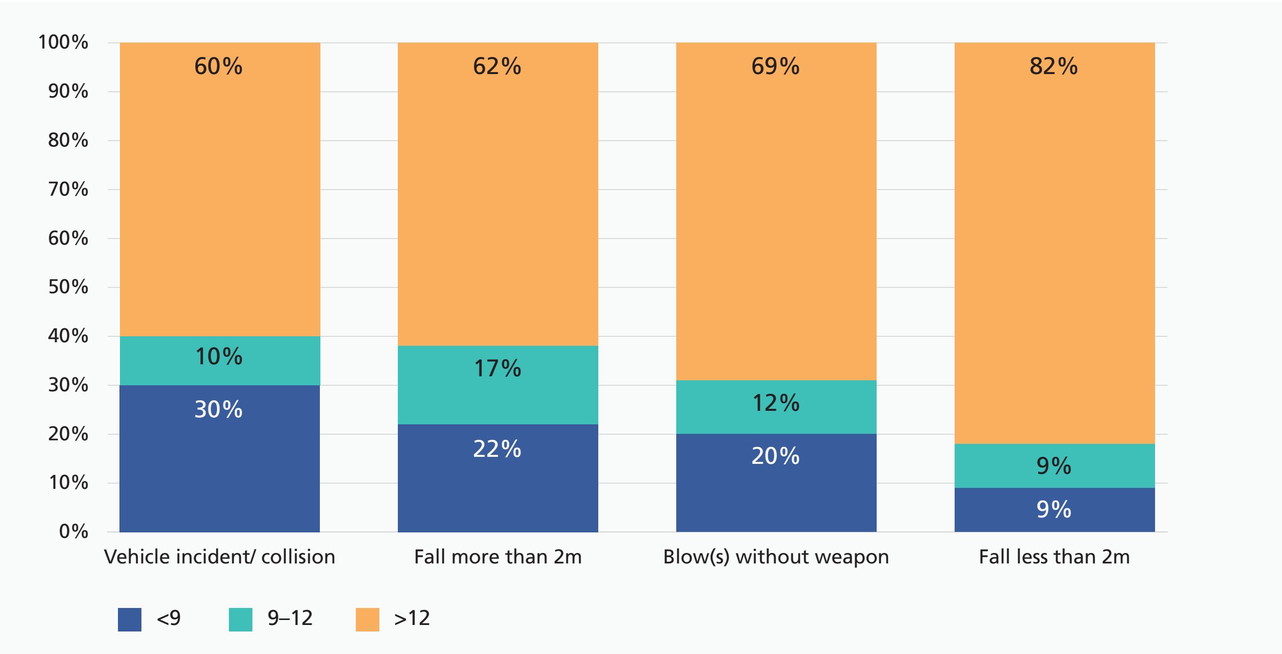
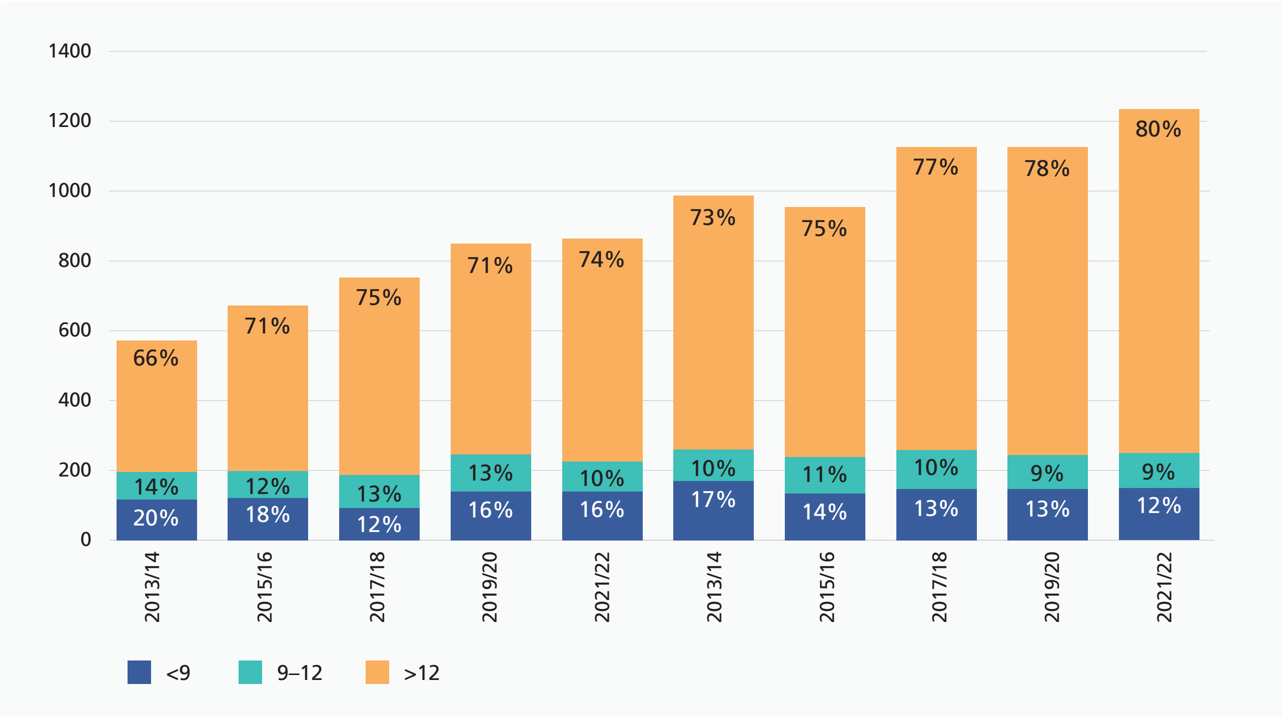


***Figure 6.14** Mechanism of severe head injury (AIS ≥3) by GCS (n=3,034), 2017/18 to 2019/20 pooled*



The increase in major trauma patients over time has resulted in more patients with mild GCS impairment. Therefore, the proportion of patients with a severe or moderate impairment has decreased from 34% in 2013/14 to 21% in 2021/22 (Figure 6.15).

Figure 6.15 Count and proportion of severe head injuries (AIS ≥3) by GCS over time (major trauma) (n=9,127)



7

Hospital catchment areas for East of England major trauma patients

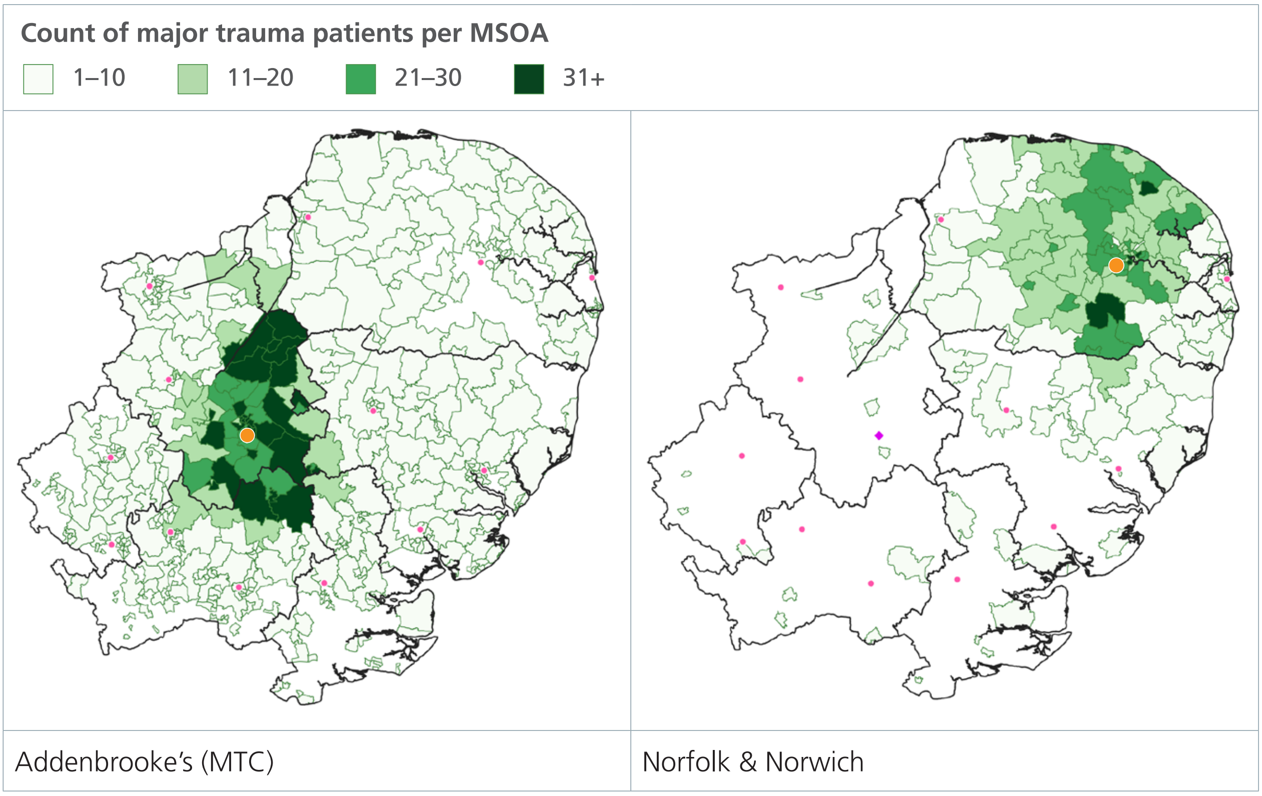
This section shows the patient catchment areas of all trauma hospitals in the East of England. This is shown as the count of major trauma patients that attended each hospital, by their postcode residence, per Middle layer Super Output Area (MSOA). Each MSOA represents about 7,000 to 10,000 people residing in that area. These catchment areas use ten years of TARN submission data from April 2012 to March 2022.

Catchment areas for direct admissions

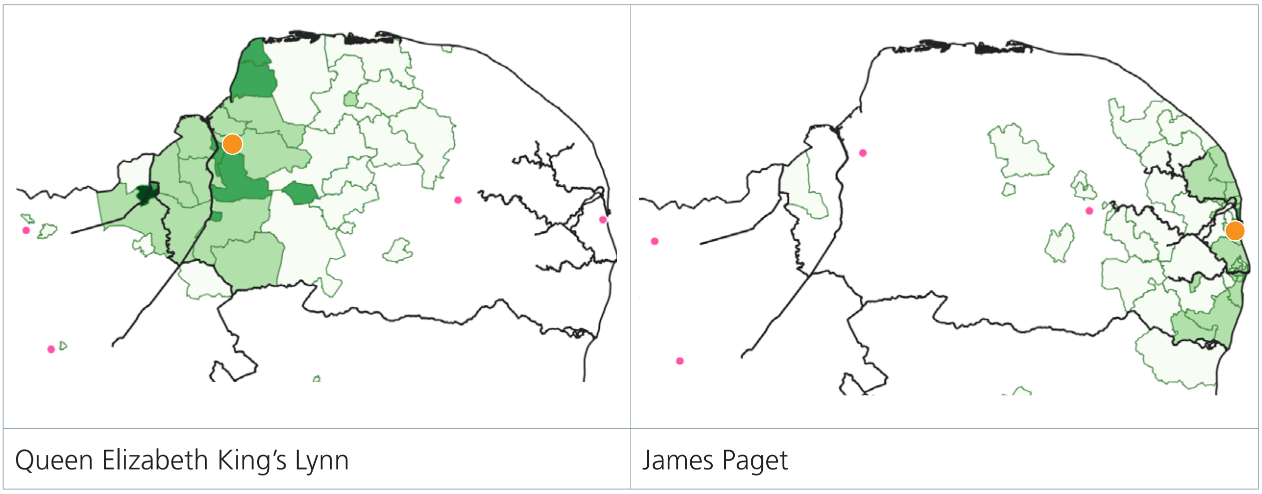
Figure 7.1 shows the catchment areas for direct admissions to hospitals for major trauma. Addenbrooke's Hospital, the Major Trauma Centre, shows a core catchment area across East and South Cambridgeshire as well as north Uttlesford and into Fenland. Small counts of major trauma patients are admitted to Addenbrooke's Hospital from across the whole East region. The exception is near the London Trauma Networks to the south and some areas in South Norfolk and East Suffolk from where no patients were admitted.

Norfolk and Norwich Hospital covers North and South Norfolk, Breckland and Broadland but has received patients across wider Norfolk and into Mid and East Suffolk.

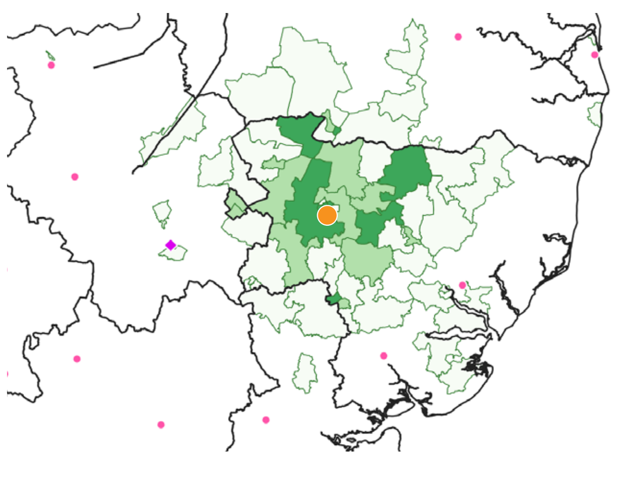
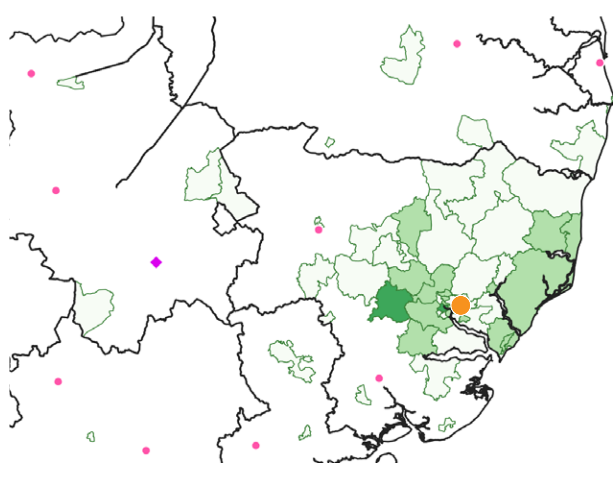
Figure 7.1 *Count of major trauma patients by MSOA area for each attended trauma hospital (2012/13–2021/22) – Direct admissions.*



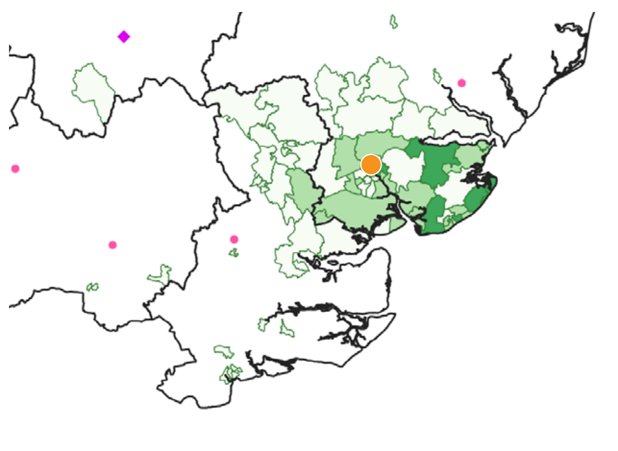
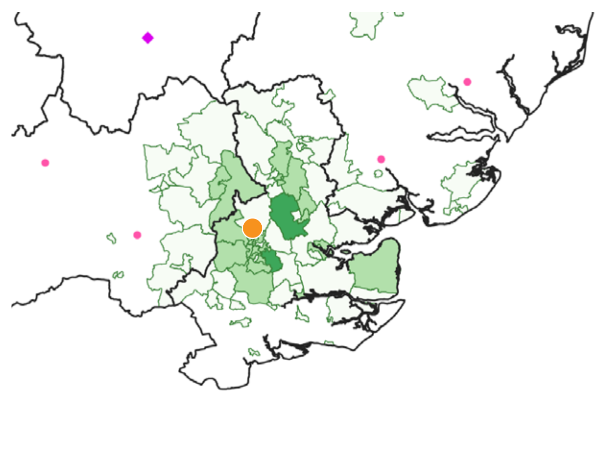
James Paget Hospital supports the east Norfolk and Suffolk coast whilst Queen Elizabeth Hospital supports West Norfolk and into Fenland, with high counts coming from Wisbech.



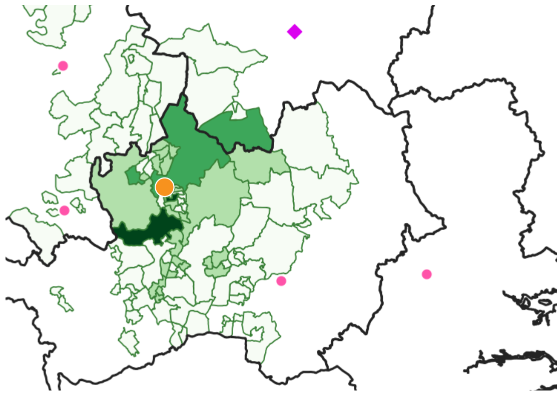
West Suffolk Hospital supports the West and Mid Suffolk areas and into Babergh. It also has a wider catchment area of low-level counts coming in from across East Cambridgeshire, Broadland, and North Essex. Ipswich Hospital supports the East Suffolk coast and parts of Babergh and Mid Suffolk.

	
West Suffolk	Ipswich

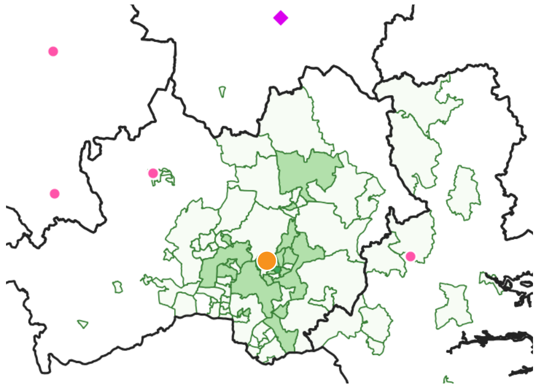
Colchester Hospital predominantly supports Colchester and Tendring areas with smaller counts also coming from Braintree. Broomfield Hospital covers the mid parts of Essex including Chelmsford, Maldon, and the southern areas of Braintree and Uttlesford.

	
Colchester	Broomfield

Hertfordshire is supported by the Lister Hospital in the north of the county. This includes Stevenage and parts of East Hertfordshire. Princess Alexandra Hospital supports West Essex including Harlow, Epping Forest and into Uttlesford but also small counts from East Hertfordshire.

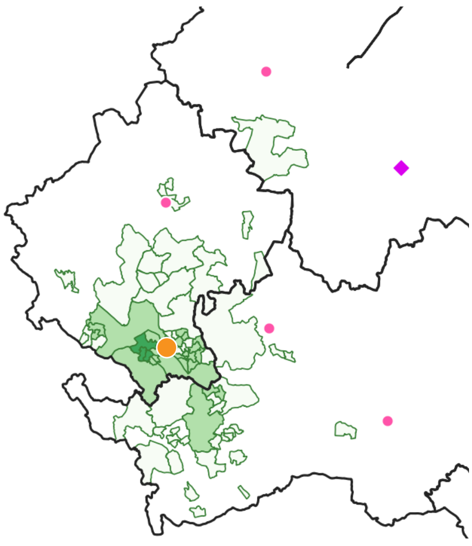


Lister

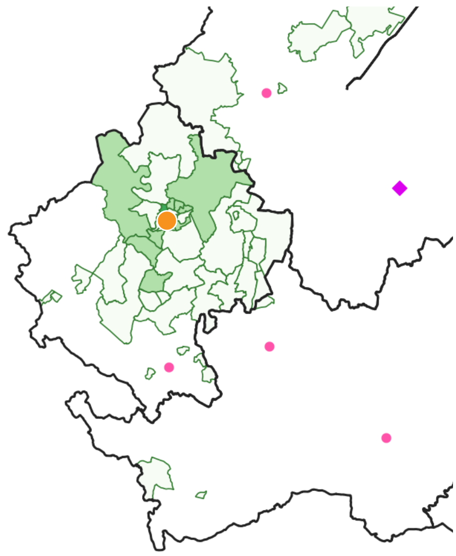


Princess Alexandra

Bedford Hospital supports the wider Bedford Borough with small counts admitted from across most of Bedfordshire. Luton and Dunstable Hospital supports the south of Bedfordshire, Luton and into St Albans with small counts admitted from the wider East Hertfordshire region.

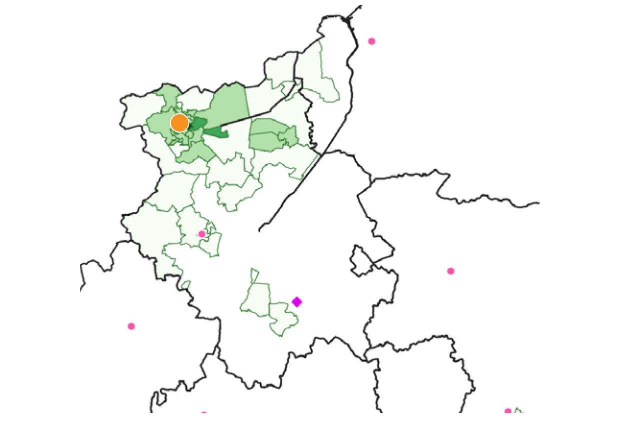
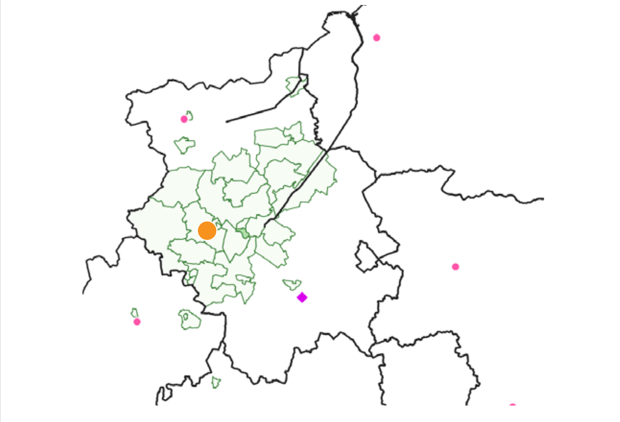


Luton & Dunstable



Bedford

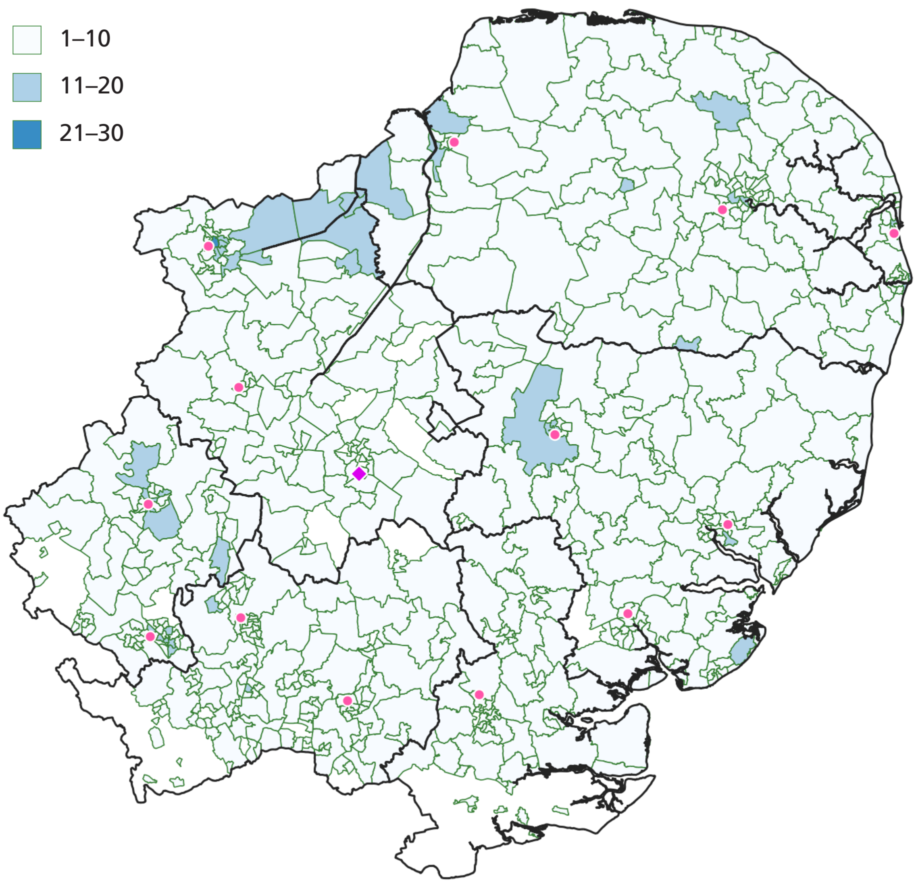
Peterborough City Hospital supports its local population and Fenland with small counts admitted from the north of Huntingdonshire. Hinchingbrooke Hospital covers the wider Huntingdonshire area and south of Fenland but has low counts per MSOA overall.

	
Peterborough City	Hinchingbrooke

Transfers to the Major Trauma Centre

Figure 7.2 shows the count of East of England residents with major trauma who were transferred to Addenbrooke's Hospital. Transfers came from all over the East of England region except in the south where patients may be using neighbouring London Trauma Network services. There were pockets of higher counts around Peterborough, Fenland, Luton, Bedford, West Suffolk, and parts of Norfolk.

Figure 7.2 *Count of major trauma transfers in to Addenbrooke's Hospital based on the number of major trauma patients per MSOA.*



8
Highlighted findings for Part One

East of England population

- The population of the East of England has grown by 8% since the 2011 census. It is estimated that the largest growth in the next ten years will be for persons aged over 75 years at a growth of 26%.

Patient characteristics

- The count of major trauma patients has almost doubled in the past decade since 2012/13 with major trauma accounting for a third of all trauma patients. The crude rate has increased from 21 in 2012 to 35 incidents per 100k persons in 2020.
- Men are more likely to have a major trauma under the age of 75 compared to women. There is no difference in the likelihood of major trauma by sex in those over 75 years.
- The largest increase in major trauma counts was seen in patients aged over 75 years. By ICB, the largest increase in counts was observed for patients from Cambridgeshire and Peterborough.
- It is forecast that trauma patients for all ISS will increase by a third between 2020 and 2026.

Major trauma injuries

- Falls less than two meters are the main cause of major trauma in both men and women over 45 years of age. Vehicle incidents are the main cause in persons aged 18 to 44 years.
- The rate of low falls per 100k persons has doubled over time whilst other causes have stayed at a similar rate.
- The highest rate of low falls is in persons aged over 75 years. The largest increase in low fall rates over time was observed in patients aged 45–74 years.
- Injuries by stabbing and blows are more common in patients from the most deprived areas and in persons aged 18–44 years.

- Half of all major trauma injuries occur at home, followed by on the road and in a public area. The likelihood of having a major trauma at home increases with age.
- Half of major trauma patients had at least two body regions injured, and a quarter had three or more. The number of body regions injured decreases with age.
- Head injuries are more likely to be the most severely injured region for major trauma patients and the likelihood of this increases with age.
- Severe head injuries with a Glasgow Coma Scale of less than nine are more likely to be in younger adults and caused by vehicle incidents or high falls.

PART TWO

Service use

Service use reviews where and how trauma patients are admitted to East of England trauma hospitals, including patients who reside outside of the region. This covers trauma patients admitted by secondary transfers and their transport mode. It then focuses on the services received whilst under the care of the trauma hospital and the resulting patient outcomes. This part ends with a review of the equity of trauma services considering the needs of vulnerable populations by whether they have access to services provided by the Major Trauma Centre.

9

Patients admitted to East of England trauma hospitals

This section reviews the count and characteristics of major trauma patients admitted directly to the Major Trauma Centre (MTC) or Trauma Units (TUs). A direct admission in this section refers to no movement to other hospitals whether part of the trauma network or outside the region before discharge and therefore care is entirely received in one hospital.

Direct admissions to the MTC or a TU

For major trauma in 2017/18 to 2019/20, 24% of patients were admitted directly to the MTC for treatment (n=1,268). Patients admitted directly to a Trauma Unit and never transferred to the MTC accounted for 55% of major trauma patients (n=2,942). Of those directly admitted to either the MTC or a TU, 324 patients were involved in transfers out to further hospitals. These patients are treated as a separate group and not included in the following description of directly admitted patients (n=3,886).

Addenbrooke's Hospital (MTC) had the largest patient count of direct admissions of all hospital sites (Figure 9.1). This was over twice the count of the largest Trauma Unit site at Norfolk and Norwich Hospital. Demand at Trauma Units varies – seven Trauma Units had admission counts above 200 patients for the analysis period.

Figure 9.1 Count of direct admissions for major trauma by site, (n=3,886), 2017/18 to 2019/20 pooled

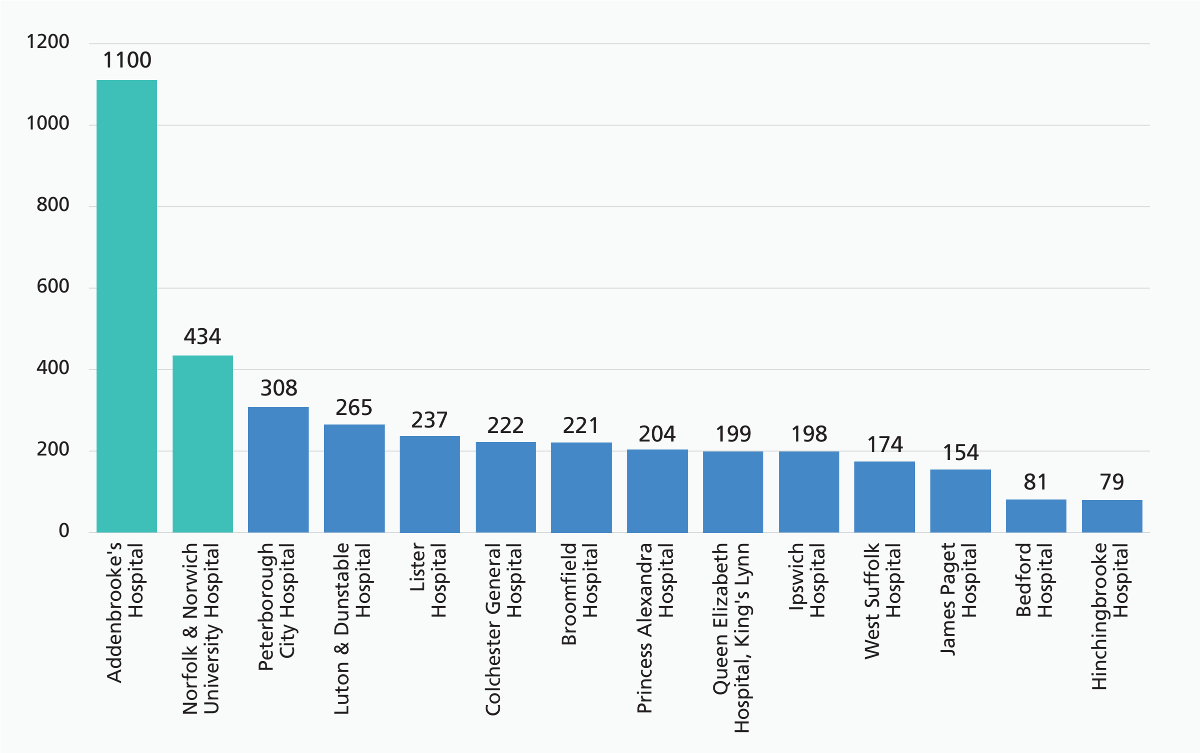
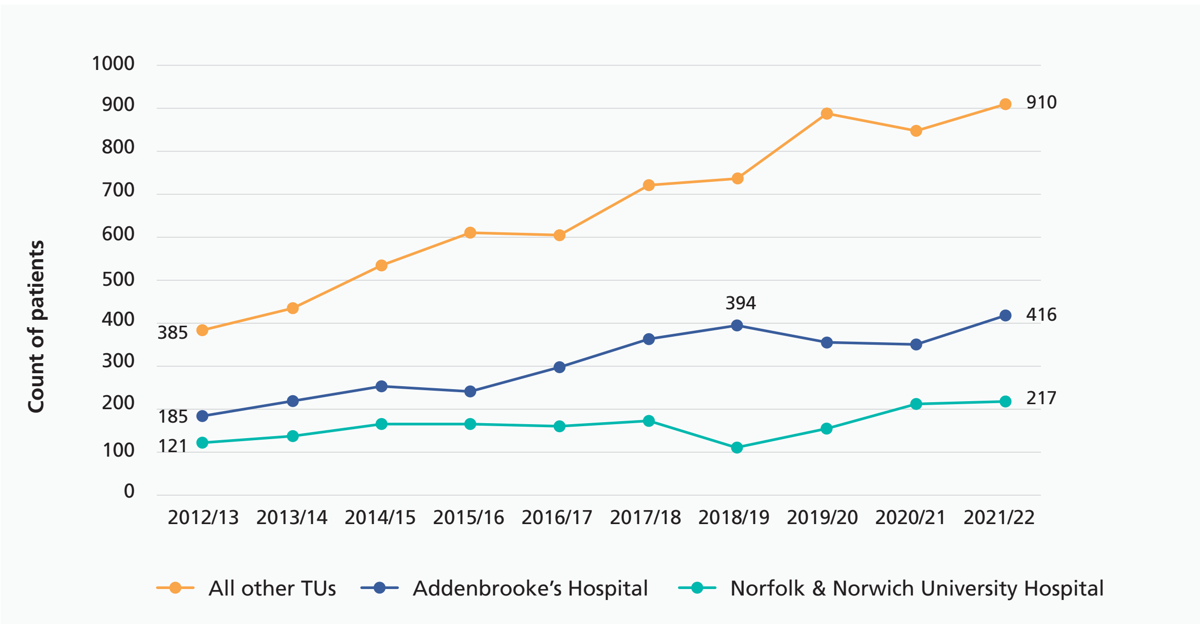


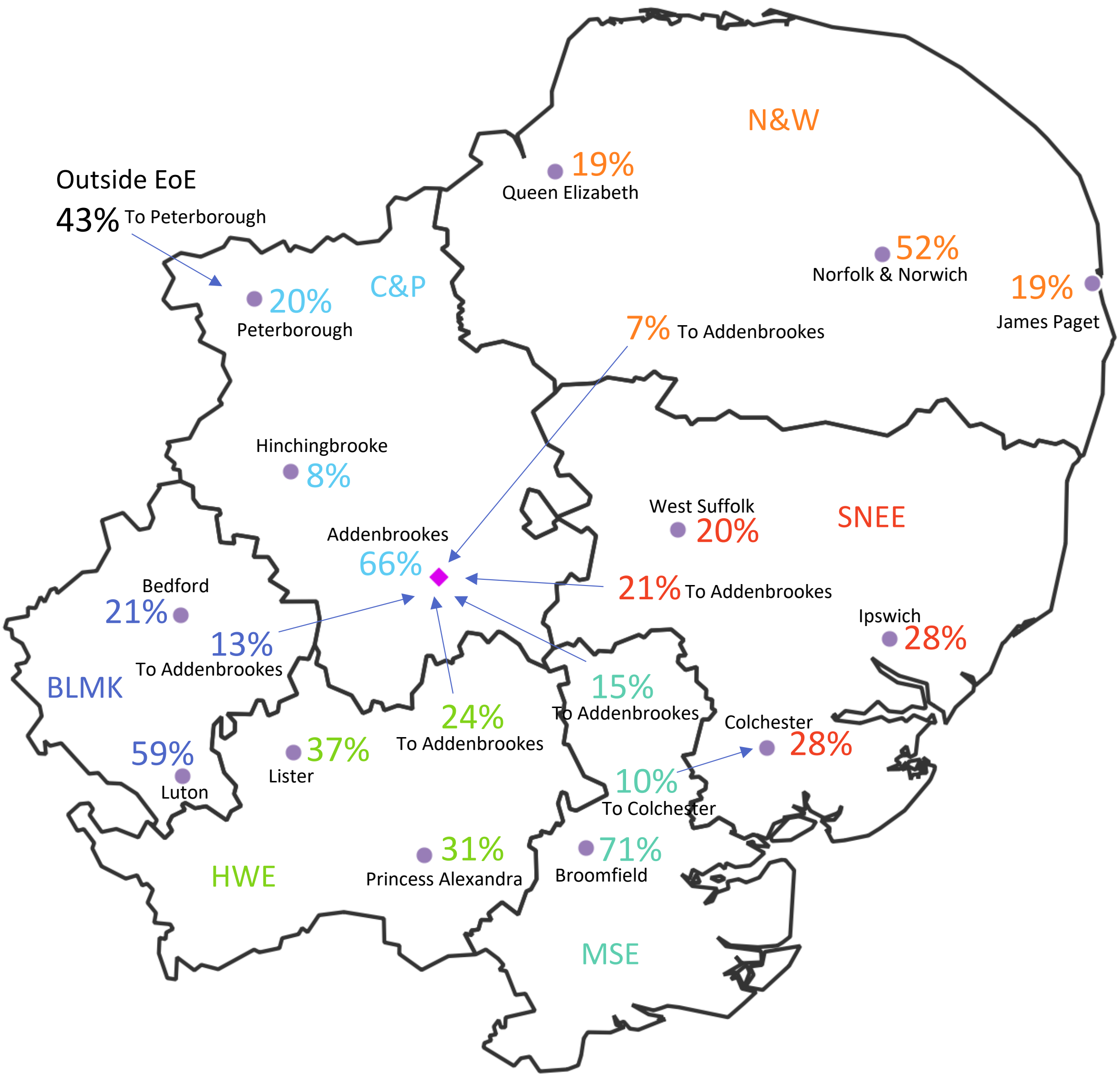
Figure 9.2 shows that the count of direct admissions has more than doubled for Addenbrooke's (x2.2) and other TUs (x2.4), comparing counts in 2021/22 to 2012/13. The growth in patients attending Addenbrooke's slowed from 2018. Growth has also slowed at Colchester, Ipswich, and Queen Elizabeth hospitals over time. Norfolk and Norwich Hospital has shown more steady growth over the last ten years (x1.2). Steady growth was also observed for Broomfield, West Suffolk, Princess Alexandra, Luton and Dunstable, and Lister hospitals.

Figure 9.2 Count of direct admissions for major trauma by site over time. (n=11,325)



Direct admissions to Addenbrooke's Hospital were most likely from patients residing in Cambridgeshire and Peterborough (C&P) ICB at 66% of their admissions (Figure 9.3). Direct admissions to Addenbrooke's were lowest from Norfolk and Waveney (N&W) at just 7% of their directly admitted patients. Broomfield, Luton and Dunstable, and Norfolk and Norwich hospitals manage most of the patients from their respective ICBs. Admissions are more evenly divided between hospitals in Suffolk and Northeast Essex (SNEE) and Hertfordshire and West Essex (HWE). Mid and South Essex (MSE) is the only ICB to send a sizeable proportion of its patients directly to a hospital in a neighbouring ICB (10% to Colchester Hospital).

Figure 9.3 *Map illustrating the proportion of major trauma patients directly admitted to hospitals by their ICB residence including direct admissions to MTC (<=5% not shown). Purple dots indicate trauma hospital location.*



Patient characteristics of direct admissions

The largest age group directly admitted across all Trauma Units were adults aged 75+ years (Figure 9.4). For Trauma Units, this proportion ranged from 54% at West Suffolk to 76% at Hinchingbrooke Hospital. The Trauma Unit with the largest proportion of direct admissions by people aged 18–44 years was at Queen Elizabeth Hospital with a range of 7% to 16% by all other Trauma Units. Admissions for patients in the age group 45–74 years, ranged from 15% at Hinchingbrooke to 36% at West Suffolk Hospital. The MTC does not follow these trends, directly admitting an equal proportion of middle-aged and elderly patients.

Figure 9.4 Proportion of major trauma direct admissions to sites by age group (n=3,886), 2017/18 to 2019/20 pooled

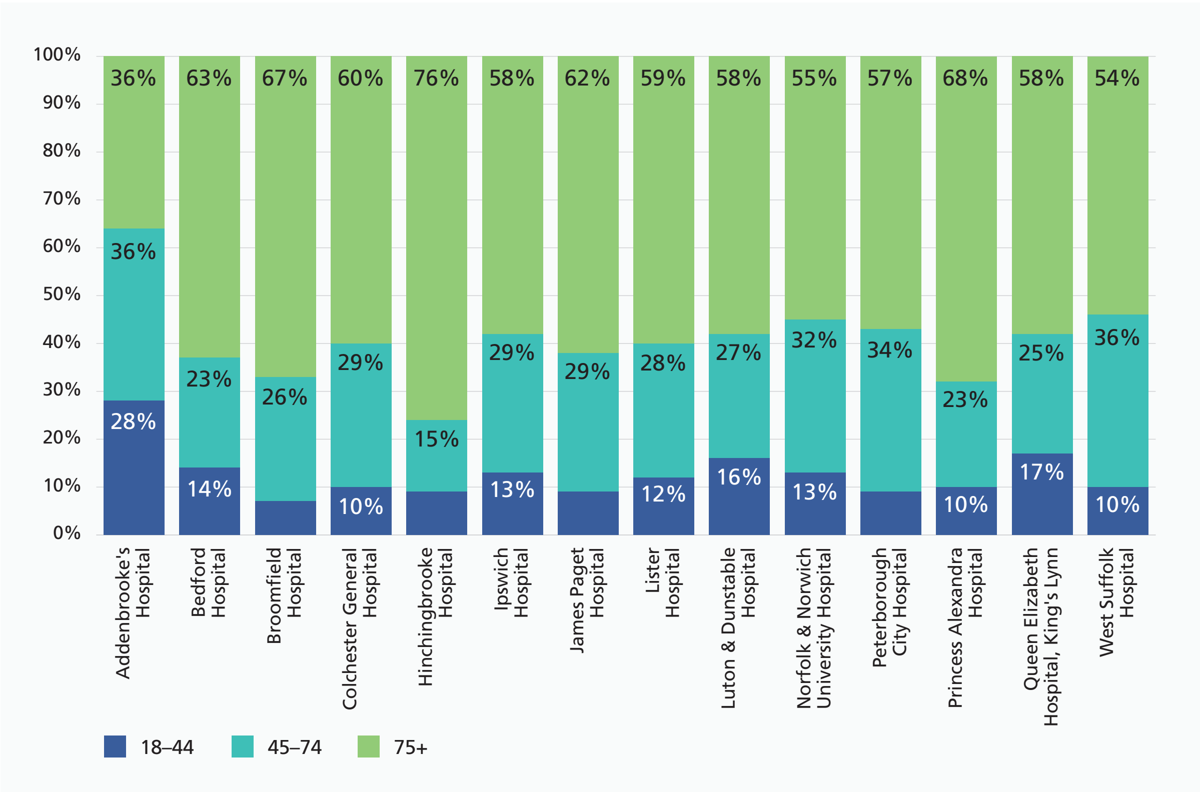


Figure 9.5 shows that nearly a third of patients with direct admissions to James Paget Hospital were from the most deprived quintile (Core20). Addenbrooke's (MTC) has one of the lowest proportions of direct admissions from deprived patients at just 5%. Norfolk and Norwich Hospital also has a low proportion of deprived patients even though Norwich is one of the most deprived areas in the region.

Figure 9.5 Proportion of major trauma direct admissions to sites from patients with a residential Index of Multiple Deprivation (IMD) score in the 20% most deprived areas. (n=383), 2017/18 to 2019/20 pooled

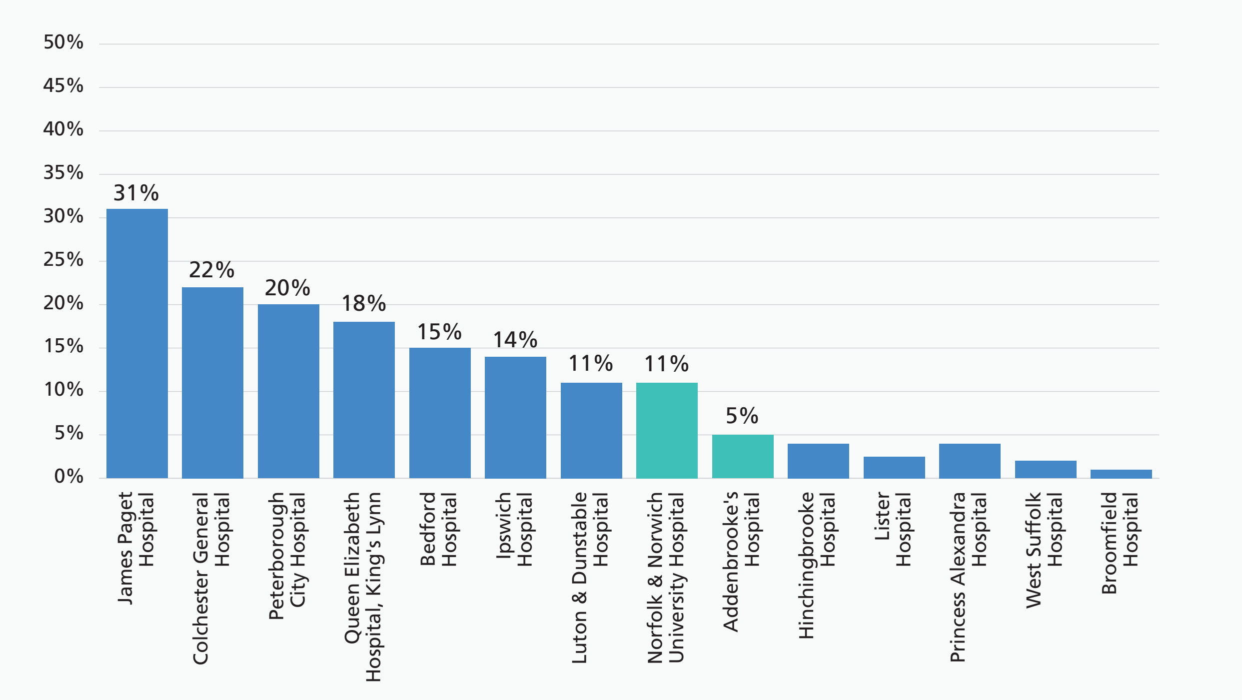
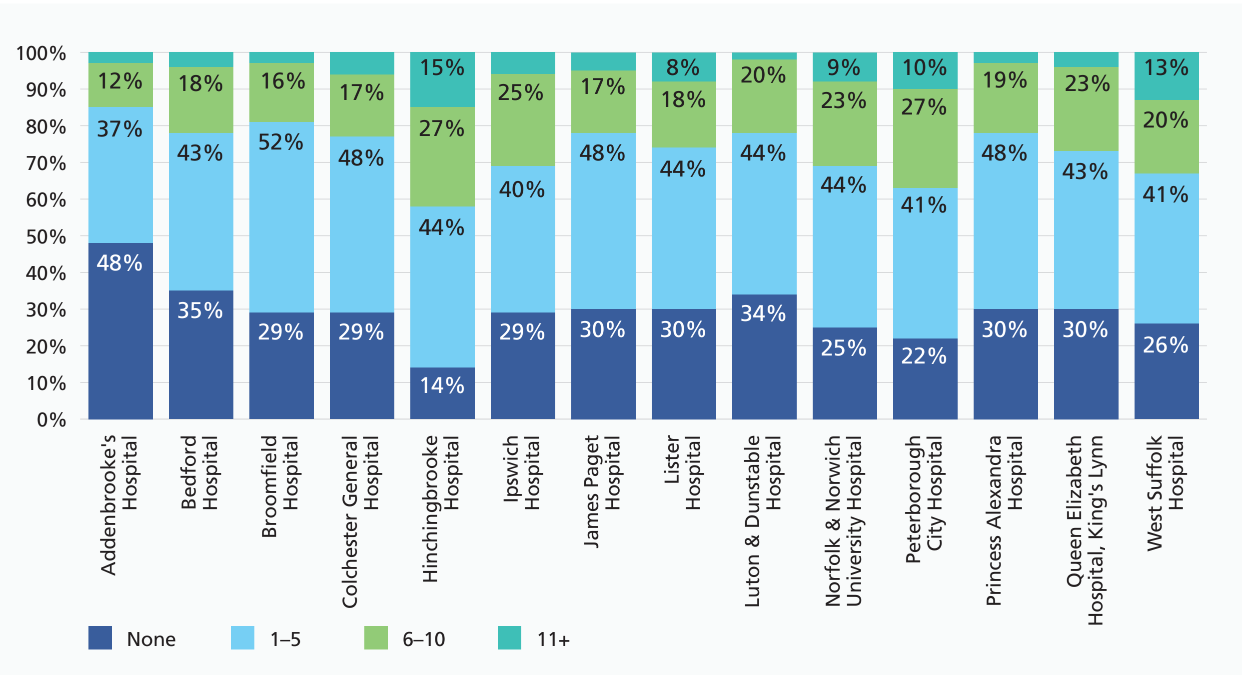


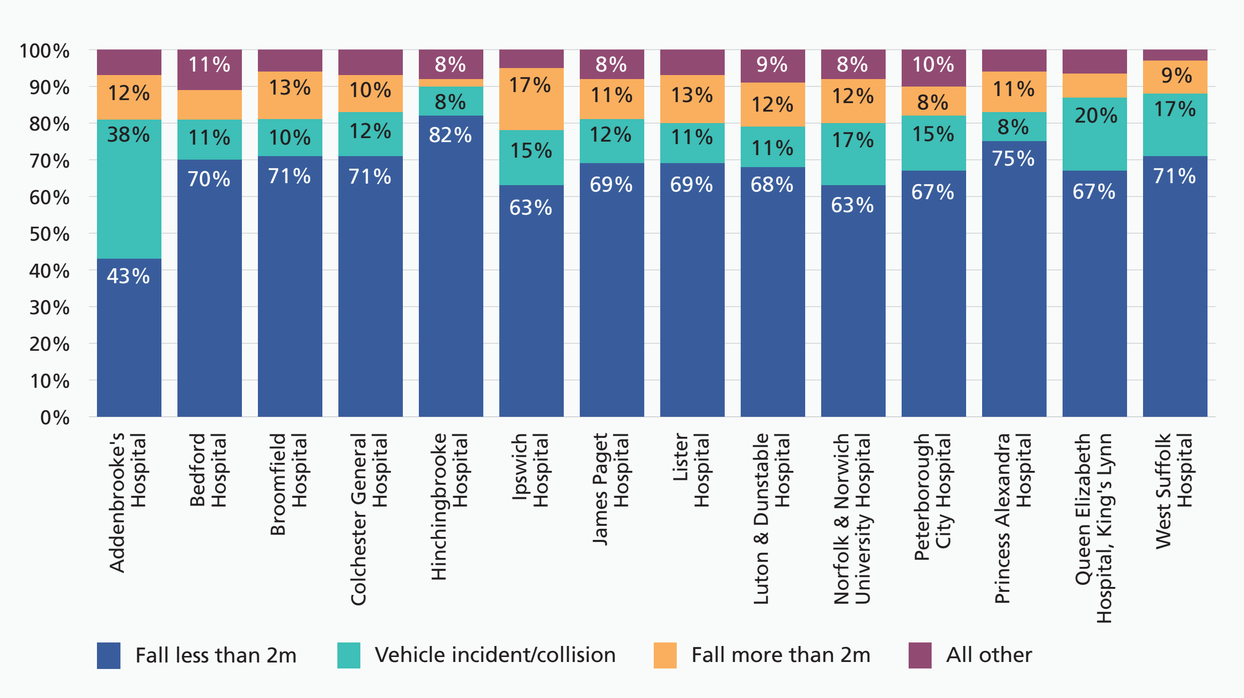
Figure 9.6 shows that the Charlson Comorbidity Index (CCI) of patients varies by hospital site admitted. Patients admitted to Addenbrooke's Hospital, followed by Bedford Hospital, are the least likely to have a pre-existing medical condition. Patients admitted to Hinchingbrooke Hospital, followed by Peterborough City Hospital are more likely to have a positive CCI score. Hinchingbrooke Hospital is also the most likely to have the highest proportion of patients with severe comorbidities with a score above 10, followed by West Suffolk Hospital.

Figure 9.6 Proportion of major trauma direct admissions by Charlson Comorbidity Index (CCI) (n=3,770), 2017/18 to 2019/20 pooled



Falls less than two meters were the largest cause of major trauma admissions across all sites (Figure 9.7). Hinchingbrooke Hospital had the largest admittance due to this cause at 82% of its direct admissions. For Trauma Units, vehicle incidents ranged from 8% at Hinchingbrooke to 20% at Queen Elizabeth Hospital. The proportion of falls greater than two meters was highest at Ipswich Hospital at 17%. Bedford and Peterborough hospitals had the highest proportion of 'other' mechanisms. The MTC had the lowest admissions for low falls at 43% but the highest proportion of vehicle incidents at 38% of admissions. This was at least double the proportion of vehicle incidents admitted at most Trauma Units.

Figure 9.7 *Proportion of major trauma direct admissions to sites by mechanism of injury (n=3,886), 2017/18 to 2019/20 pooled*



10 Transfers between hospital sites within the East of England Trauma Network

This section considers the quantity and characteristics of movement between hospitals, particularly between Trauma Units and the MTC. Transfer in or transfer out refers to the movement to another acute hospital, usually with a Trauma Unit. However, this can include specialised hospitals or hospitals outside of the East of England region. Admission data related to patients from our region treated in out of region hospitals are not in scope.

Major trauma hospital transfers

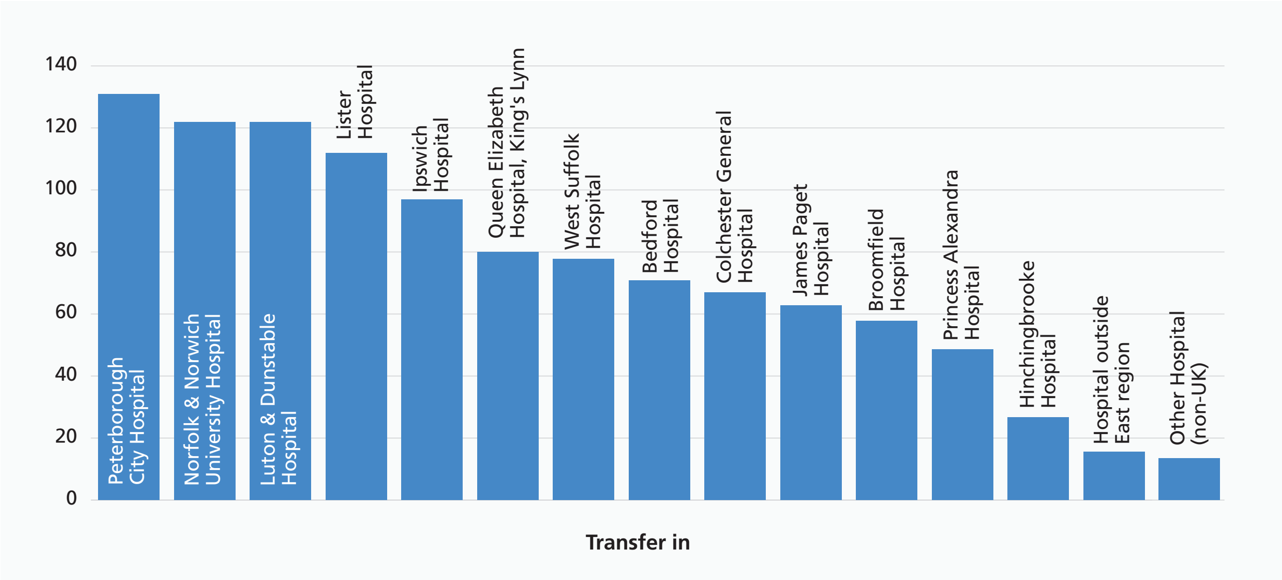
About 21% of major trauma patients are initially admitted to a Trauma Unit before being transferred to the MTC (n=1,125). A third of these transferred patients involve both a transfer in to the MTC and a transfer out (repatriation) to the initial Trauma Unit. This section includes the small number of patients that are transferred out from the MTC to another hospital (n=157). These transfers out involve trauma, out of region and non-trauma hospitals. Norfolk and Norwich and Royal Papworth hospitals received 11% each of transfers out from the MTC.

A small number of transfers occurred between Trauma Units and other hospitals that never involved the MTC (n=165). Queen's Hospital Romford, in Essex, which has a neurosurgical unit, was the receiving hospital for 37% of transfers out for these patients. Colchester (25%) and Princess Alexandra (20%) were the hospitals most likely to transfer patients out. These patients are not included in the next section on transfers involving the MTC.

Transfers to and from the Major Trauma Centre – Addenbrooke's Hospital

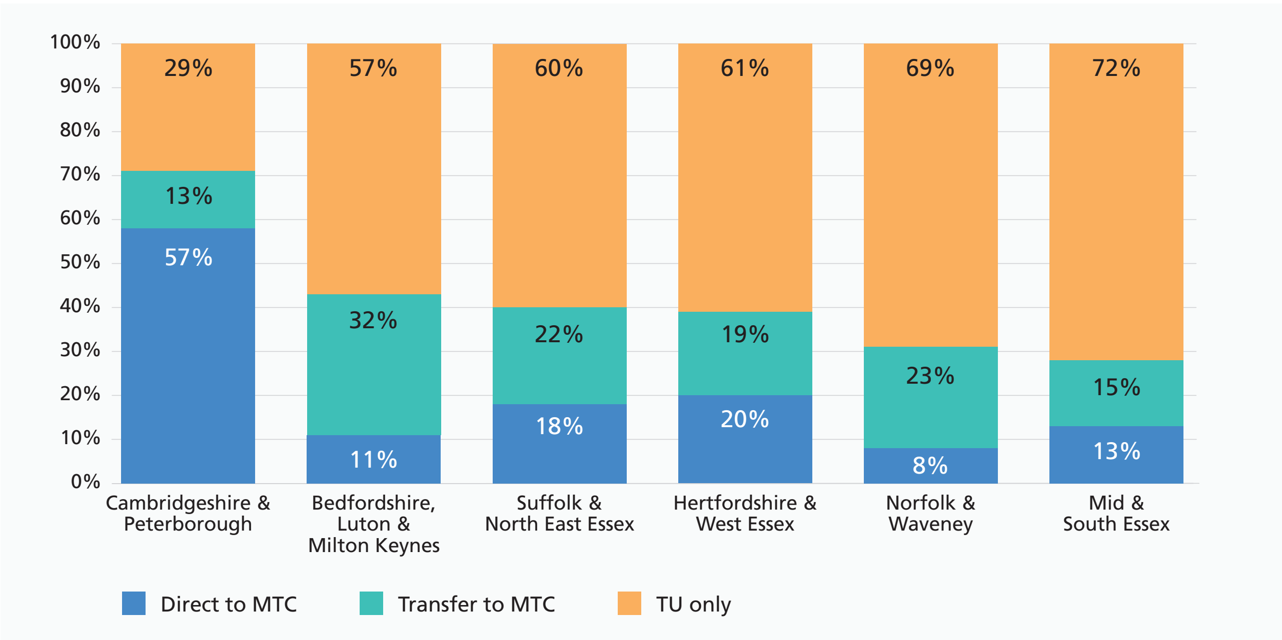
The five largest counts of transfers into Addenbrooke's Hospital came from Peterborough City, Norfolk and Norwich, Luton and Dunstable, and the Lister hospitals (Figure 10.1).

Figure 10.1 *Count of major trauma transfers in to Addenbrooke's by previous hospital (n=1,107), 2017/18 to 2019/20 pooled*



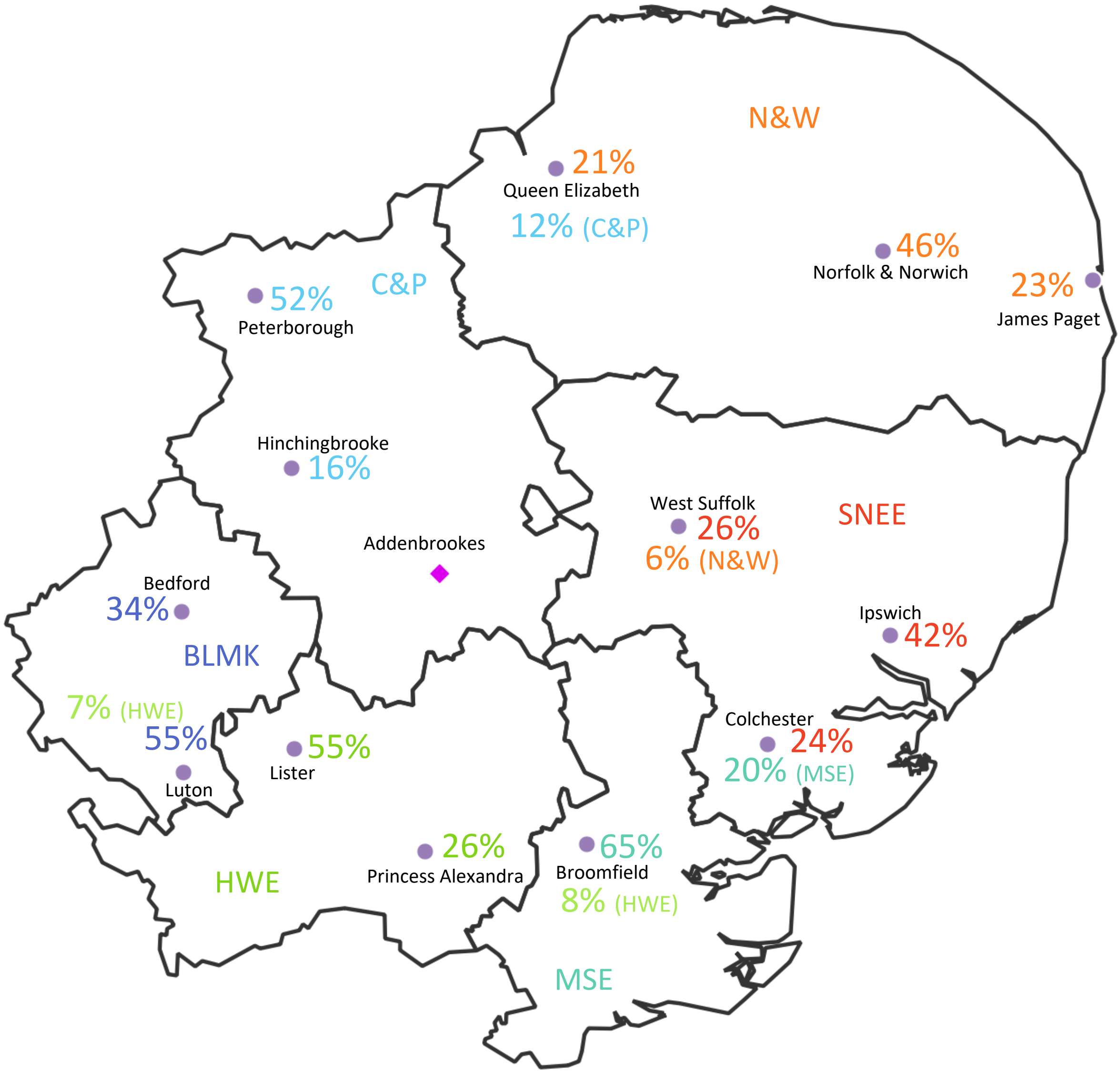
By ICB, BLMK has the largest proportion of transfers into the MTC at 32% of its major trauma patients (Figure 10.2). BLMK has the second highest proportion of patients being treated at the MTC after C&P. MSE patients are the least likely to be treated by the MTC with 72% of patients remaining in its Trauma Units.

Figure 10.2 *Proportion of major trauma movement to the MTC or remaining TU by residential ICB (n=4,865), 2017/18 to 2019/20 pooled. Note that in this chart, patients with transfers out of the MTC are included under Direct to MTC. Transfers between Trauma Units are included as TU only.*



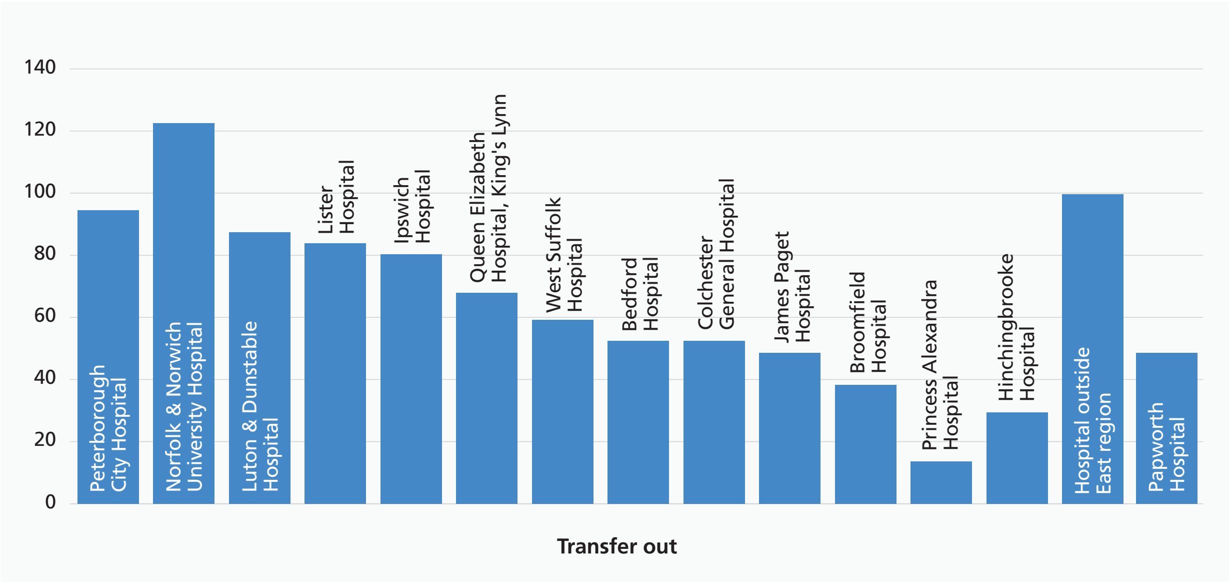
The map in Figure 10.3 shows the ICB residence of transfer patients to Addenbrooke's Hospital by their initial hospital. For example, 26% of SNEE patients and 6% of N&W patients attended West Suffolk Hospital before transferring to the MTC. The Trauma Unit to which a patient is admitted may not be located in their ICB of residence. Colchester Hospital was attended by 20% of patients residing in MSE before being transferred to Addenbrooke's Hospital.

Figure 10.3 Map of proportion of major trauma transfers in to Addenbrooke's Hospital from initial admitted Trauma Unit by patient residential ICB <=5% not shown.



For transfers out of Addenbrooke's Hospital, the volume of counts was lower, and the ranking of hospitals by count was similar to transfers into the MTC. The exception was Peterborough Hospital where the count of transfers out was lower (Figure 10.4). Of note is the high count of transfers out to Royal Papworth Hospital, out of region hospitals and the low count of transfers out to Princess Alexandra Hospital.

Figure 10.4 Count of major trauma transfers out from Addenbrooke's Hospital to the next hospital (n=561), 2017/18 to 2019/20 pooled



Patient characteristics of transfer types involving the MTC

Middle-aged patients comprise the largest proportion of transfers in to the MTC. Transfers in and subsequent transfer out are more likely to be by elderly patients. This age group has the lowest proportion of single transfers in or a single transfer out. Transfers in have a higher proportion of adults aged 18–44 years compared to direct admissions.

Figure 10.5 Proportion of major trauma patients by transfer type to Addenbrooke's Hospital by age group (n=2,376), 2017/18 to 2019/20 pooled

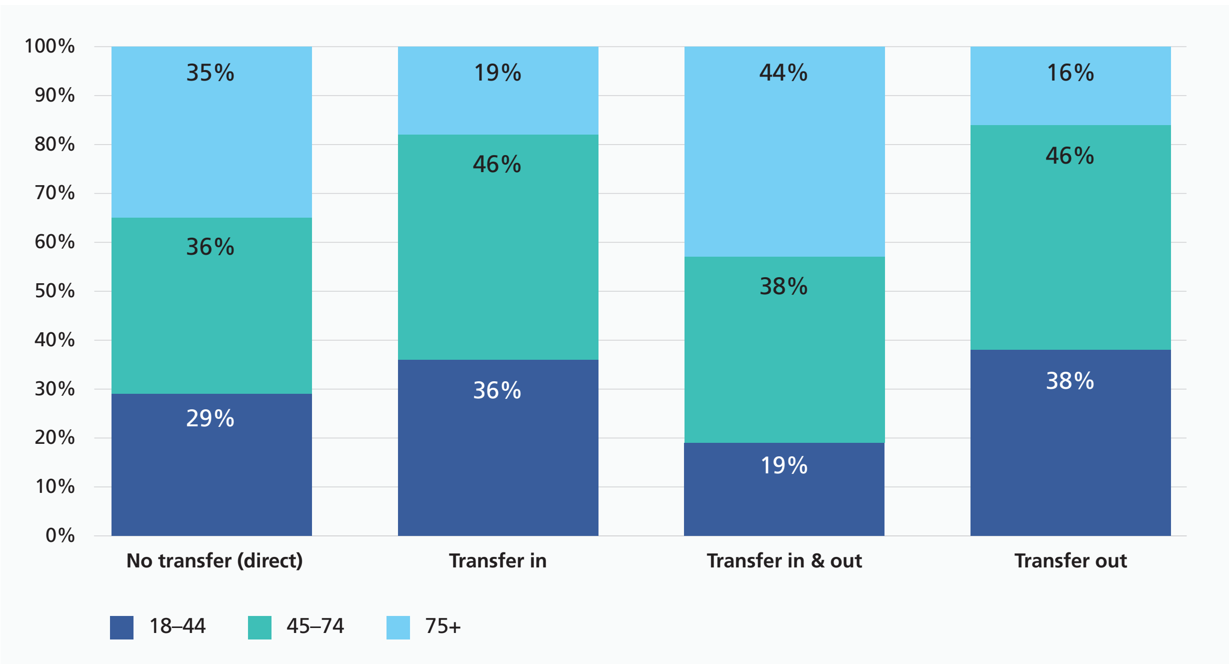
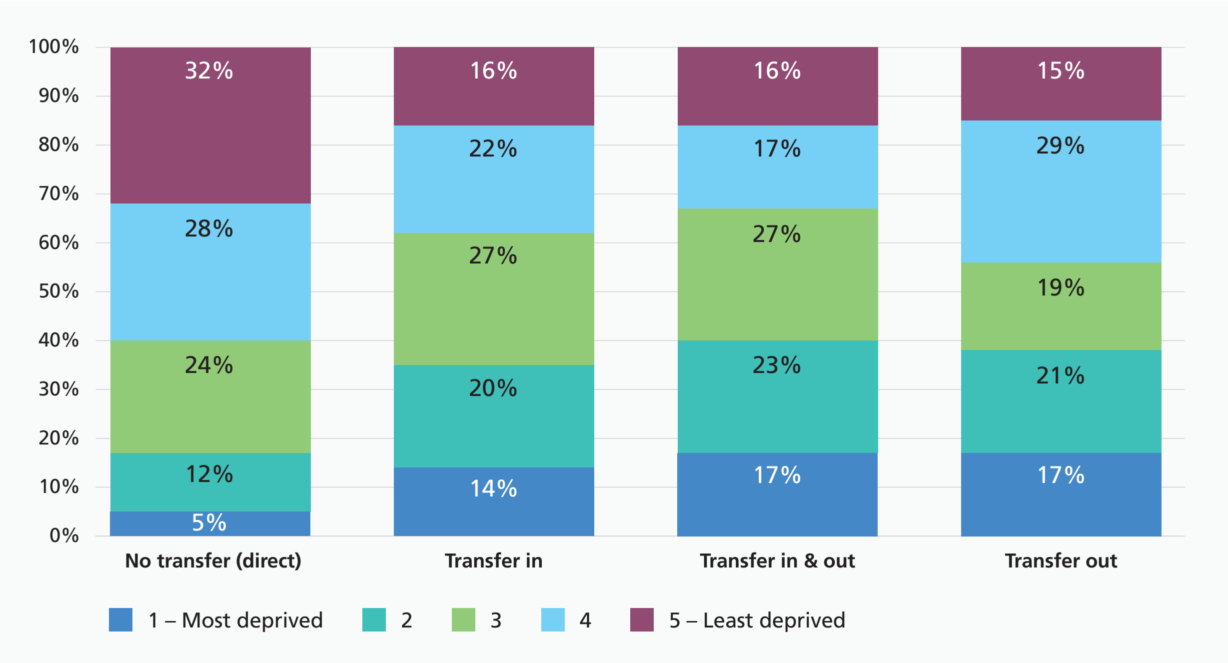


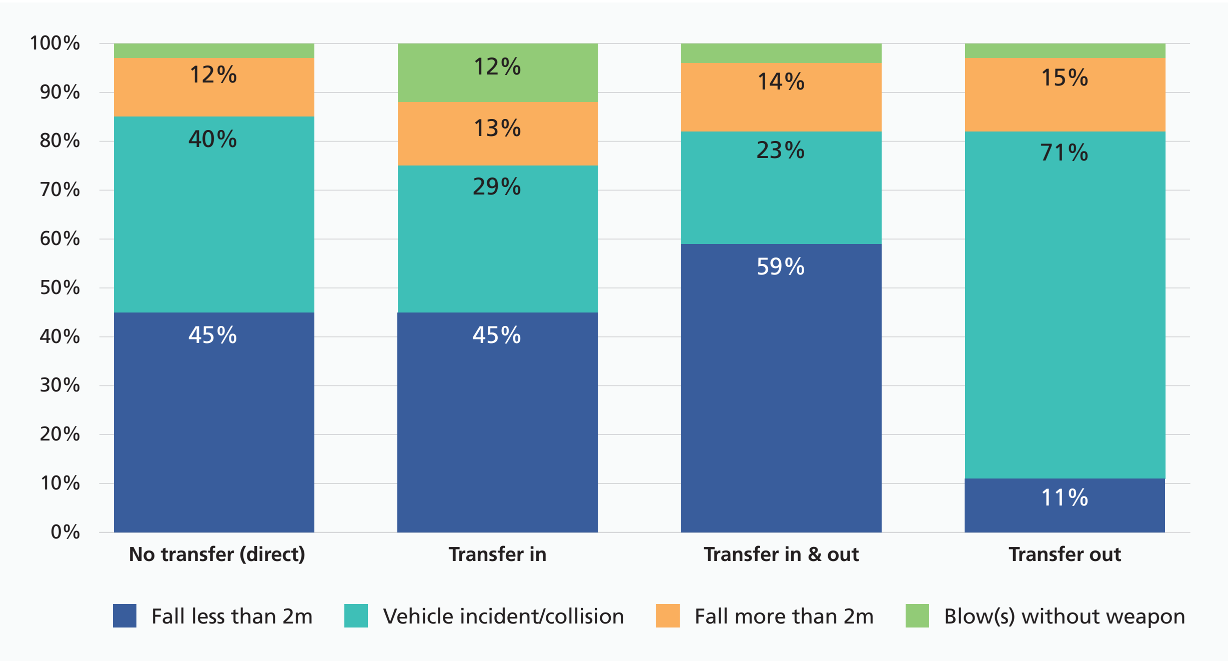
Figure 10.6 shows that nearly a third of direct admissions are by the least deprived patients. Transfers of any kind have a higher proportion of the most deprived patients (quintile 1) compared to direct admissions.

Figure 10.6 *Transfer type to Addenbrooke's Hospital by patient area deprivation quintile (IMD) (n=2,344), 2017/18 to 2019/20 pooled*



Falls less than two meters were the main injury cause for direct admissions and transfers in to the MTC (Figure 10.7). Vehicle incidents are the main injury cause for transfers out to another hospital, suggesting a high need for repatriating care. Transfers in have a higher proportion of injuries by blows compared to other transfer types.

Figure 10.7 *Transfer type to Addenbrooke's Hospital by mechanism of major trauma injury (n=2,332), 2017/18 to 2019/20 pooled*



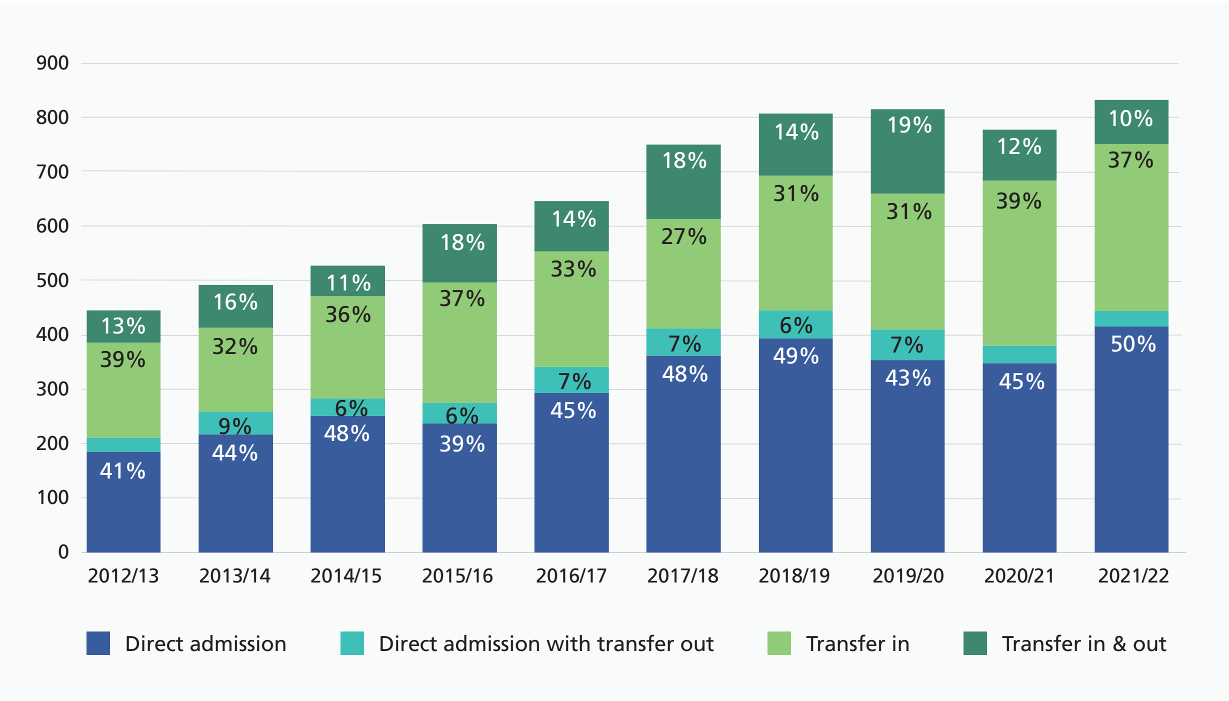
Direct and transfer admissions over time

Figure 10.8 shows that direct admissions are currently half of all admissions to the MTC (a) and around 80% of admissions to Norfolk and Norwich Hospital (b). This is higher than the average of all other Trauma Units at 68% for 2021/22 (c). Norfolk and Norwich Hospital has proportionally fewer transfers to the MTC compared to the average of all other Trauma Units.

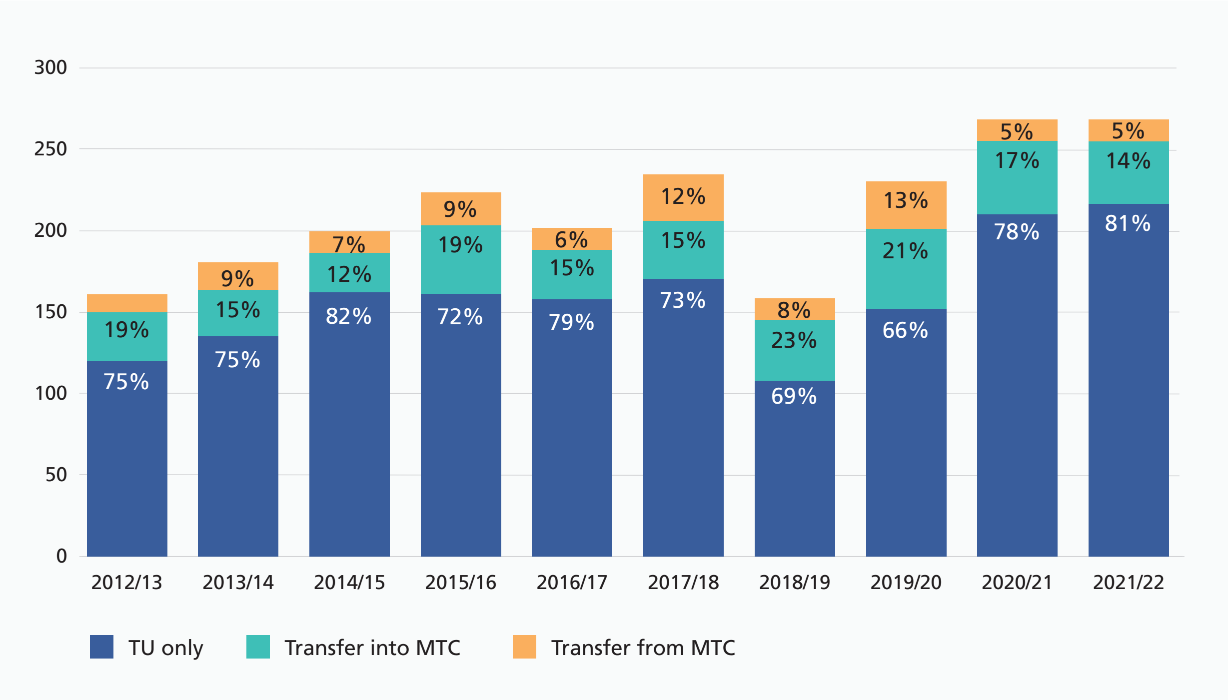
The count and proportion of direct admissions have grown across all sites. Growth in direct admissions to the MTC slowed from about 2018, whilst direct admissions to Trauma Units continued to grow. Transfers from TUs to the MTC plateaued in 2020, possibly due to COVID-19. This has resulted in patients being more likely to remain at their initially admitted hospital over time with major trauma care increasingly being the responsibility of Trauma Units.

Figure 10.8 *Count and proportion of major trauma patient movement across sites over time.*

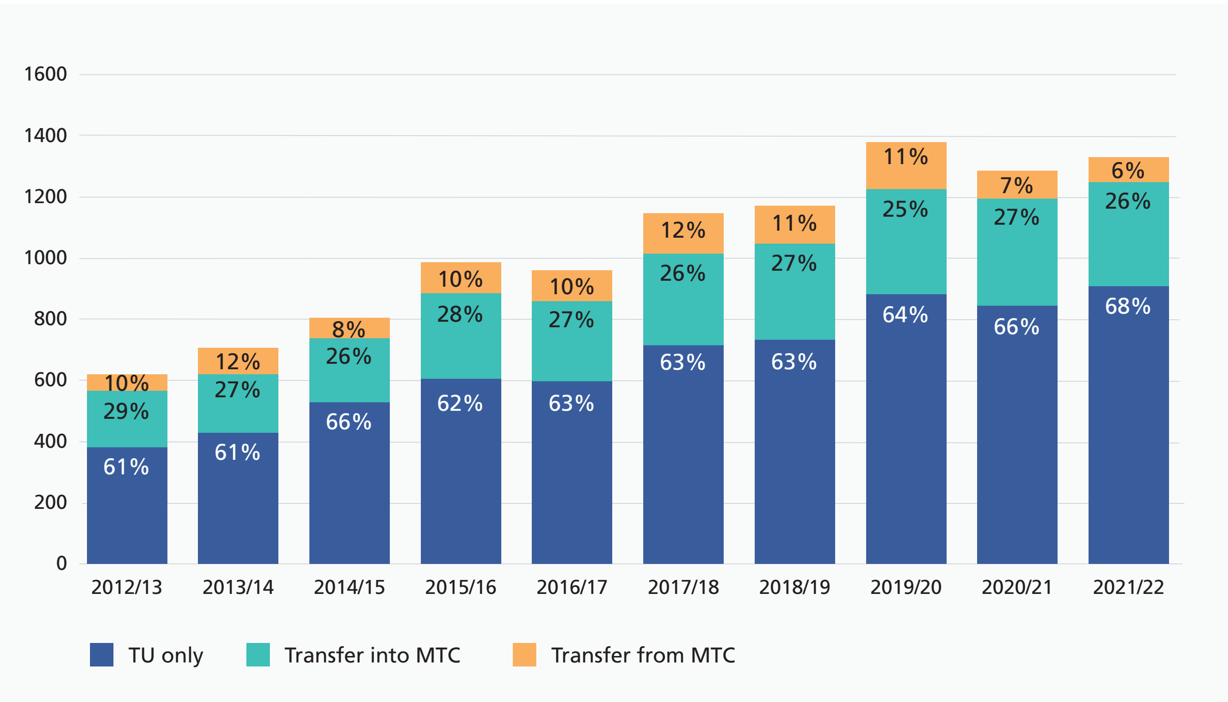
a – Addenbrooke's Hospital (n=6,705) – Major Trauma Centre



b – Norfolk and Norwich University Hospital (n=2,131)



c – All other Trauma Units (n=10,425)



11
Out of region patients admitted to East of England services

This section reviews major trauma patients admitted to East of England Trauma Network services who have a residence postcode outside of the NHS East of England region[1]. There were 2,814 TARN submissions of major (n=1,312) or severe trauma (n=1,502) from non-East of England residences between 2012/13 and 2021/22. Of these, 204 submissions involved transfers and 31 involved multiple episodes of trauma in the same individual.

Out of region patients were 7% of all major trauma patients using East of England services. There were more out of area patients from the Midlands than all other regions combined (Figure 11.1). These patients contributed to 60% of out of area patients for both major and severe trauma. London patients were the second largest users at 19% of out of area patients. The number of patients from the Midlands has almost doubled over time with a 53% increase in counts between 2017/18 and 2018/19 (Figure 11.2). Similar increases were observed for other regions but were small in actual counts.

1 As defined by the NHS Digital ODS.

Figure 11.1 *Count of submissions to Trauma Units in the East of England by resident home region by ISS. (n=2,814), 2012/13 to 2021/22 pooled*

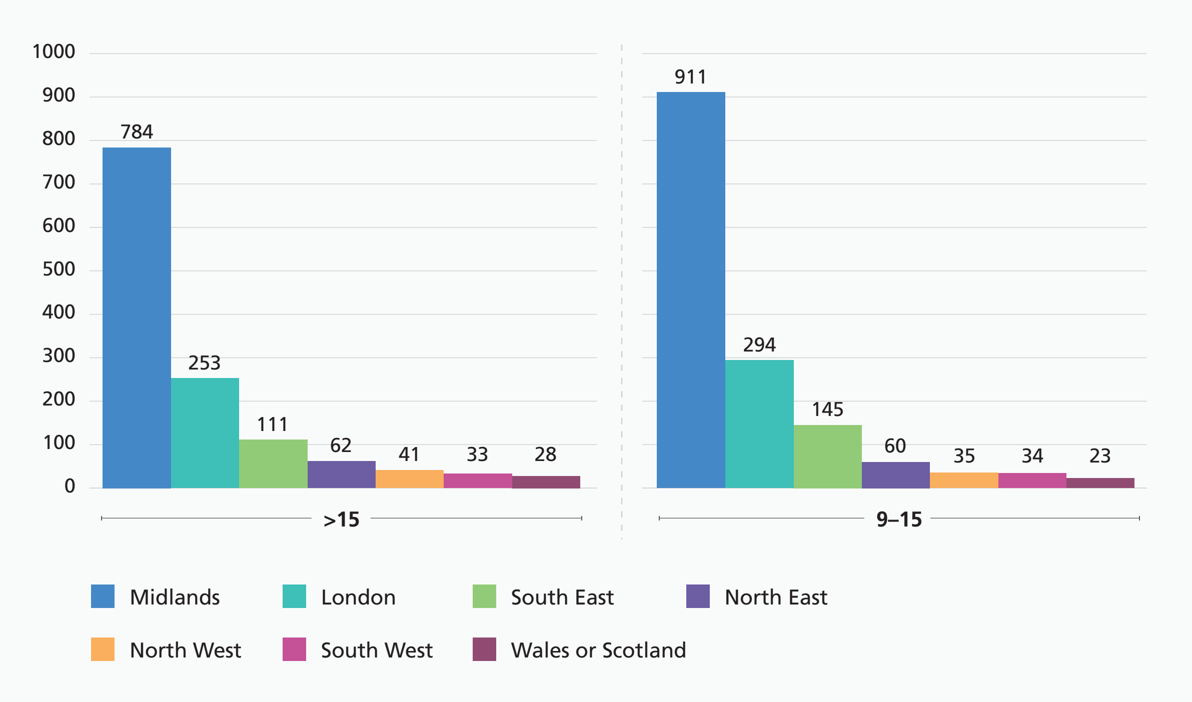
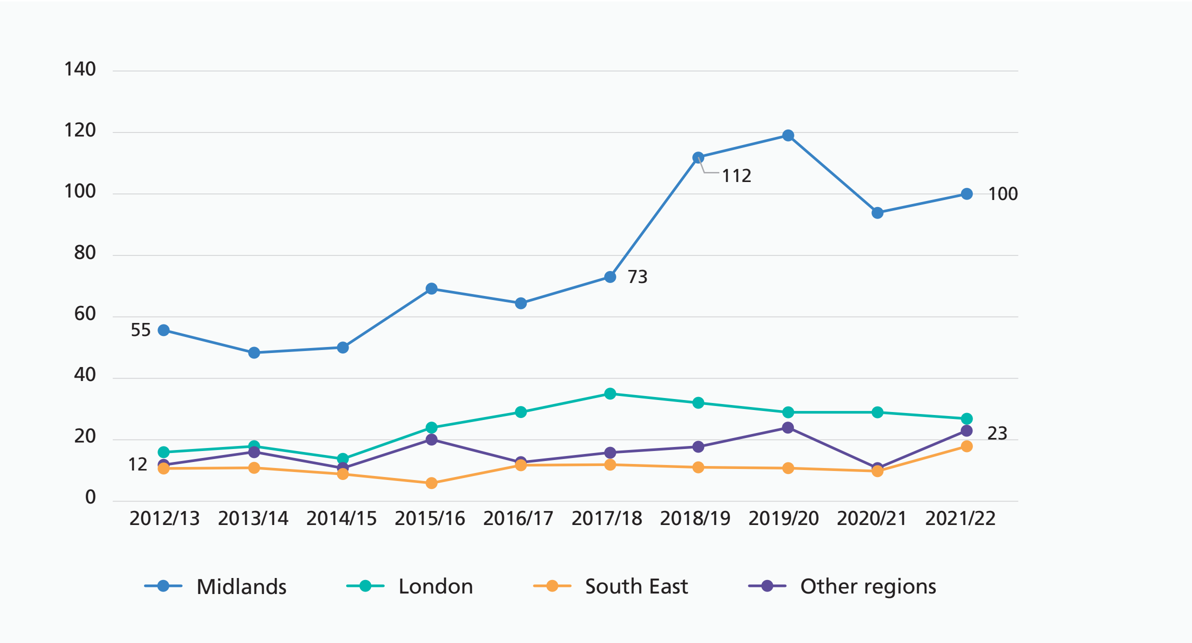
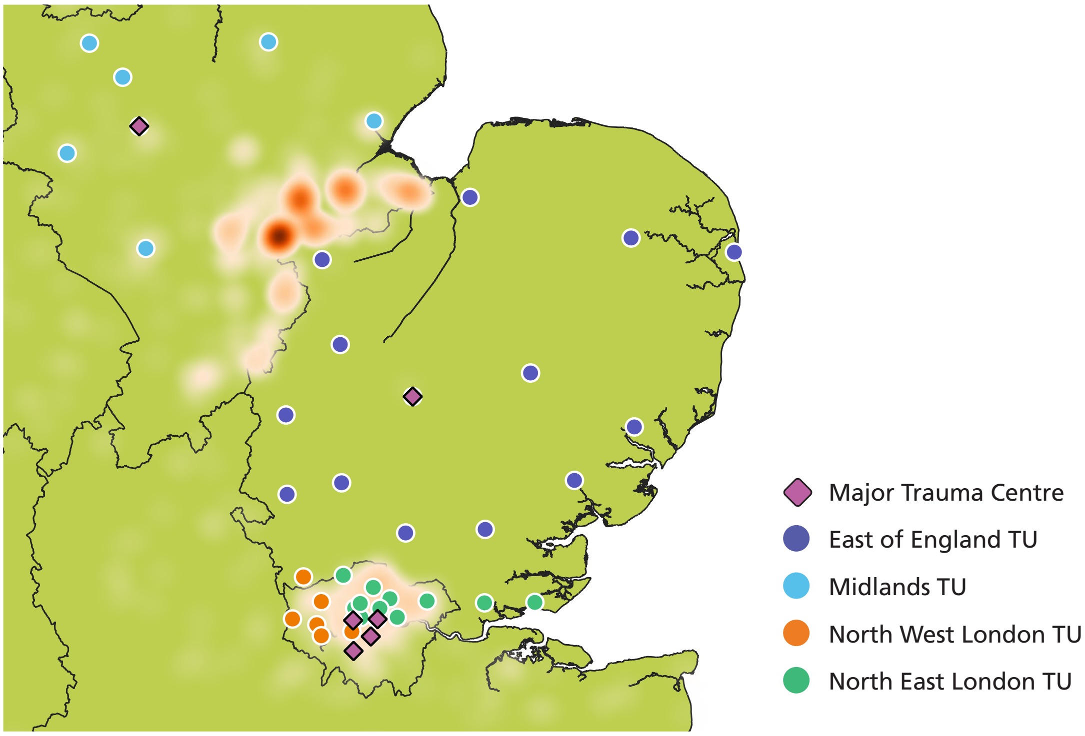


Figure 11.2 *Count of major trauma submissions to Trauma Units in the East of England by resident home region over time (n=1,312)*



The heat map of patient occurrences in Figure 11.3 suggests that patients from the Midlands are concentrated along the East of England border, particularly at Stamford and Spalding. London patients are more spatially dispersed across the north of their region.

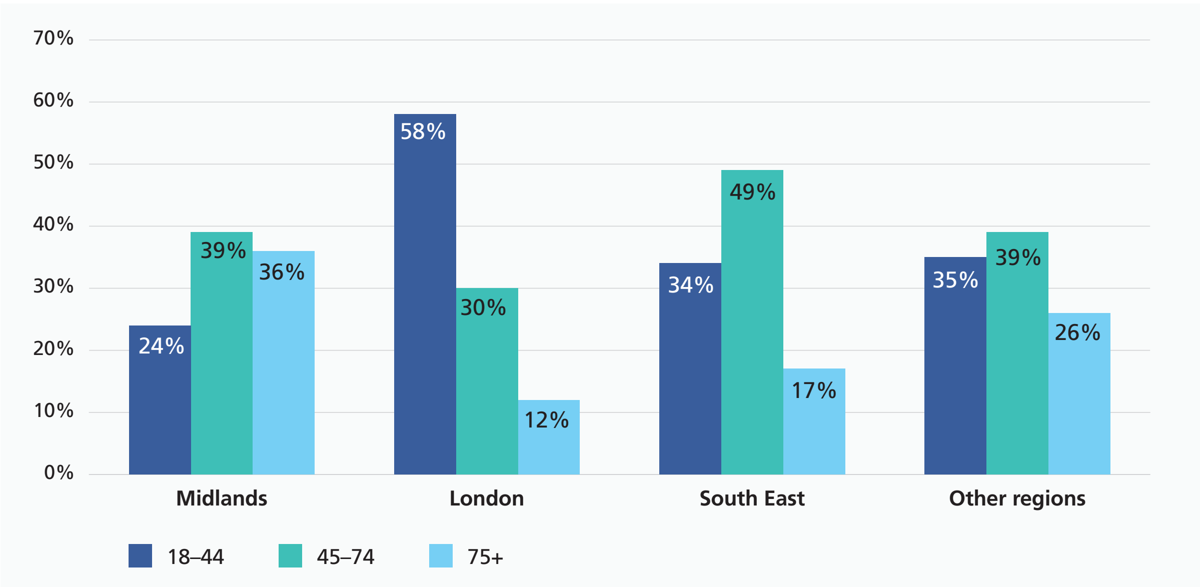
Figure 11.3 Heat map of major trauma patients using East of England trauma hospitals with home residence outside of the region (Government Office Region boundaries illustrated)



Demographics

Figure 11.4 shows contrasting age profiles for Midlands and London area patients. Patients from the Midlands were more likely to be over 45 years whilst 58% of London patients were younger, aged 18–44 years. Patients from other out of area regions were also more likely to be under 75 years.

Figure 11.4 Proportion of out of area major trauma patients by residence region and age group (n=1,312), 2012/13 to 2021/22 pooled



By mechanism of injury, half of Midland's major trauma was due to falls below two meters. In other regions, the most common cause was vehicle incidents, comprising 59% of London's major trauma (Figure 11.5). Patients from the Midlands are more likely to have a major trauma at home (36%), or institution (7%) compared to other regions where it is more likely to be on the road.

Figure 11.5 Proportion of out of area major trauma patients by residence region and trauma mechanism (n=1,243), 2012/13 to 2021/22 pooled

Hospital site attended

Figure 11.6 shows that over half of Midlands patients attended Peterborough City Hospital. This is the nearest Trauma Unit to the Midlands border, followed by Addenbrooke's Hospital. Major trauma patients from the Midlands were more likely to attend Addenbrooke's Hospital (37%) than those with severe trauma (12%). In contrast, half of London patients attended Addenbrooke's Hospital with the rest attending Trauma Units across the whole of the East of England region (Figure 11.7). Princess Alexandra is the second most attended site by London trauma patients.

Based on the characteristics of injury mechanism, age, and attendance patterns, it can be speculated that patients from the Midlands border attend East of England Trauma Services as they are the most accessible trauma network hospitals from their residence. Their high proportion of low falls and elderly patients is similar to the major trauma profile of East of England patients. In contrast, patients from all other regions are more likely to be younger and injured by road incidents. They tend to be admitted more widely across all Trauma Units in the region, implying they are more likely to be visitors to the East of England region, such as commuters and temporary visitors.

Figure 11.6 Proportion of Midlands major trauma patients by attending hospital and ISS. (n=1,695), 2012/13 to 2021/22 pooled

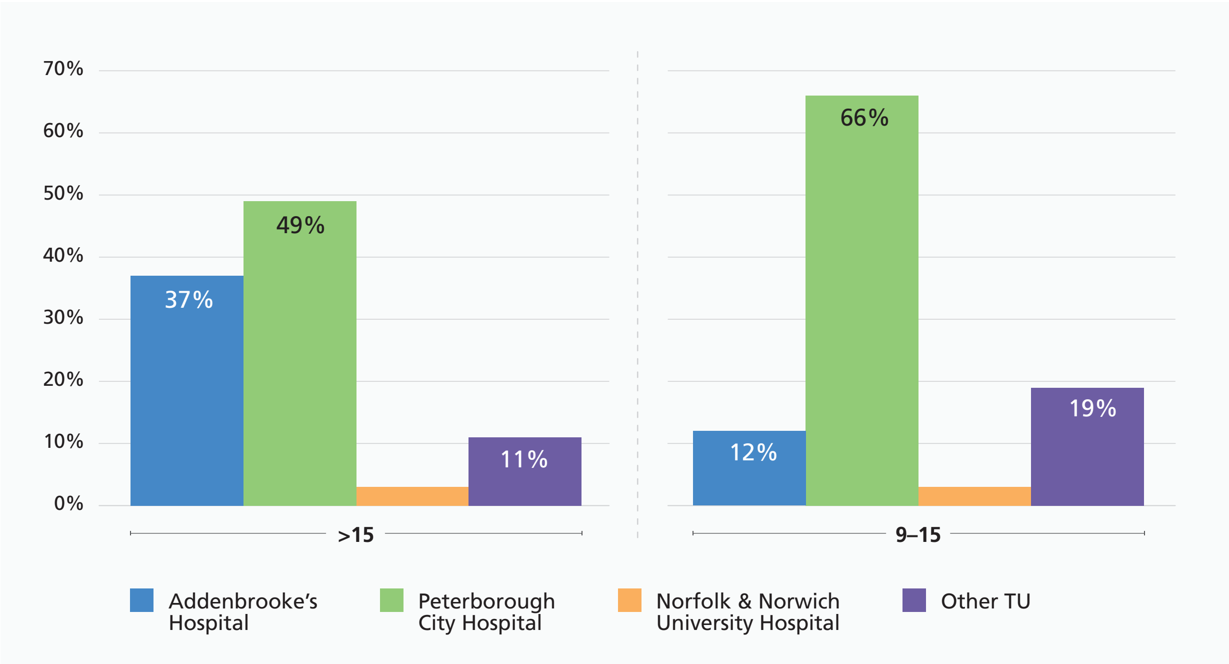
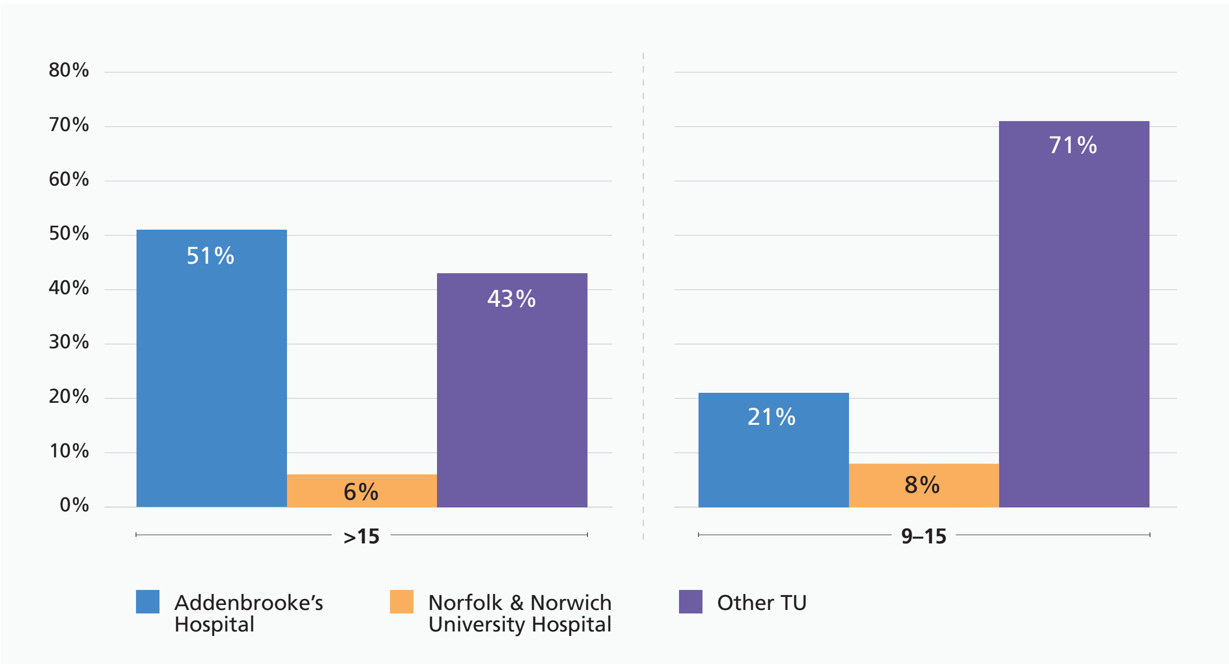


Figure 11.7 Proportion of London major trauma patients by attending hospital and ISS. (n=547), 2012/13 to 2021/22 pooled

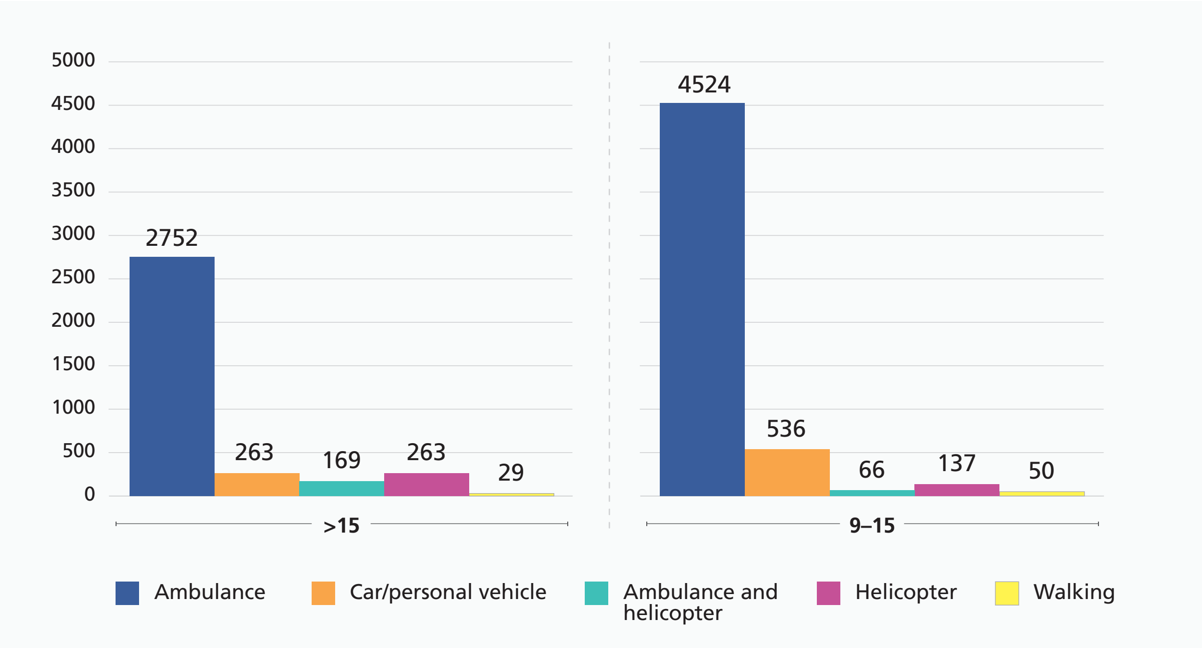


12
Mode of transport for trauma patients to East of England hospitals

This section reviews how patients travelled to a trauma hospital during a direct admission. Results in this section do not include journeys related to transfers due to a low recording of transfer transport mode. Travel modes labelled as not applicable, often due to a patient having a fall whilst already at the hospital, are also not included.

Most trauma injuries are brought to hospital by ambulance for both major and severe trauma (Figure 12.1). For major trauma injuries, there are twice the number of patients transported by helicopter (air ambulance) compared to severe trauma. Severe trauma patients are more likely to use a car for transport compared to major trauma patients.

Figure 12.1 *Arrival mode to all trauma hospitals by ISS, direct admission (n=8,789), 2017/18 to 2019/20 pooled*



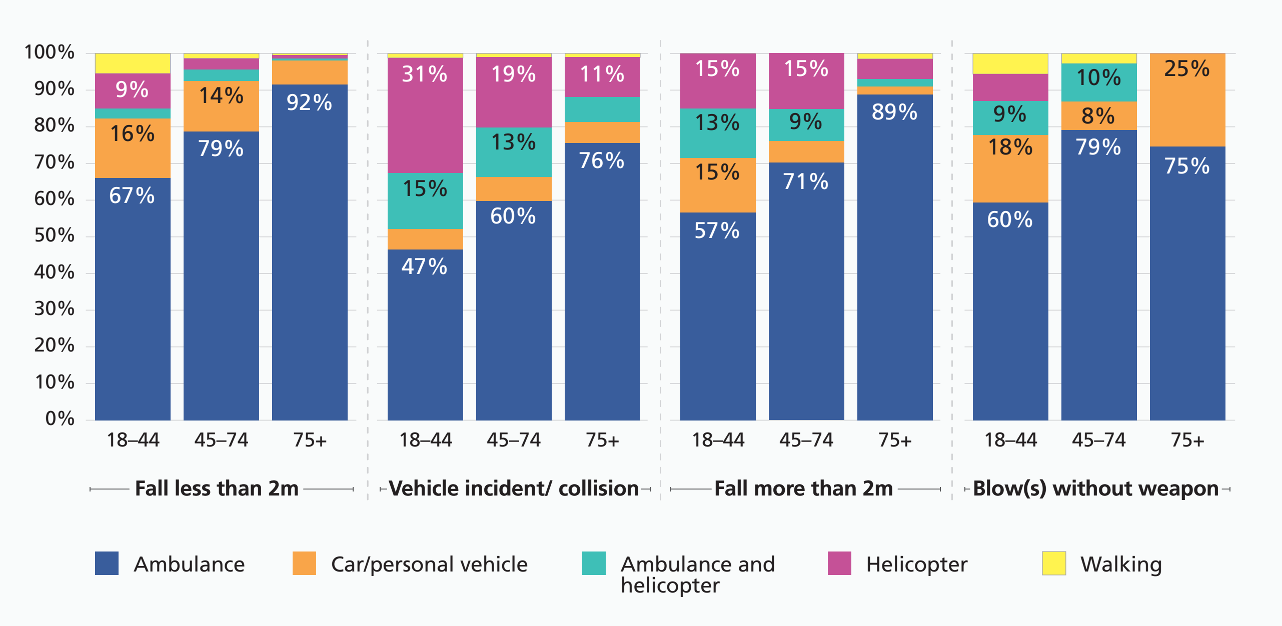
Pre-alert

Overall, 39% of 4,868 major trauma patients were pre-alerted by the transport team to their initial arrival hospital. Pre-alert recording was unavailable for 12% of patients. Of those pre-alerted, 28% were elderly patients, meaning younger patients were more likely to be pre-alerted.

Major trauma transport by patient characteristics and injuries

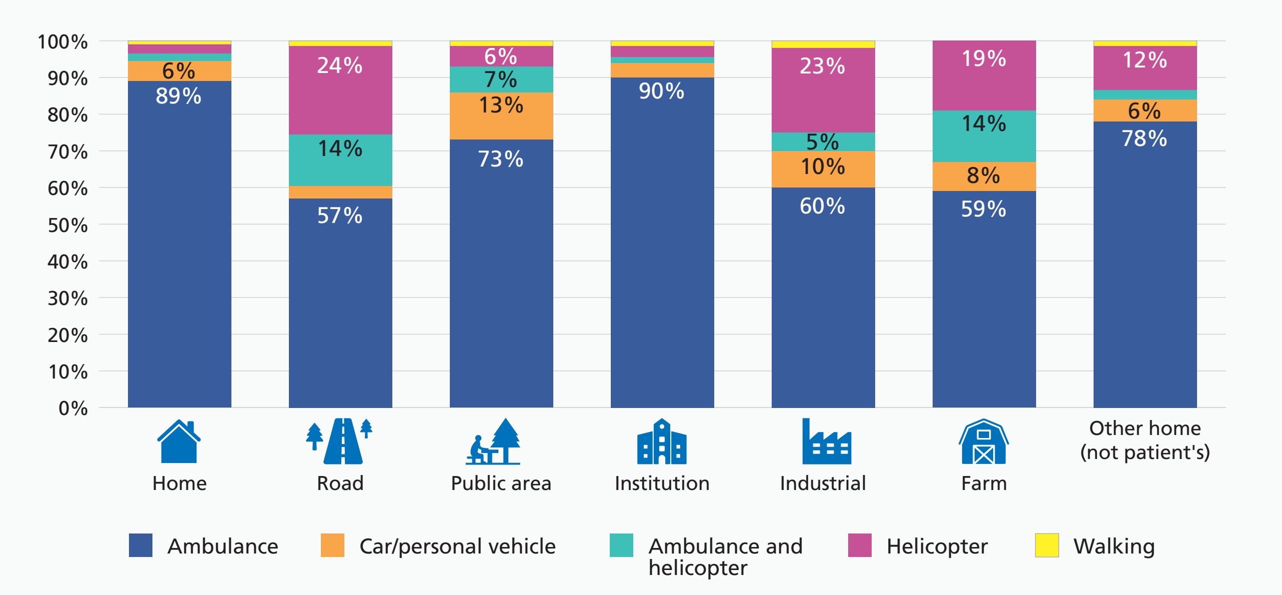
The use of ambulance increased with age across the main causes of major trauma except blows (Figure 12.2). Helicopter transport, including combined with ambulance mode, was used more often for vehicle incidents and high falls compared to low falls. Major trauma patients aged 18–44 years were the most likely to be transported by helicopter modes across all causes. Journeys completed by car were found to reduce with age except for blows in the elderly. Walking to hospital was higher in the youngest age group.

Figure 12.2 Arrival mode to hospital by major trauma mechanism and age group, direct admission (n=3,339), 2017/18 to 2019/20 pooled



Helicopter transport was used most often for road (38%), farm (32%) and industrial site-based injuries (28%) (Figure 12.3). Home and institution-based injuries were mainly transported by ambulance and less than 10% by other forms. The car was most used with injuries in public areas (13%).

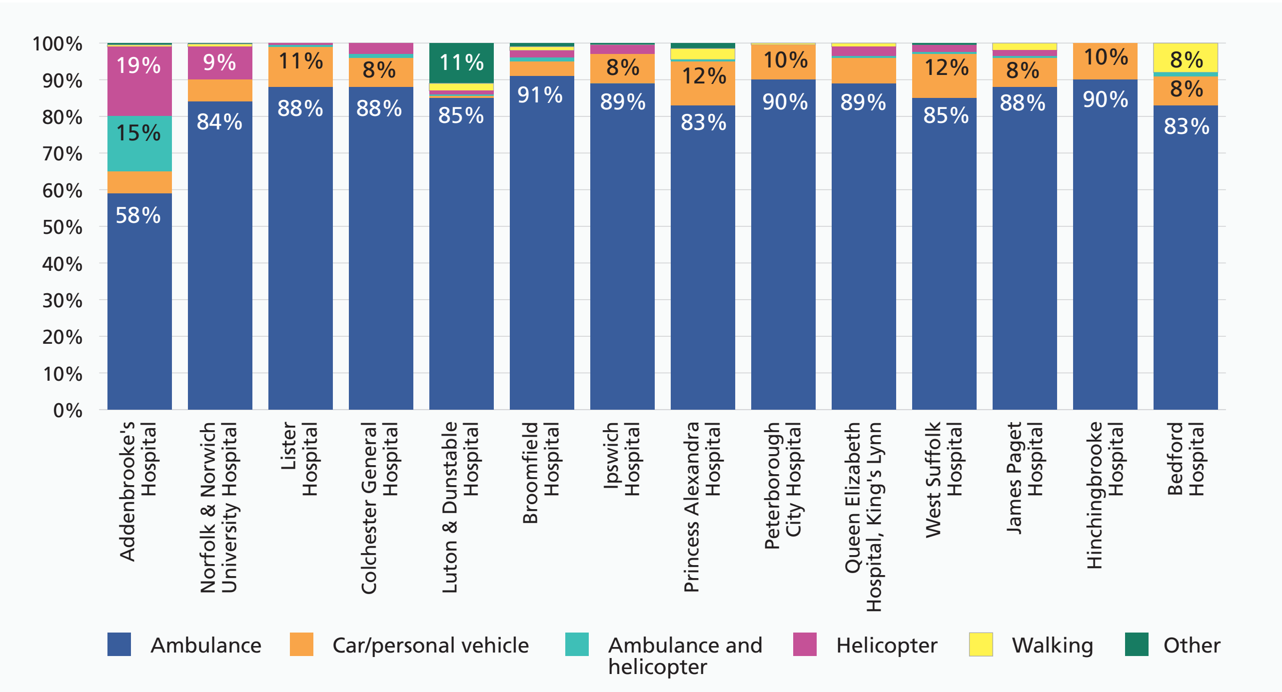
Figure 12.3 *Arrival mode to hospital by place of major trauma injury, direct admission (n=3,344), 2017/18 to 2019/20 pooled*



Transport by hospital site

Ambulance was the main form of transport at all sites at 83% to 91% of total transport use at Trauma Units (Figure 12.4). A third of patients transported to the MTC involved a helicopter (the helicopter with ambulance mode is only applicable to Addenbrooke's Hospital). Helicopter use was a minor form of transport for Norfolk and Norwich (9%) and Colchester (4%) hospitals with other Trauma Units at <1%. Car use was a small but consistent use across all sites except Luton and Dunstable Hospital where it may be mislabelled as 'other'. Walking as a mode of transport was highest at Bedford Hospital.

Figure 12.4 *Proportion of arrival mode to hospital by site of admission, direct admissions (n=3,512), 2017/18 to 2019/20 pooled*



Mode of travel over time

Until 2016/17 there were variable levels of unrecorded transport mode, particularly in 2014/15. For the MTC, ambulance use was around 60% of transport for most years. The exception was the COVID-19 pandemic year (2020/21) when it was at least 10% higher (Figure 12.5). Combining helicopter and ambulance/helicopter modes, use has been around 30–35% except for in 2012/13 and 2020/21. For Trauma Units, the proportion of car and ambulance use has remained steady since recording was complete in 2017/18 (Figure 12.6).

Figure 12.5 *Arrival mode over time for the Major Trauma Centre (Addenbrooke's Hospital), direct admissions (n=2,820)*

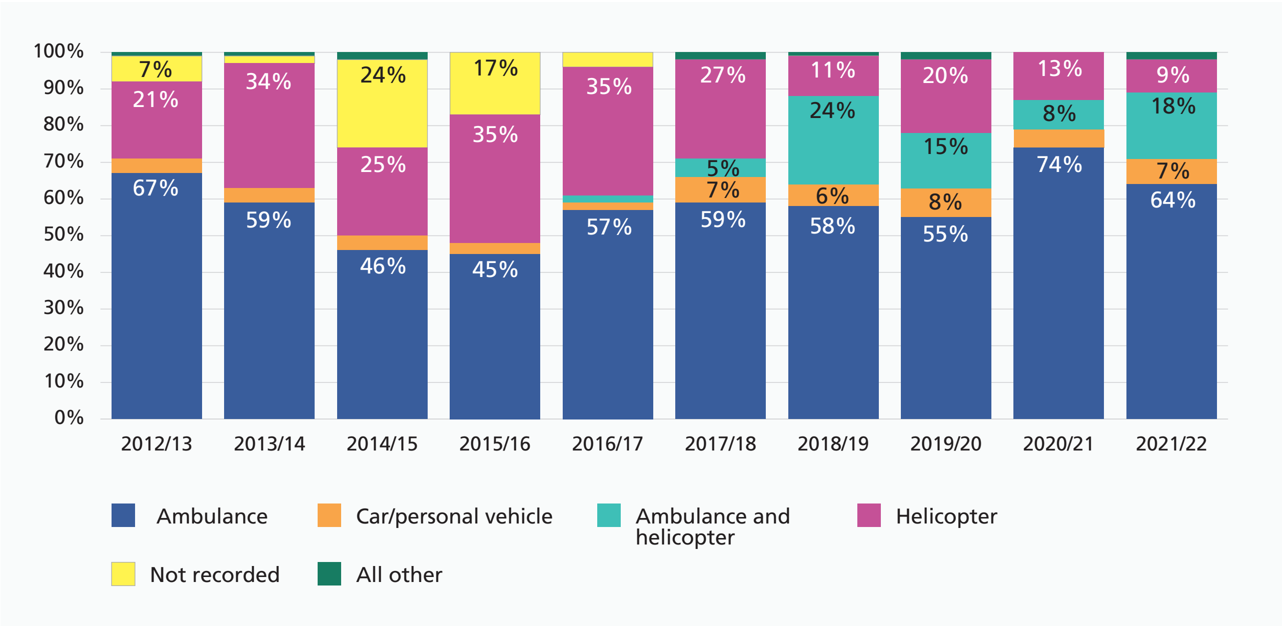
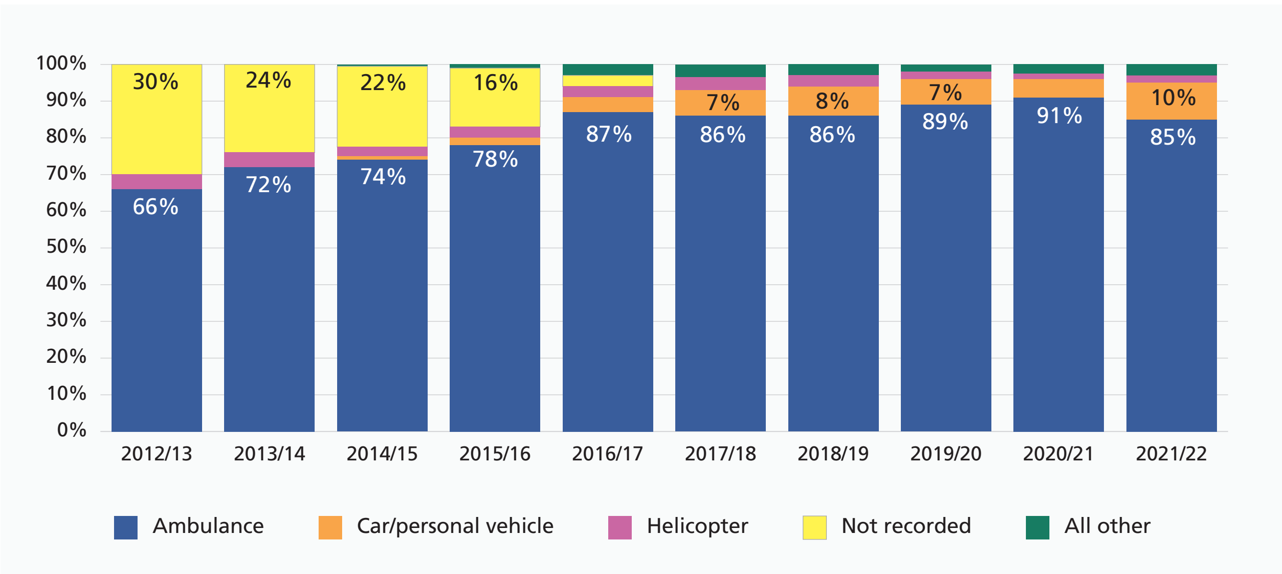


Figure 12.6 *Arrival mode for Trauma Units over time, direct admissions (n=7,487)*



13
Hospital care of major trauma patients

This section reviews the state of trauma care across hospital sites and changes over time. This includes factors such as timeliness and availability of services by patient characteristics. Hospital capacity is quantified by describing length of stay trends and using forecasting to predict future needs. This section ends with a review of operations performed and patient ward use.

Hospital performance metrics

A number of metrics were reviewed to provide a picture of the overall performance, quality, and resource pressures within the trauma services and network with reference to the Best Practice Tariff (BPT). All East of England Trauma Network hospitals were included in the analysis, with subsections of direct comparisons on the metrics between Addenbrooke's Hospital (current MTC), and Norfolk and Norwich Hospital (proposed second MTC). This is to provide a baseline understanding of resource needs and current performance metrics gaps when considering investment for Norfolk and Norwich Hospital as a second MTC. Note that not all metrics related to the BPT are available in the Performance Review Indicators extract used for this analysis.

Access to a trauma team at initial hospital

Half of major trauma patients were received by a trauma team at the MTC (Figure 13.1). For Trauma Units, this ranged from 27% at Colchester and Broomfield hospitals to 15% at Norfolk and Norwich Hospital. Figure 13.2 shows that being received by a trauma team decreases with age. At Addenbrooke's Hospital, 73% of patients aged 18–44 years were received by a trauma team but only 21% of elderly patients. The proportion of major trauma patients being seen by a trauma team at the MTC has declined over time from 60% in 2013/14 to 53% in 2018/19 to 43% in 2021/22.

Figure 13.1 *Proportion of major trauma patients seen by a trauma team (of those who attended the ED) – As initial hospital only. (n=4,480), 2017/18 to 2019/20 pooled*

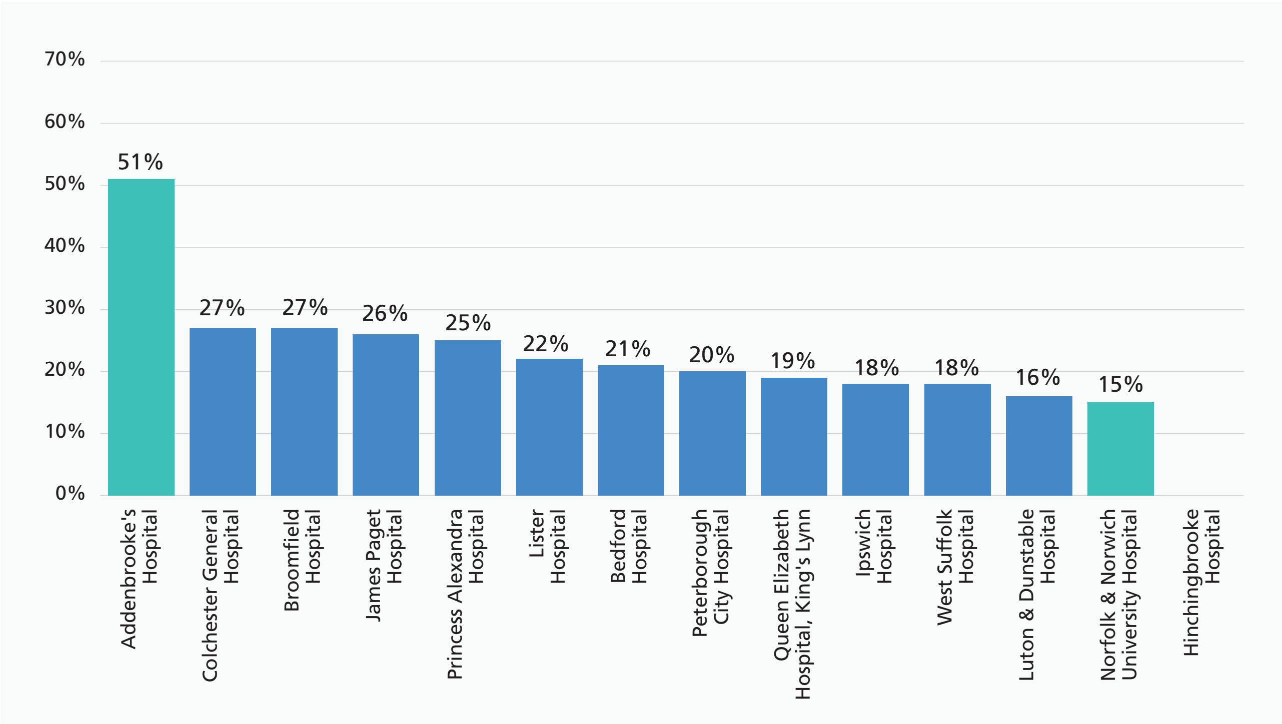
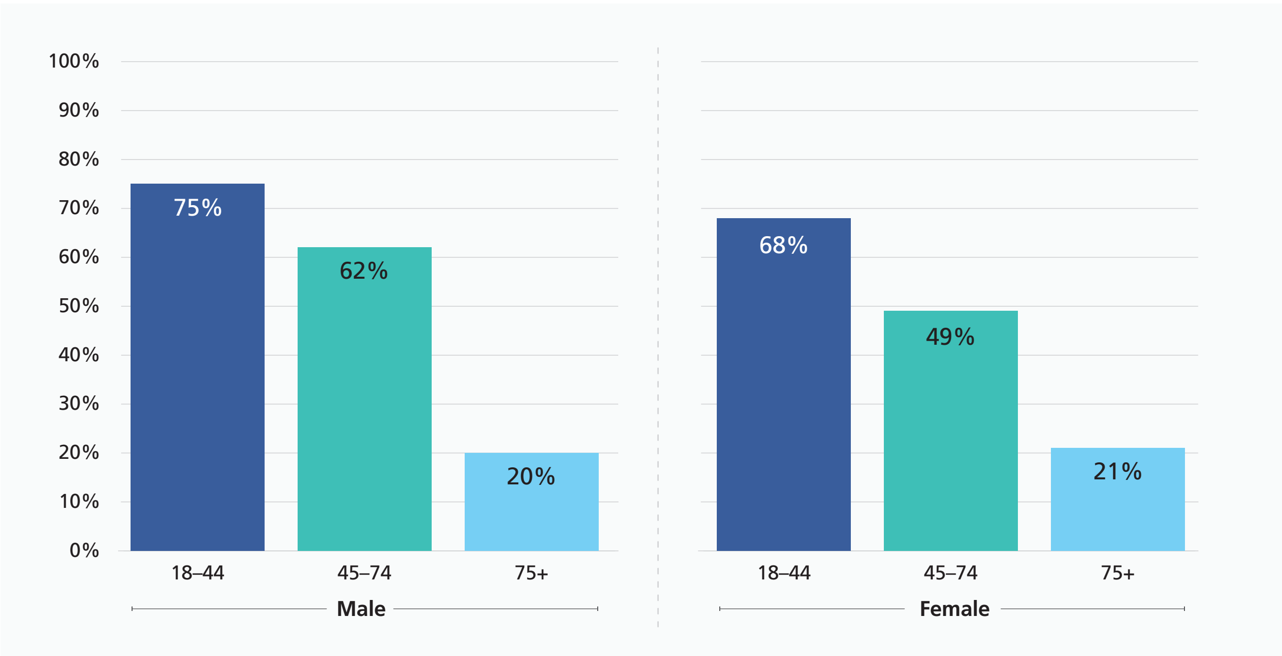


Figure 13.2 *Proportion of major trauma patients seen by trauma team (of those who attended the ED) by age group and sex at Addenbrooke's Hospital – As initial hospital only (n=1,348), 2017/18 to 2019/20 pooled*



Time to doctor

Figure 13.3 shows that 84% of patients were seen by a doctor within the target of 30 minutes of arrival at Addenbrooke's Hospital. At Trauma Units, this ranged from 56% at Colchester to 37% at Princess Alexandra Hospital. Norfolk and Norwich Hospital has one of the lowest performances at 39%. Broomfield Hospital has a poor level of recording for this measure with 47% of patient doctor seen time missing. Figure 13.4 shows that being seen within 30 minutes of arrival has declined since 2018/19 for both Addenbrooke's and Norfolk and Norwich hospitals. The likelihood of being seen within 30 minutes at the MTC reduces with age from 97% of those aged 18–44 years to 65% of those aged over 75 years.

Figure 13.3 *Proportion of major trauma seen by an ED doctor within 30 minutes of arrival across sites – As initial hospital only. (n=4,480), 2017/18 to 2019/20 pooled*

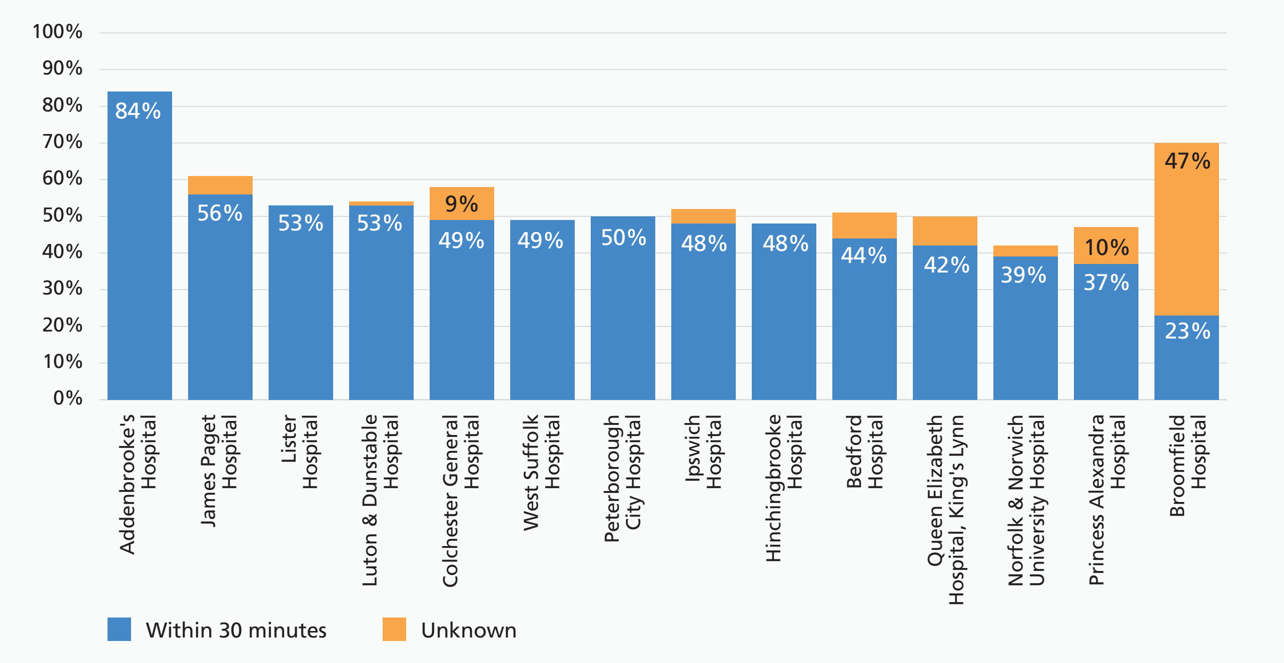
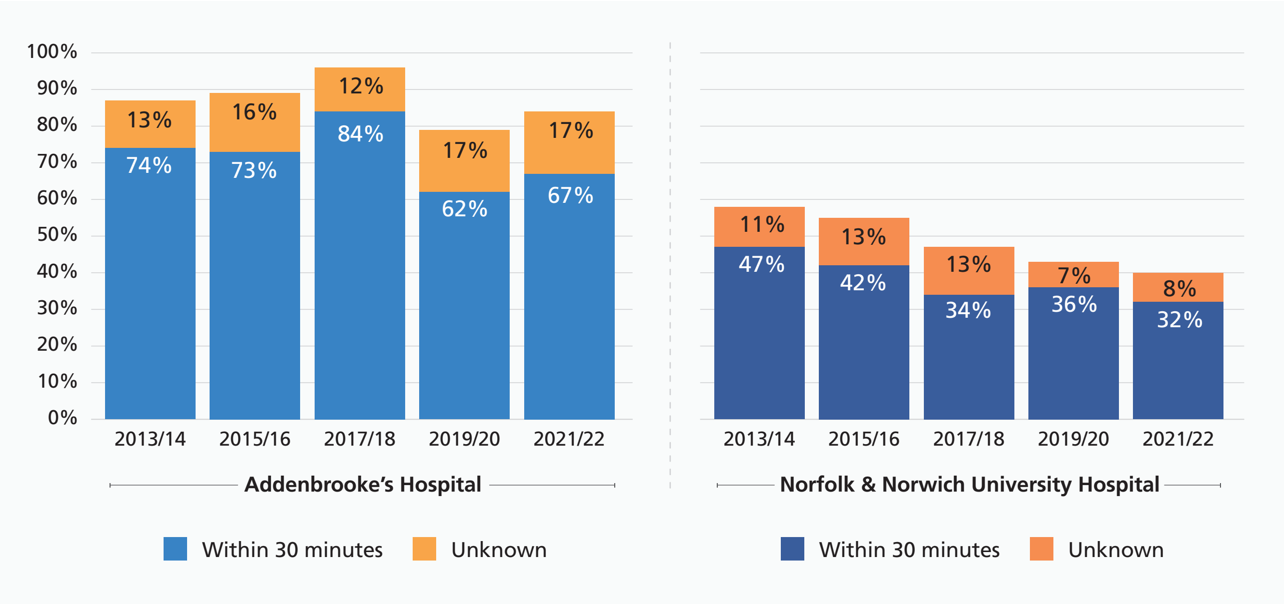


Figure 13.4 *Proportion of major trauma seen by an ED doctor within 30 minutes of arrival at Addenbrooke's and Norfolk and Norwich hospitals over time – As initial hospital only. (n=3,225), 2017/18 to 2019/20 pooled*



Doctor grade

There were 89% of major trauma patients seen by a consultant at Addenbrooke's Hospital (Figure 13.5). Patients were more likely to be seen by a specialist trainee at Trauma Units, with consultant access ranging from 36% at Hinchingbrooke to 14% at Ipswich Hospital. Broomfield Hospital has a poor recording of doctor grade with 37% of patients missing information. Of those patients who were received by a trauma team at the MTC, all were seen within 30 minutes at an ED led by a consultant. At Trauma Units, only 66% of patients (who were received by a trauma team and were seen within 30 minutes) were at an ED led by a consultant.

Figure 13.5 First doctor grade seen at the ED across sites – As initial hospital only. (n=4,480), 2017/18 to 2019/20 pooled

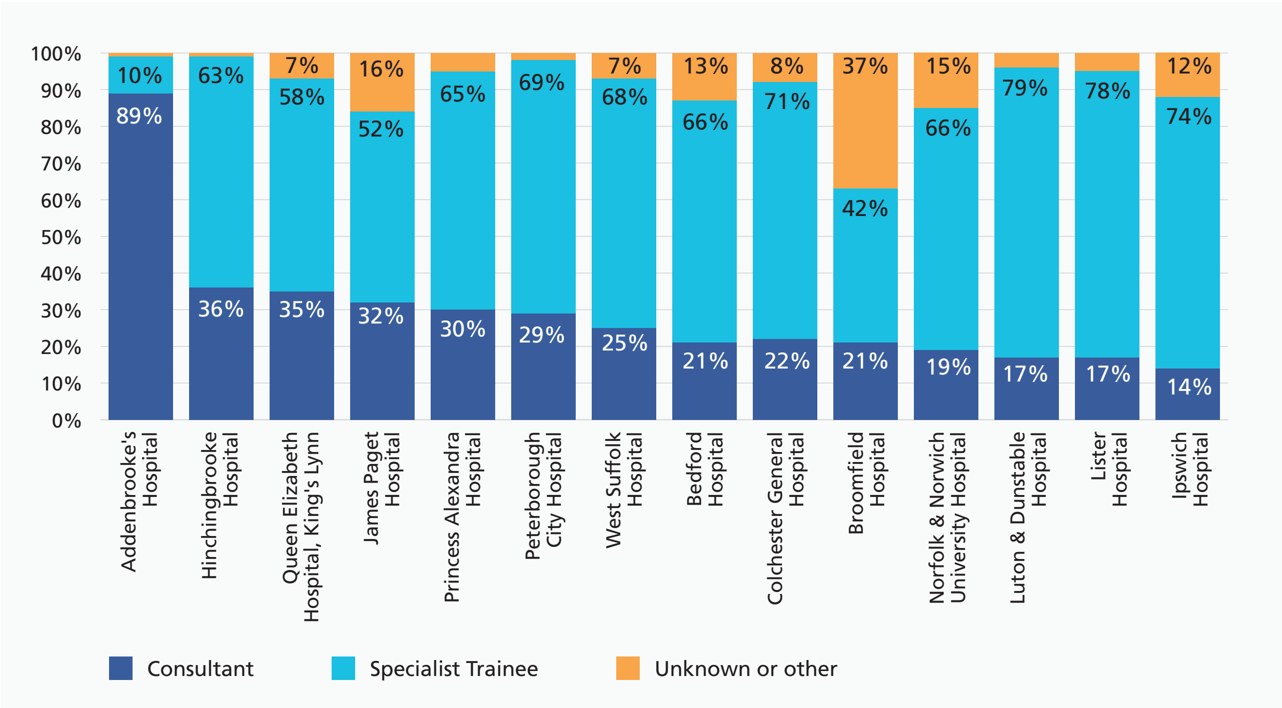


Figure 13.6 shows that being seen by a consultant at the MTC is related to age, with 78% of those aged 75+ years but 98% of those aged 18–44 years seen by a consultant. Figure 13.7 shows that consultant attendance at the MTC has been high over time, peaking in 2017/18 at 96% and declining since then to 74% in 2021/22.

Figure 13.6 First doctor grade seen at the ED by age group and sex at Addenbrooke's Hospital – As initial hospital only. (n=1,348), 2017/18 to 2019/20 pooled

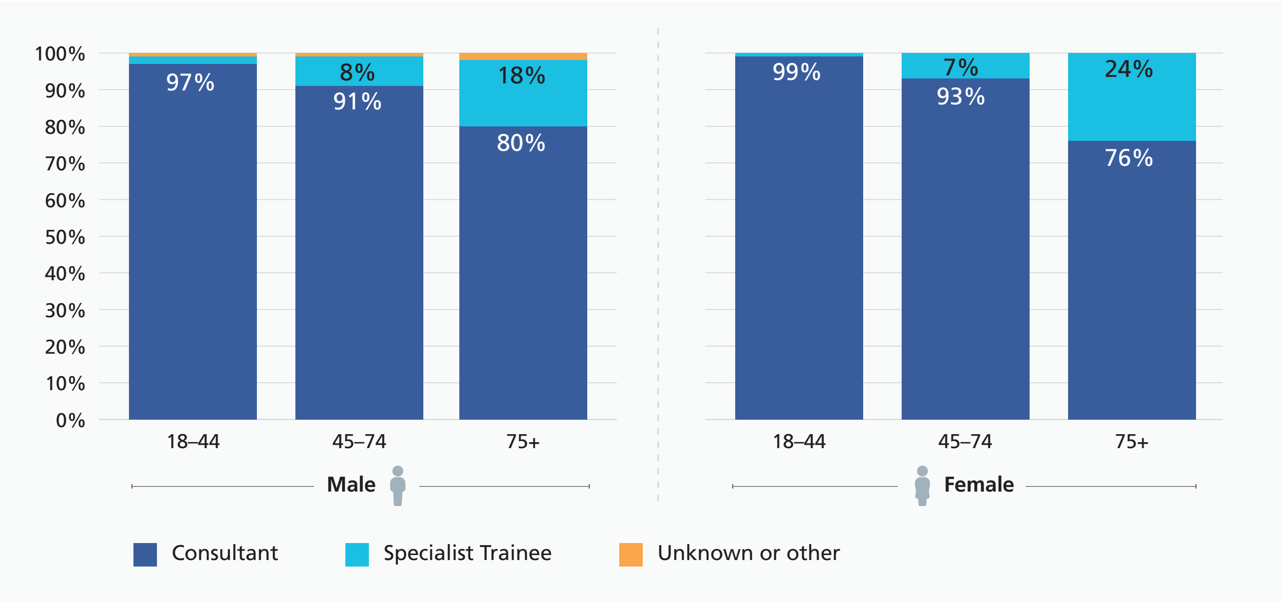
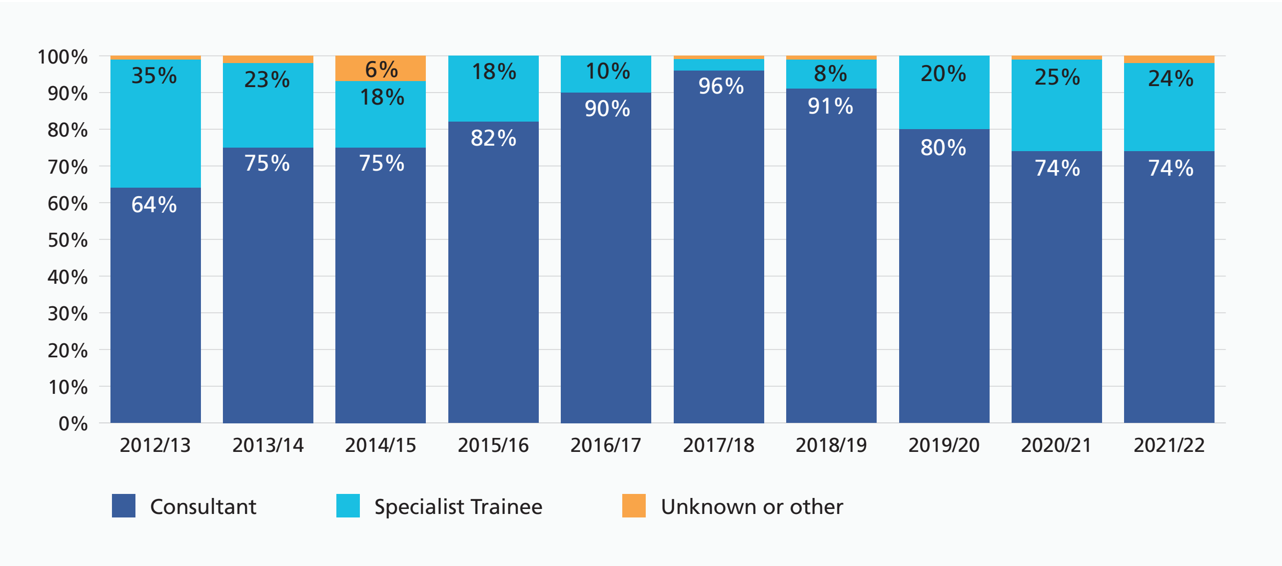


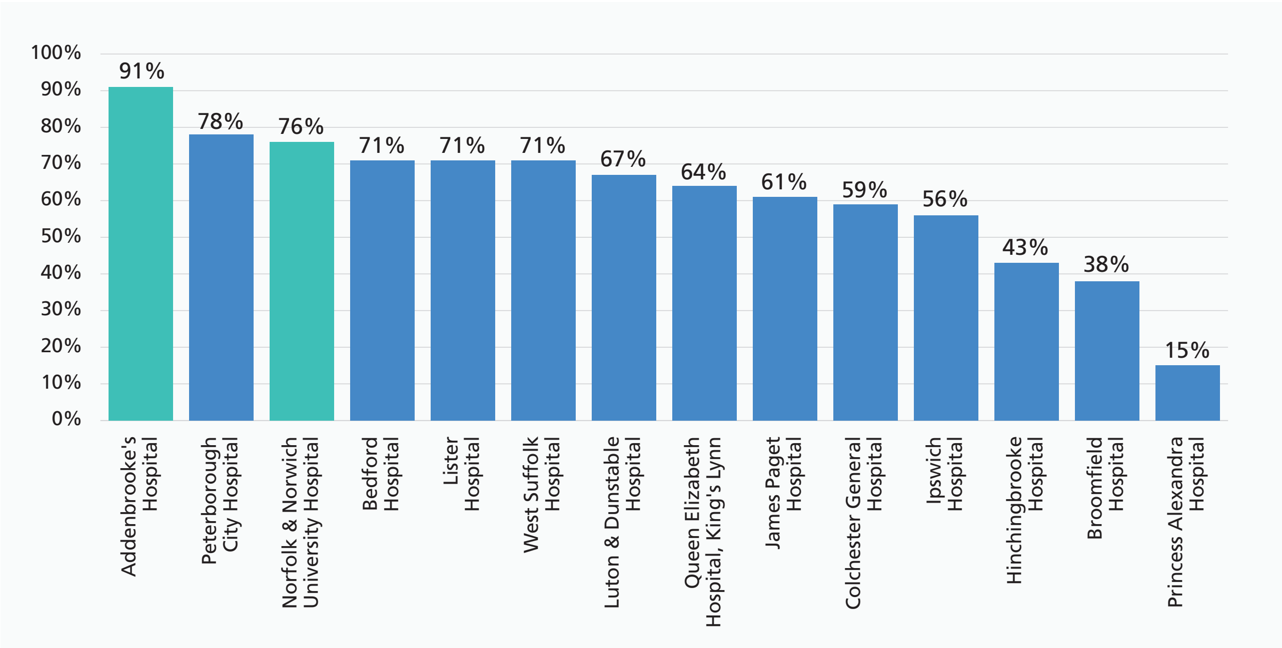
Figure 13.7 First doctor grade seen at the ED at Addenbrooke's Hospital over time – as initial hospital only (n=3,753)



Intubation

Almost all patients with a GCS <9 were intubated when admitted to Addenbrooke's Hospital (91%) (Figure 13.8). Norfolk and Norwich Hospital performs quite well for this indicator, alongside Peterborough Hospital, however some Trauma Units were below 50%. Elderly patients are less likely to be intubated at Trauma Units with 38% receiving this procedure compared to 86% of persons aged 18–44 years. At Addenbrooke's Hospital, 74% of the elderly were intubated.

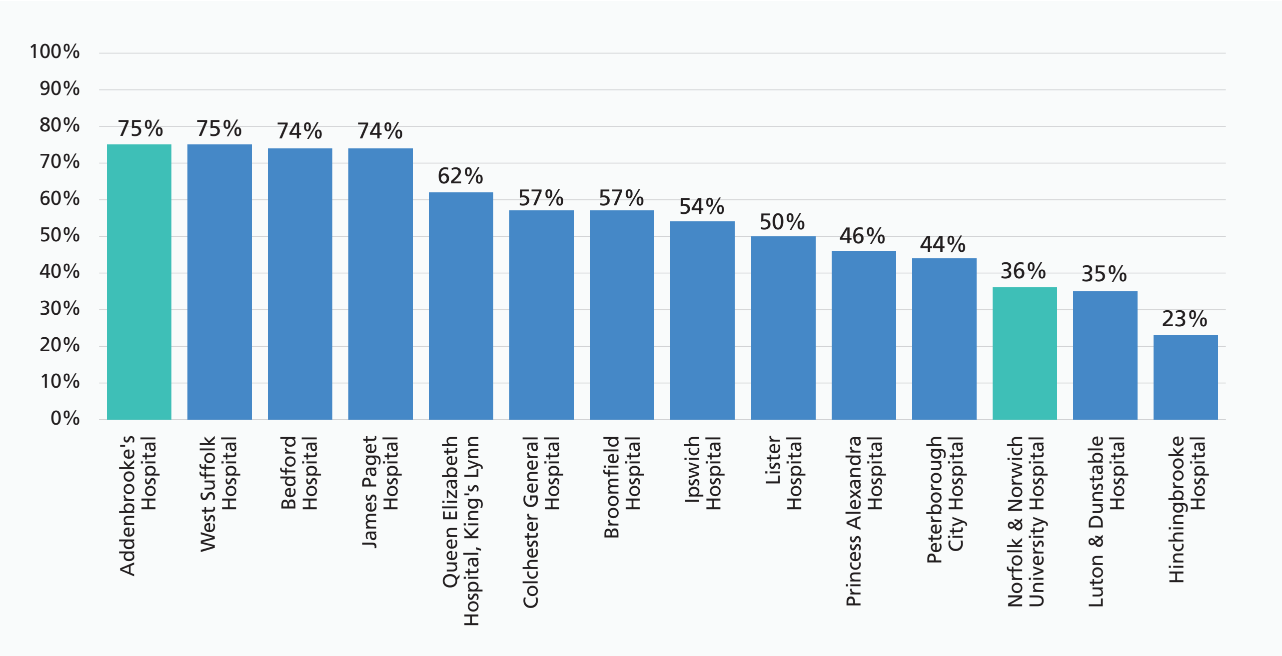
Figure 13.8 Proportion of major trauma with GCS <9 that went to the ED that were intubated – as initial hospital only (n=530), 2017/18 to 2019/20 pooled



CT scans

Of the patients with a GCS <13, 75% of patients were scanned within the target of an hour at Addenbrooke's Hospital (Figure 13.9). However, some Trauma Units perform poorly for this metric where under 40% were scanned within the hour, including Norfolk and Norwich Hospital. The likelihood of receiving a timely scan across sites reduces with age from 71% in patients aged 18–44 years to 54% in patients aged over 75 years. The proportion of patients receiving scans in those with GCS <13 at the MTC has declined from 86% in 2013/14 to 64% in 2021/22.

***Figure 13.9** Proportion of major trauma with GCS <13 CT scans that were performed within 1 hour of arrival across sites – as initial hospital only (n=828), 2017/18 to 2019/20 pooled*

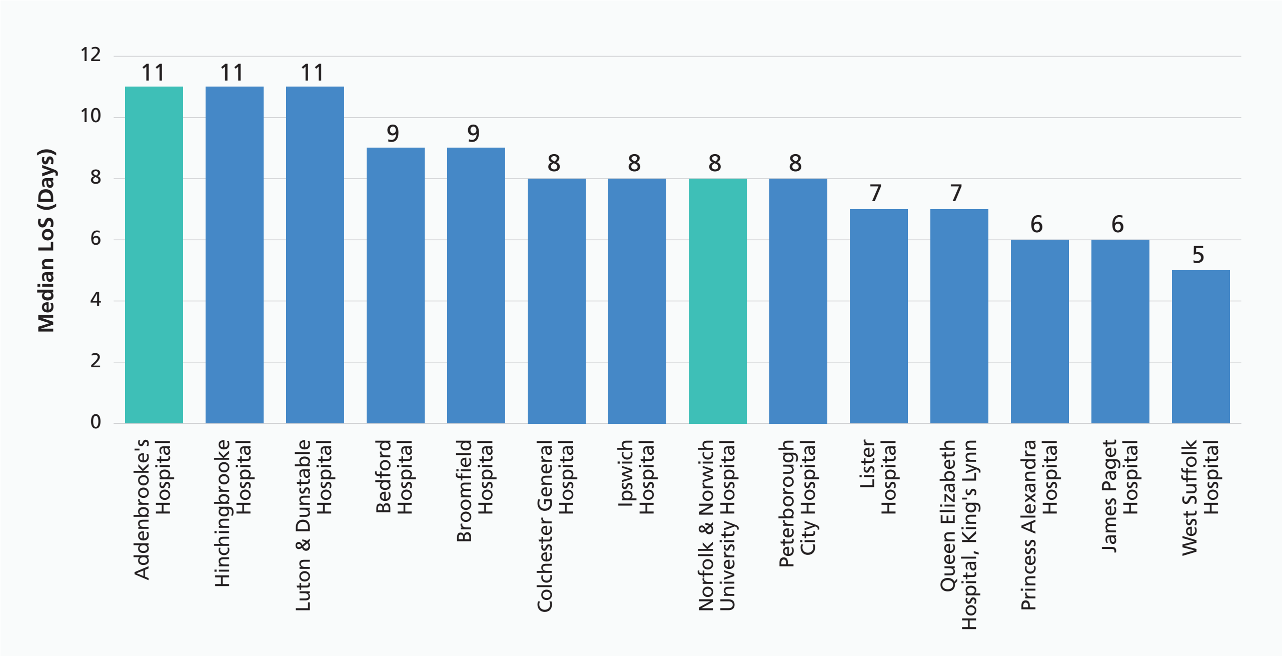


Length of stay (LoS)

By site, median LoS ranged from 11 days at Addenbrooke's, Luton and Dunstable, and Hinchingbrooke hospitals to just 5 days at West Suffolk Hospital (Figure 13.10). Norfolk and Norwich Hospital has a median LoS of 8 days. There was no difference in the median LoS between major trauma patients admitted directly to the MTC or patients transferred to the MTC from a TU (11 days). However direct to TU patients without a transfer had a shorter median LoS (8 days).

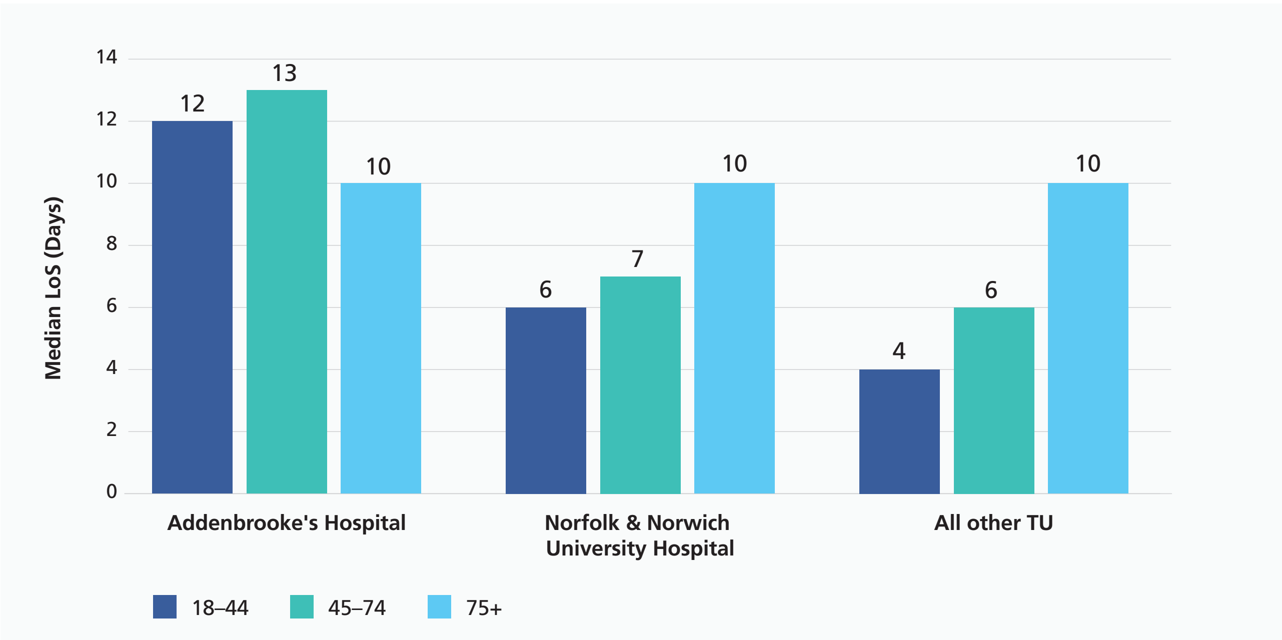
LoS has a wide range across patients and does not appear to be correlated with ISS. The longest LoS observed for a major trauma patient was 287 days but LoS over 100 days are less than 1% of all submissions. LoS can be adversely impacted by the availability of appropriate rehabilitation and social care provision which may lead to delays in discharge.

Figure 13.10 Median length of stay for major trauma by hospital site, 2017/18 to 2019/20 pooled



The median length of stay for elderly patients was 10 days at both the MTC and Trauma Units (Figure 13.11). However, for adults aged 18–44 and 45–74 years, the median LoS was twice as long at Addenbrooke's Hospital (12 days) compared to TU (6 days). Note that the data presented in TARN analytics includes all ISS and suggests a longer LoS with increasing age. Our analysis is only for major trauma (ISS >15) and suggests a longer LoS for younger adults at the MTC compared to TUs.

Figure 13.11 Median length of stay for major trauma by age group and site, 2017/18 to 2019/20 pooled

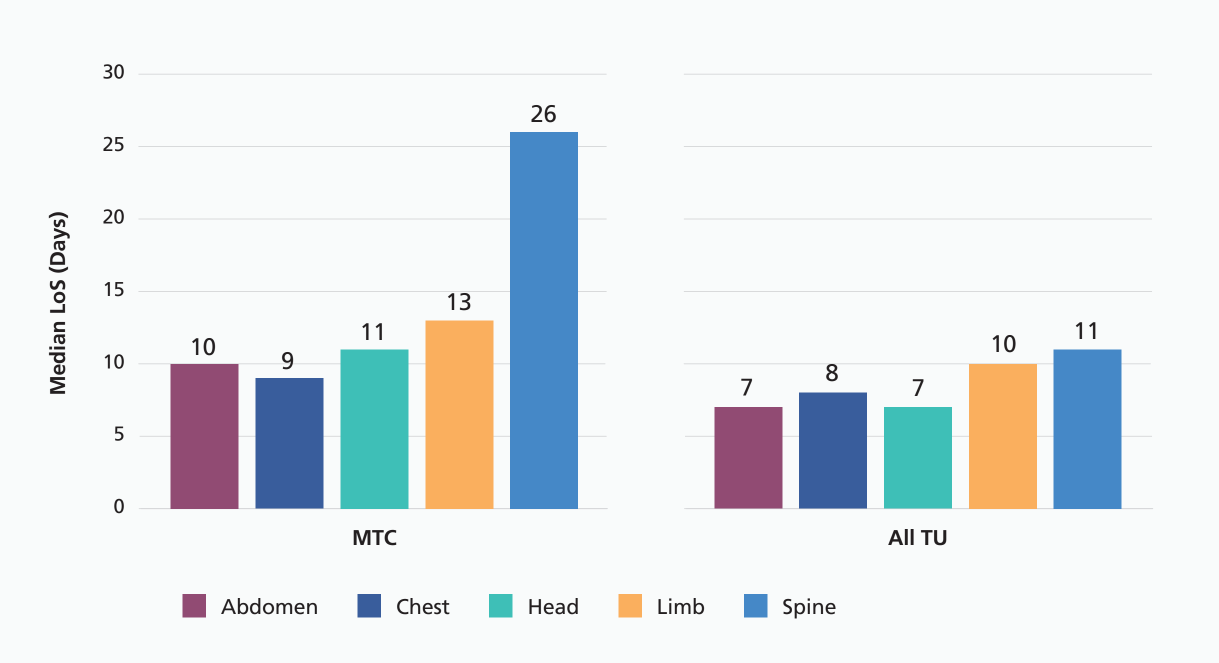


Over time, the median LoS per year has stayed at around 12 days for the MTC and 8 days for TUs. However, the median upper quartile range has declined from 29 to 25 days for Addenbrooke's Hospital and from 20 to 16 days for TUs over time. This suggests a reduction in very long stays.

Median ICU stays at Addenbrooke's Hospital remained at 4 to 5 days over time. ICU stays were shorter at TUs at 2 to 3 median days over time. The median LoS for a patient with severe head injury (AIS ≥3, GCS <9) at Addenbrooke's Hospital was 21 days, including 6 ICU days.

The longest LoS by most severely injured body region was for major trauma patients with spinal injuries. The LoS at the MTC for this injury was over twice that for a Trauma Unit (Figure 13.12). Recall from Part One that spinal injuries are the most severely injured region in less than 4% of major trauma patients. However, around a third of patients with any spinal injury have this as their most severely injured region. Transfers to out of region Spinal Injuries Units are prone to long waiting times. Further data related to spinal injury patients is available in Appendix 4.

***Figure 13.12** Median length of stay by most severely injured body region by site type, 2017/18 to 2019/20 pooled*

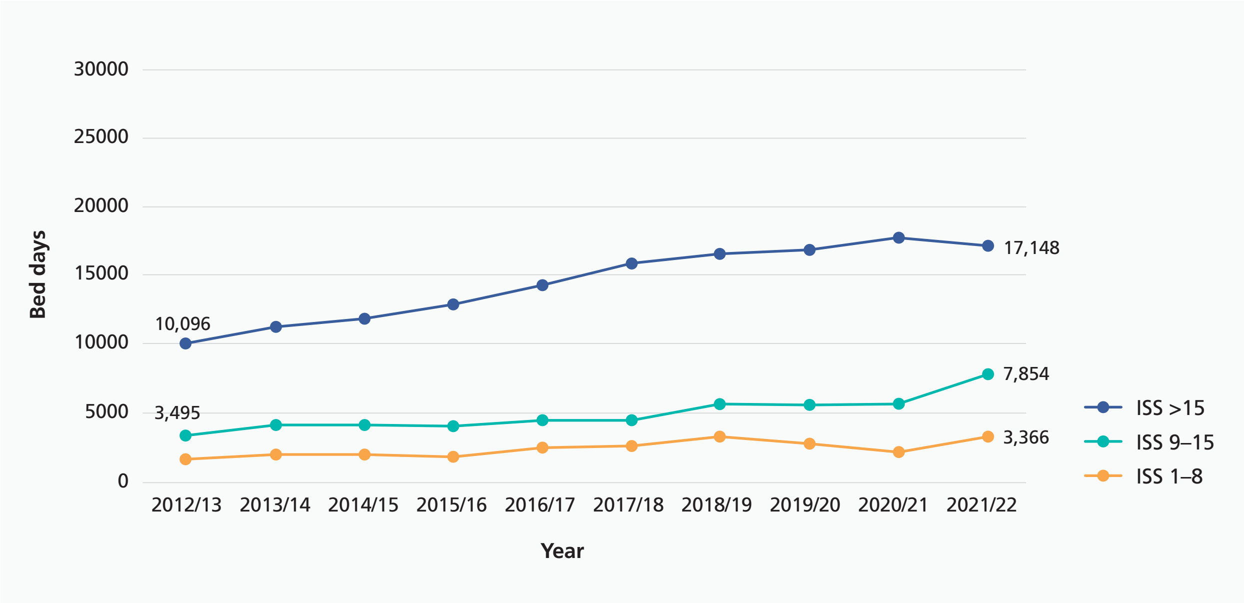


Bed occupancy

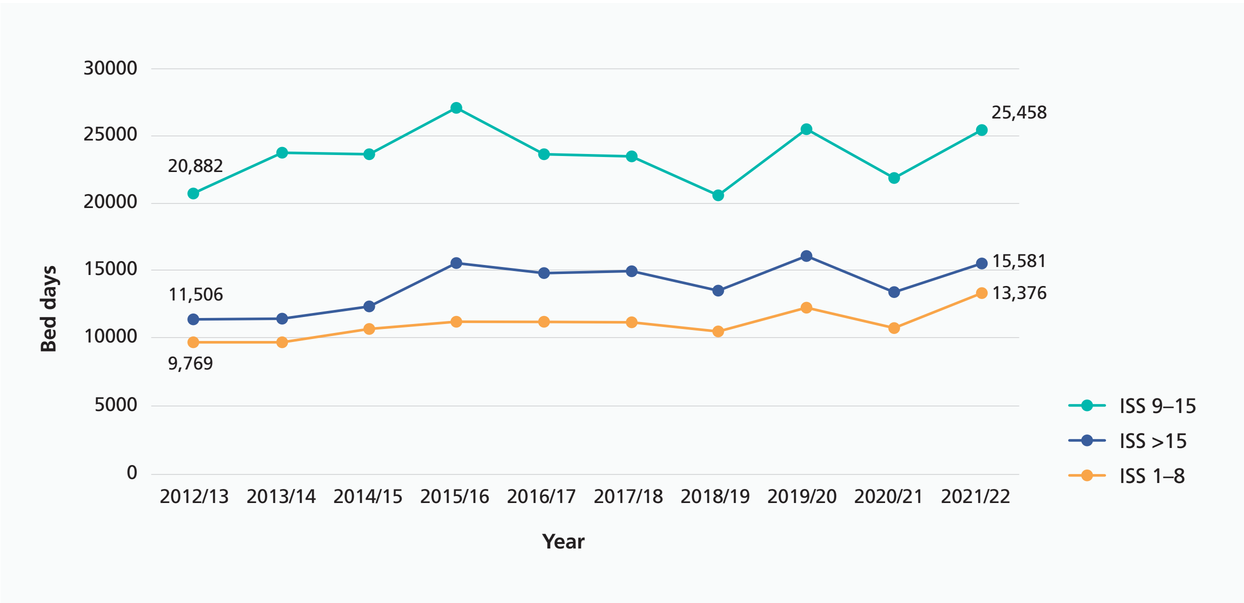
Figure 13.13 shows that bed days for all ISS have increased for the MTC (a) and TUs (b) over time. On average, half of all major trauma bed days have occurred at the MTC and half at TUs. Norfolk and Norwich Hospital accounts for an average of 10% of these bed days. The MTC has taken on more major trauma bed days over time leading to greater growth at the MTC compared to TUs. When considering bed days for all trauma as a measure of occupancy, Addenbrooke's Hospital and the TUs took on more bed days in 2021/22 than ever before. For the MTC this was an average of 78 beds per day and for TUs 149 beds per day. For TUs, this is a similar count to the peak in bed days observed in 2015/16 and 2019/20.

Figure 13.13 Total bed days per year over time for trauma by ISS for a) Addenbrooke's Hospital b) All Trauma Units combined.

a



b



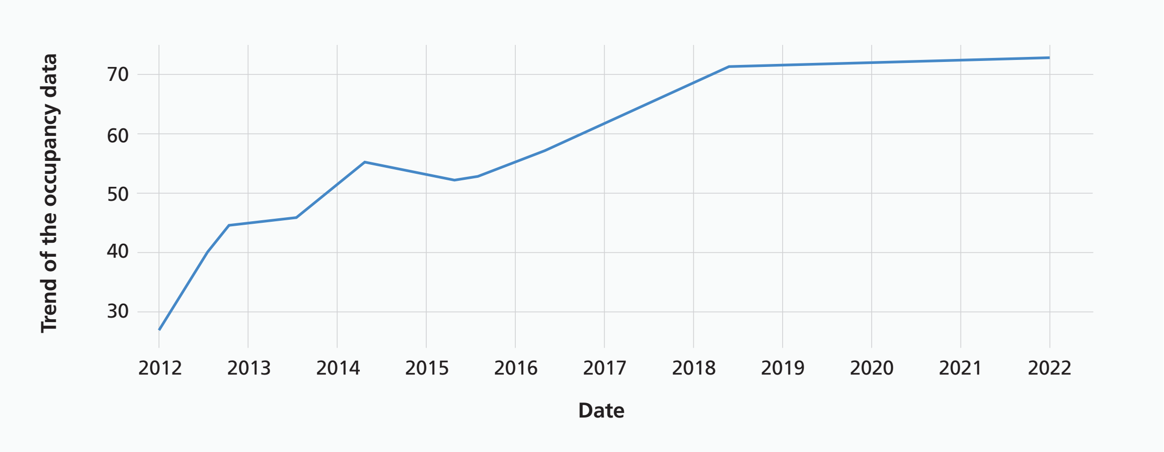
Modelling bed occupancy

When daily bed occupancy for all trauma (all ISS) is modelled into a trend line, Figure 13.14 shows a stark plateau in the occupancy of the MTC at around 72 beds from 2018 onwards (a). In contrast, the daily bed occupancy for TUs is modelled to rise from the same year (b). The model for Norfolk and Norwich Hospital has a similar trend to that seen for all TUs with even sharper rising bed occupancy but with a stronger dip in 2018/19 (c). The model also provides consistent seasonal, and day of the week trends aligned to wider literature which show a peak occupancy in July and November and on Mondays. The model forecasts use Facebook Prophet, the details of which are available in Appendix 5.

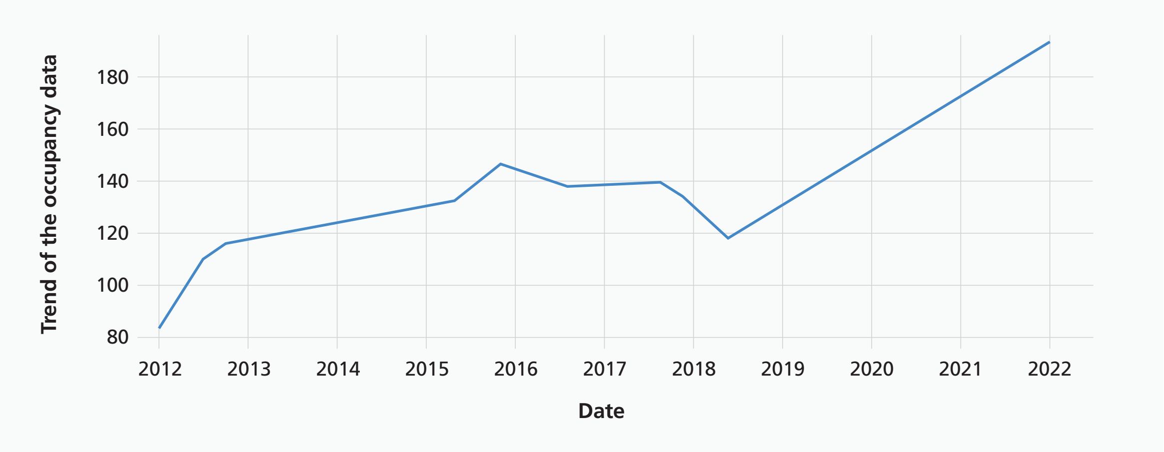
The constant trend of 72 beds occupancy at Addenbrooke's Hospital suggests that the system has reached its capacity, and there is potentially an active selection of cases into the MTC to provide the best possible trauma care in the East of England within this capacity. The current MTC capacity may have been saturated since 2018 and it is likely that TUs have been absorbing the spillover demand.

Figure 13.14 *Forecast of bed occupancy for all trauma (all ISS) for*

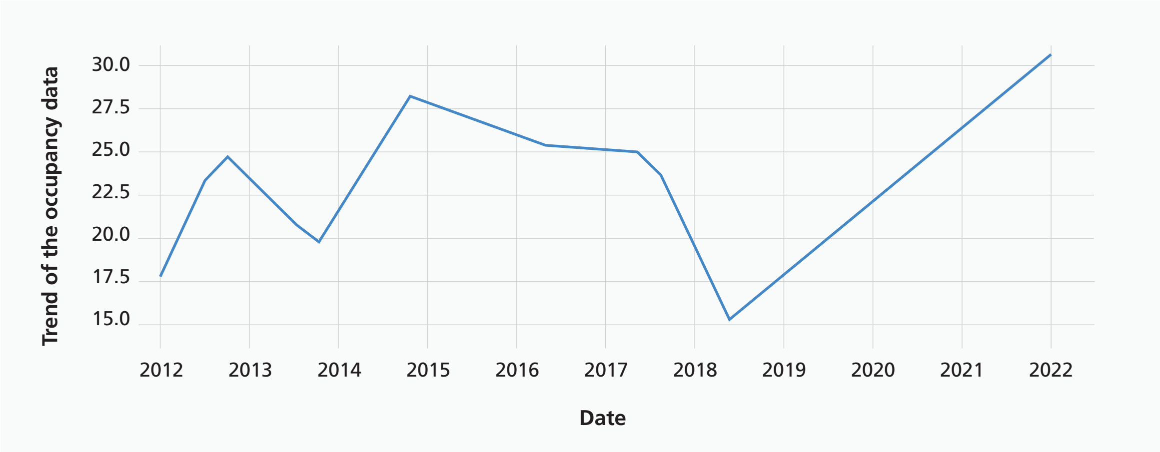
a MTC



b All TUs over time



c Norfolk and Norwich Hospital

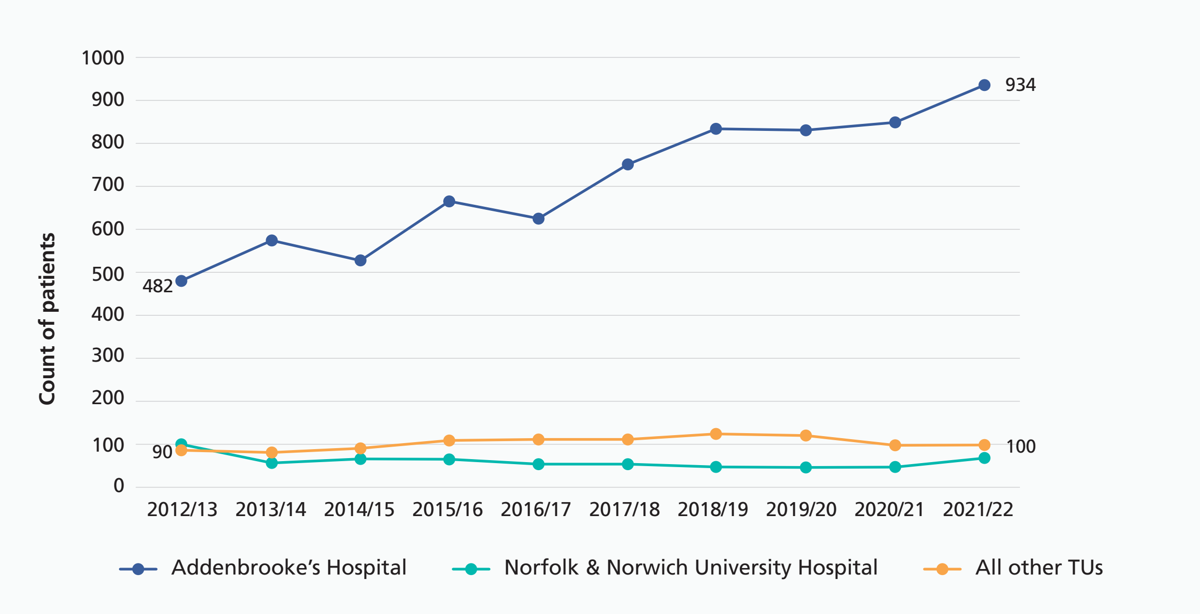


Surgical operations

For the 2017/18 to 2019/20 period, there were 2,992 operations performed on major trauma patients, of which 83% were performed at Addenbrooke's Hospital and 5% at Norfolk and Norwich Hospital. Figure 13.15 shows that operations at Addenbrooke's Hospital have almost doubled over time from 482 to 934 operations in 2021/22. At Trauma Units, the number of operations has remained stable. Of the total surgeries across sites, 72% were performed on men and only 19% were in patients aged over 75 years.

The proportion of major trauma patients having at least one operation over time has been stable at between 28% and 32% of all patients. Of major trauma patients admitted to Addenbrooke's Hospital, between 56% and 63% required an operation. Of those patients who had a hospital transfer, 10% of operations were performed at the initial site. Of major trauma patients who required an operation, 31% required multiple operations with a trend towards this proportion declining over time.

Figure 13.15 Count of major trauma operations over time by site



Patient ward

Table 13.1 shows the first and subsequent wards of major trauma patients attending Addenbrooke's or Norfolk and Norwich hospitals. Over half of Addenbrooke's Hospital patients attended the Level 3 ward as their initial ward (57%). For Norfolk and Norwich patients, 78% attended the Emergency Admissions Unit (EAU) as their initial ward. This may have implications on the structural organisation of ward use if Norfolk and Norwich Hospital is to become a second MTC. Use of the EAU occurred for only 8% of patients at Addenbrooke's Hospital. Over a third of patients attended a neurosurgical ward as their second ward at Addenbrooke's (37%) with the majority coming from Level 3. The largest second ward attended for Norfolk and Norwich was the Geriatric ward (27%).

Table 13.1 Proportion of first and subsequent second ward attended by major trauma patients. <=1% not shown. Excludes transfers out, 2017/18 to 2019/20 pooled.

First ward attended	Addenbrooke's Hospital	Norfolk & Norwich University Hospital
Level 3	**57%**	**6%**
Second ward attended from Level 3		
Neurosurgical ward	29%	0%
Orthopaedic (inc. paediatric)	10%	2%
Surgical ward (inc. paediatric)	10%	1%
Neurosurgical rehabilitation ward	2%	0%
General acute (inc. paediatric)	2%	1%
Neurosurgical ward	**17%**	**1%**
Second ward attended from Neurosurgical		
Level 3	4%	0%
Neurosurgical rehabilitation ward	9%	0%
Level 2	**9%**	**11%**
Second ward attended from Level 2		
Neurosurgical ward	4%	0%
Orthopaedic (inc. paediatric)	2%	5%
Surgical ward (inc. paediatric)	2%	4%
Emergency Admissions Unit (EAU)	**8%**	**78%**
Second ward attended from EAU		
Neurosurgical ward	1%	6%
Orthopaedic (inc. paediatric)	1%	15%
Surgical ward (inc. paediatric)	1%	10%
General acute (inc. paediatric)	1%	4%
Medical ward (inc. palliative care)	1%	12%
Geriatric	3%	26%
Emergency Admissions Unit (EAU)	0%	2%
Medical ward (inc. palliative care)	**3%**	**0%**
Surgical ward (inc. paediatric)	**1%**	**2%**
All other wards	**4%**	**3%**
Grand total	**100%**	**100%**

14
Patient outcomes (mortality, discharge and survival)

This section considers the outcomes of major trauma patients treated in trauma hospitals. Mortality is considered a crude outcome measure compared to survival and disability outcomes, which are described later in this section. Currently, we do not have the data for pre-hospital major trauma deaths or rehabilitation outcomes.

Mortality – outcome at 30 days post-discharge

Between 2012/13 and 2021/22, East of England trauma hospitals reported that 2,575 persons died because of major trauma injuries sustained. Of those who died, 22% were recorded as involving shocked patients (systolic blood pressure <110mmHg). About a third of major trauma deaths, recorded 30 days post discharge, were discharges from the MTC with an average of 80 deaths per year. The count of deaths peaked in 2018/19 for Addenbrooke's Hospital at 111 deaths. In contrast, Trauma Units had a lower count of deaths than average in that year (Figure 14.1).

***Figure 14.1** Annual count of major trauma deaths after 30 days post discharge over time (n=2,575).*

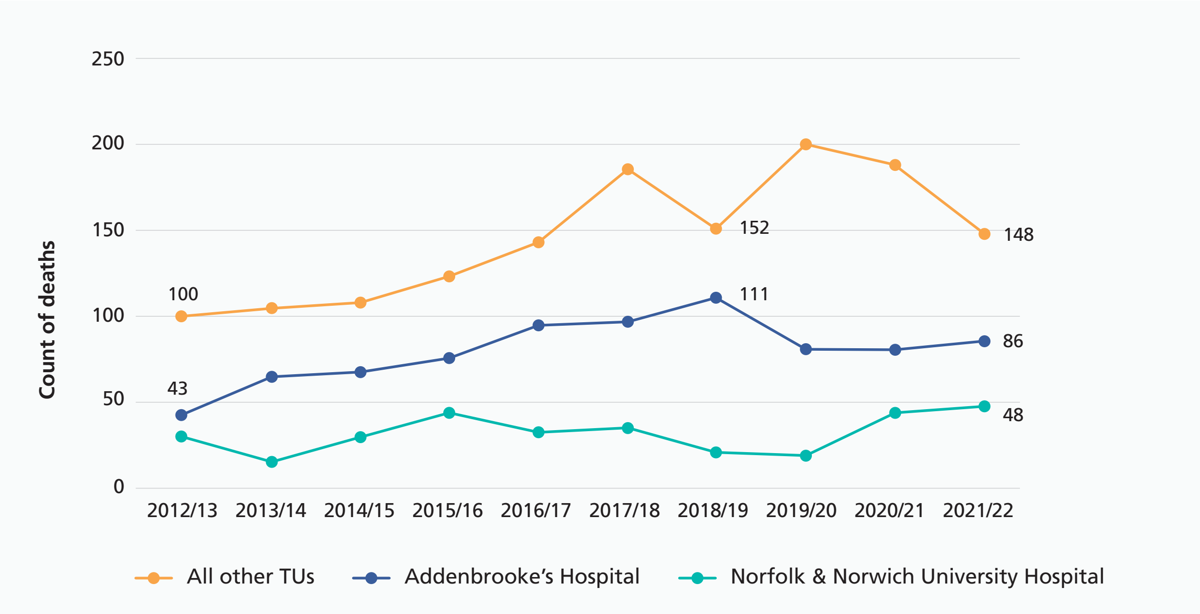
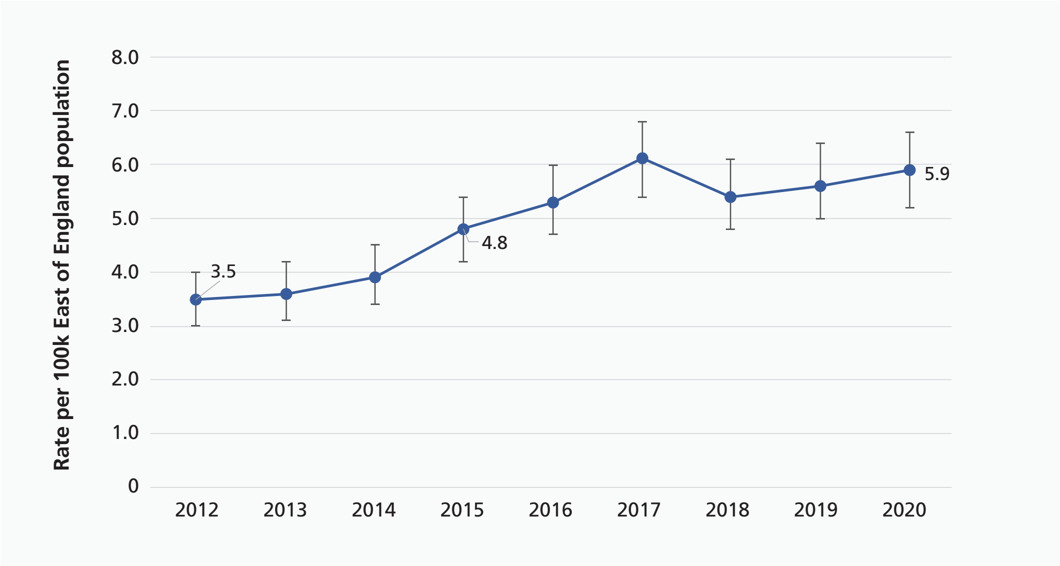


Figure 14.2 shows that the crude death rate from major trauma significantly increased in 2015 compared to 2012 from 3.5 to 4.8 per 100k persons. However, it has not significantly increased since 2016 which coincides with the slowing growth of major trauma incidence from this year (Part One).

Figure 14.2 Major trauma deaths per 100k for East of England 18+ years population over time (crude rate)



Mortality demographics

By demographics, deaths increase with age with elderly deaths accounting for 64% of total major trauma deaths. Deaths in men accounted for 60% of major trauma deaths which is equivalent to their incidence compared to women (Part One). Despite the incidence of major trauma being equal between males and females at age 75+ years, proportionally there were slightly more deaths in men (Figure 14.3).

Figure 14.3 Proportion of major trauma deaths by sex and age group (n=901), 2017/18 to 2019/20 pooled

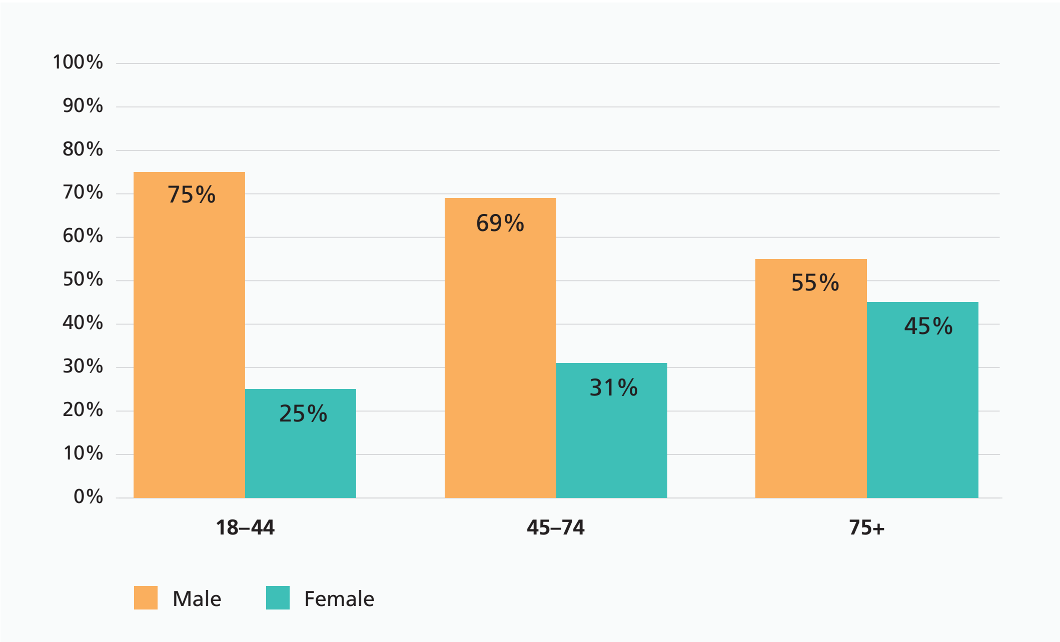


Table 14.1 shows more detail about death rates over time than can be determined from the rate across all groups. The major trauma death rate for persons aged 45–74 and those over 75 years increased over time but slowed in the later part of the decade. In the elderly, the death rate significantly increased from 19.3 per 100k to 31.1 per 100k in 2016/17 but has not significantly increased since this year. Similarly, the death rate in persons aged 45–74 years has significantly increased from 1.9 per 100k in 2012/13 to 3.1 per 100k in 2017/18 but has not significantly increased since this year.

Figure 14.4 shows how the proportion of deaths is shifting more towards the older age group in both sexes over time.

Table 14.1 Crude rate per 100k of East of England population by age group for major trauma deaths over time

Falls less than 2 meters	Rate per 100k		
Year	**18–44**	**45–74**	**75+**
2012/13	1.6	1.9	19.3
2013/14	1.5	1.9	22.5
2014/15	1.6	2.3	23.5
2015/16	1.8	2.7	27.5
2016/17	1.9	2.9	31.1
2017/18	1.7	3.1	37.8
2018/19	1.7	3.1	31.2
2019/20	1.5	3.1	33.9
2020/21	1.4	3.6	34.2

Figure 14.4 Count and proportion of major trauma deaths at 30 days by sex and age group over time (n=1,329)

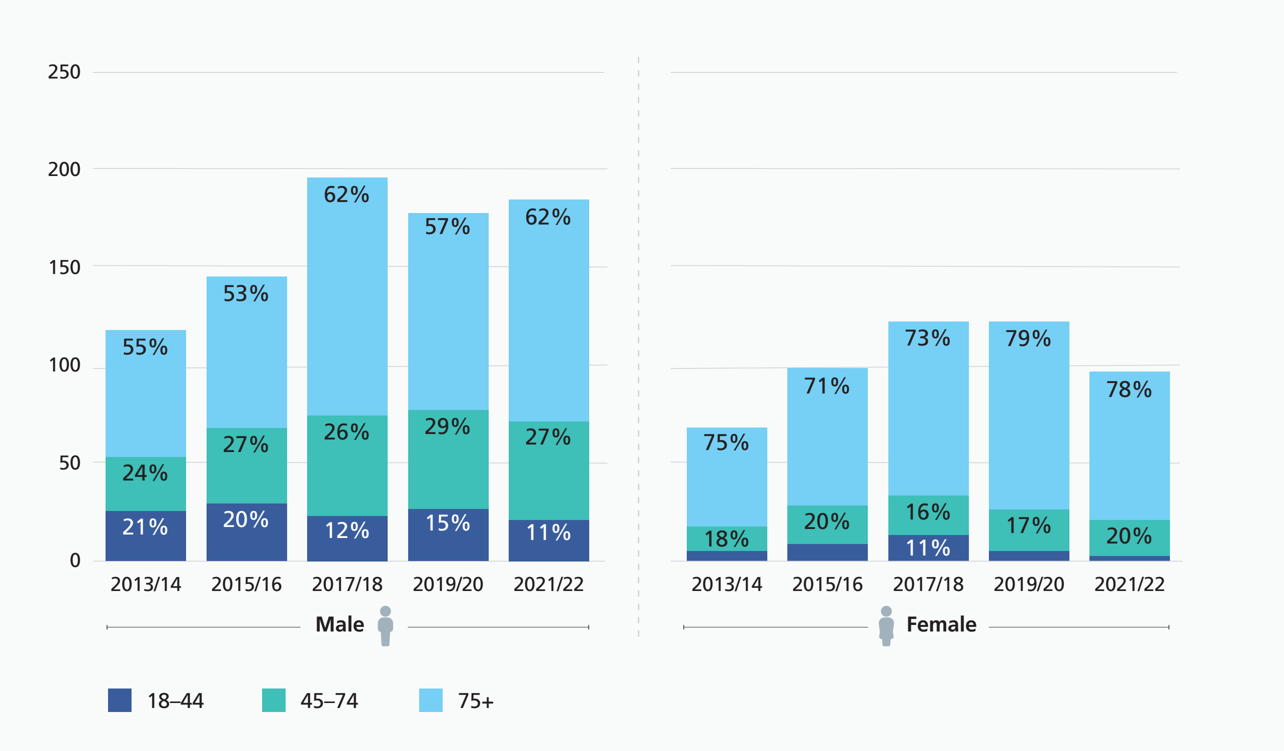
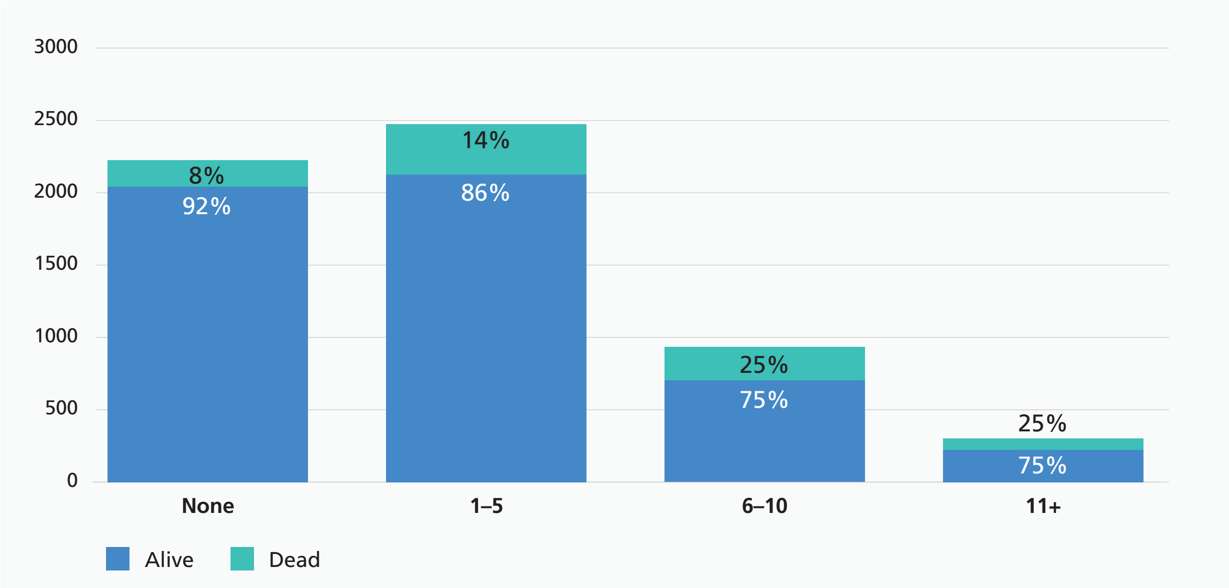


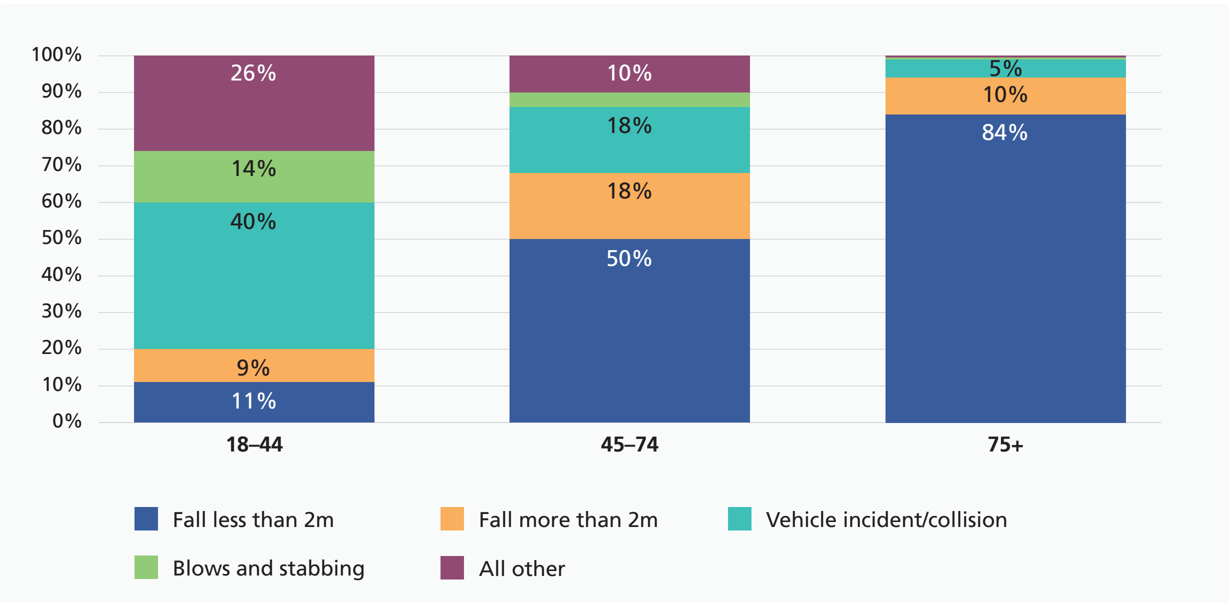
Figure 14.5 shows that major trauma patients with more comorbidities by the Charlson Comorbidity Index are more likely to have died 30 days post-discharge. A quarter of those with a score of 6 or more died from their injuries compared to only 8% of those with no score.

Figure 14.5 Count and proportion of major trauma deaths at 30 days by Charlson Comorbidity Index (n=5,963), 2017/18 to 2019/20 pooled



Falls less than two meters accounted for 65% of all major trauma deaths. In the elderly, such falls accounted for 84% of deaths in this age group and half of middle-aged deaths (Figure 14.6). The proportion of deaths by mechanism and age is similar to their incidence with vehicle incidents being the main cause of death in patients aged 18–44 years. Other injuries had a high mortality compared to their incidence in this age group (Part One). Head injuries are the most severely injured body region in 75% of major trauma deaths.

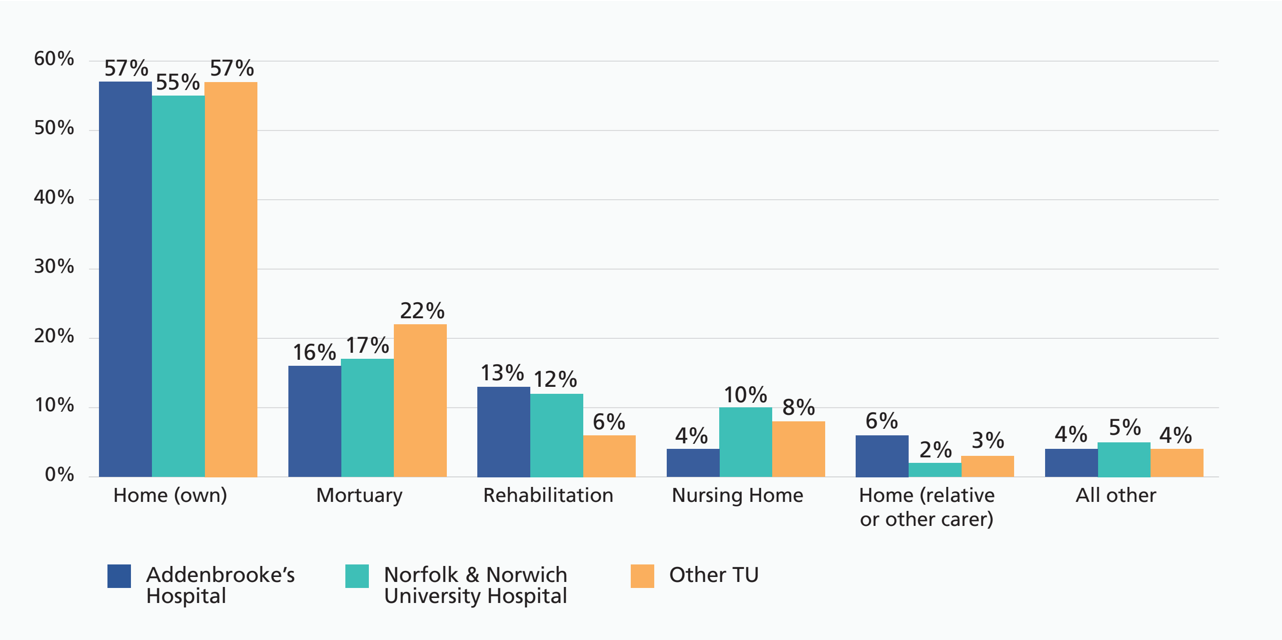
Figure 14.6 Proportion of major trauma deaths at 30 days by injury mechanism and age group (n=901), 2017/18 to 2019/20 pooled



Discharge location

Figure 14.7 shows that 57% of major trauma patients are discharged to their own home from the MTC and this proportion is similar to the TUs. However, Addenbrooke's Hospital patients are twice as likely to be discharged to rehabilitation whilst TUs are more likely to discharge to a nursing home. Note, that this analysis excludes submissions where the final discharge location is unclear due to a transfer out to another acute hospital (n=1,197). Mortuary is not equivalent to mortality which is 30 days after discharge.

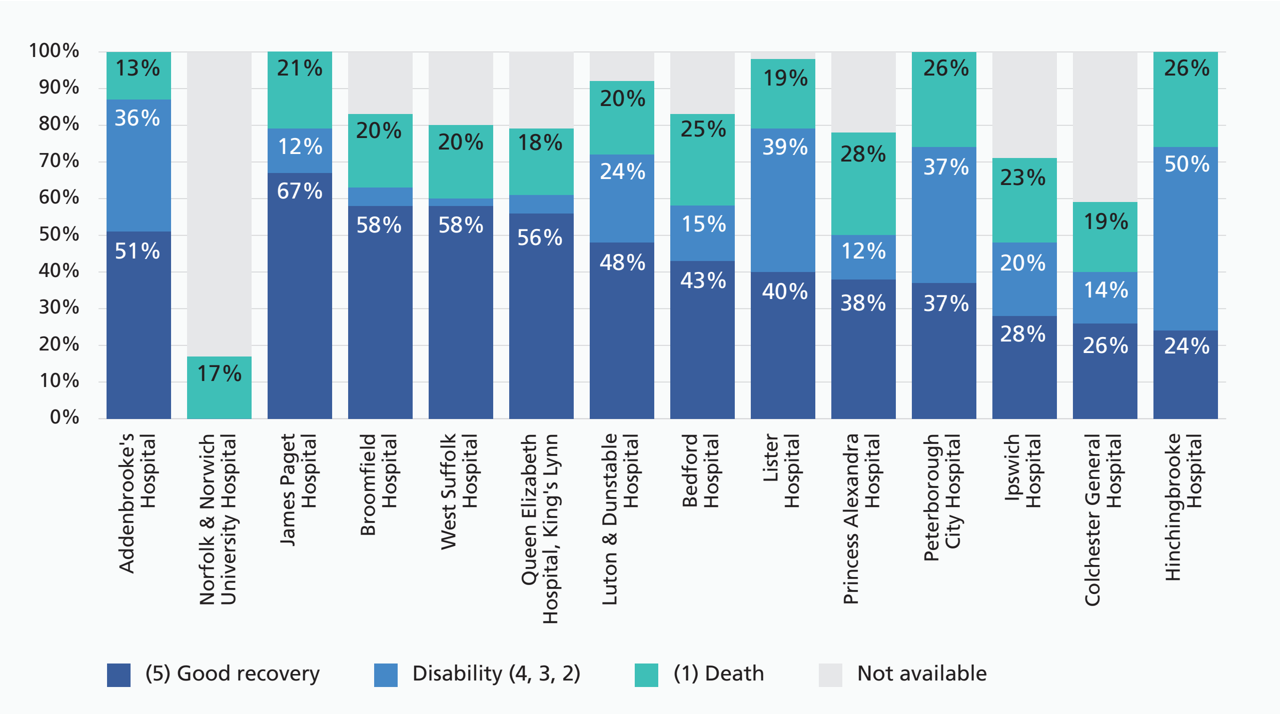
Figure 14.7 *Discharge location of major trauma patients by site (n=4,747), 2017/18 to 2019/20 pooled*



Disability

Figure 14.8 shows that half of all discharges from Addenbrooke's Hospital resulted in a good recovery using the Glasgow Outcome Scale (GOS). In Trauma Units, good recovery ranged from 67% at James Paget to just 24% at Hinchingbrooke Hospital. Most hospitals are missing some patient GOS outcomes, with over 20% missing at Colchester, Ipswich, and Princess Alexandra hospitals. Norfolk and Norwich Hospital does not submit GOS outcomes. Note that GOS does not adjust for severity of injury or case mix.

Figure 14.8 Glasgow Outcome Scale (GOS) for major trauma across sites (discharging hospital) (n=4,871), 2017/18 to 2019/20 pooled



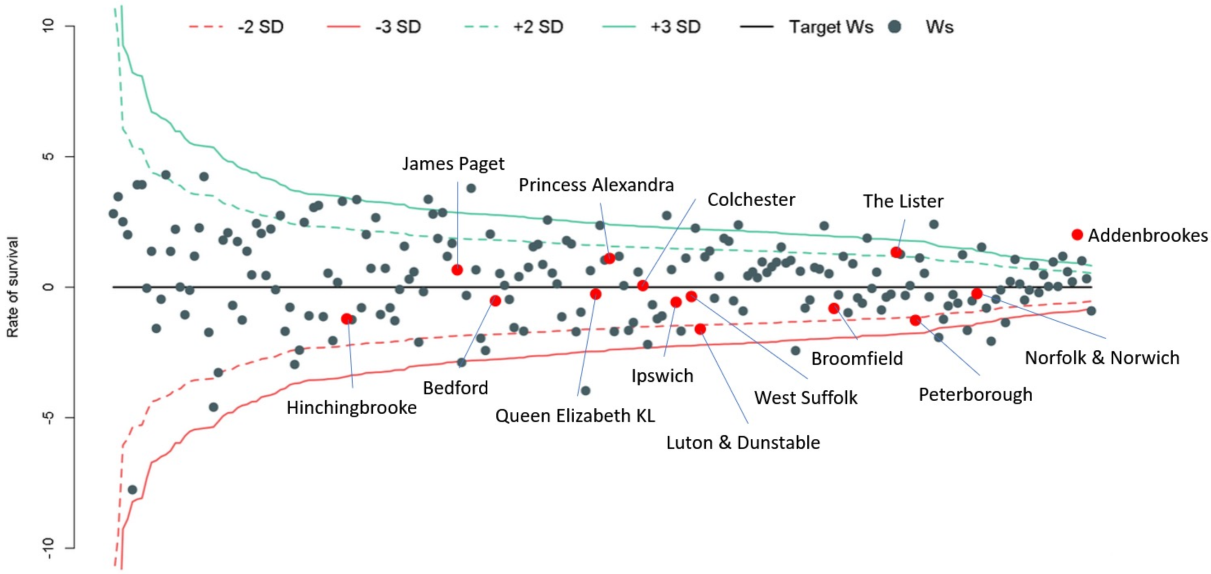
Survival

The Ws value of a hospital is the survival rate adjusted for confounding factors such as age, comorbidities, and injury severity. This creates a score that is comparable across hospitals. The value of Ws indicates how many 'additional' patients out of 100 were saved beyond the expectation of the probability of survival (Ps) calculated by the hospital.

From 2017/18 to 2019/20, major trauma patients transferred to the MTC had the highest median Ps (median 94.3). Ps was higher for patients admitted directly to the MTC (median Ps 92.2) compared to those remaining in Trauma Units (median Ps 84.9). This reflects crude mortality outcomes (30 days after discharge), where direct to MTC patients had a higher survival (85%) than TU only patients (80%).

Figure 14.9 shows the adjusted survival based on all trauma injuries. Addenbrooke's Hospital has the highest adjusted survival in the region of 2.02. Luton and Dunstable, and Peterborough City hospitals have Ws values -2 standard deviation from the target Ws value. This means fewer patients were saved at these hospitals than expected.

Figure 14.9 *Ws scores by English trauma hospital for 2020–2022 (all trauma)*



→ X axis represents size of patient population which impacts reliability.

Hospital	Ws	Case Ascertainment
Addenbrooke's	2.02	114.4
Lister	1.38	87.8
Princess Alexandra	1.11	93.9
James Paget	0.67	63
Colchester	0.08	50.5
Norfolk & Norwich	-0.22	102
Queen Elizabeth King's Lynn	-0.24	74.6
West Suffolk	-0.34	107.1
Bedford	-0.5	85.4
Ipswich	-0.57	100.7
Broomfield	-0.84	89.6
Hinchingbrooke	-1.21	93.1
Peterborough	-1.25	83.1
Luton & Dunstable	-1.69	98.3

Adapted from TARN Analytics, University of Manchester (2020–2022).
Data with a case ascertainment below 80% should be interpreted with extreme caution.

15
Equity of access to Addenbrooke's Hospital (MTC) and Norfolk and Norwich Hospital (Proposed Second MTC)

In this section, equity of access is considered by both availability of MTC services by patient characteristics and access by site distance. Drive time is determined by using car drive times due to the unavailability of ambulance drive times at the time of this report. When reviewed, car drive time boundaries were found to closely match areas covered by the original Mackenzie et al (2013)[1] report. A 45-minute drive time is the triage area used for coverage of the East of England Trauma Network to the MTC. The national recommendation is a 60-minute drive time.

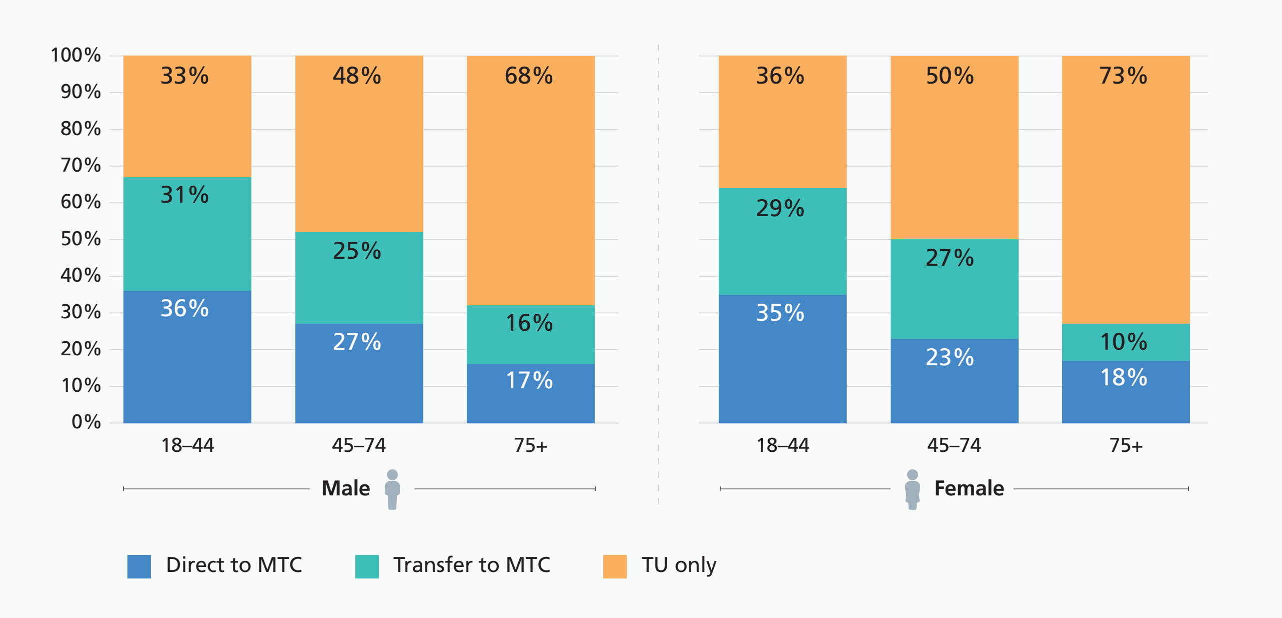
Equity of admission to the MTC by demographics and mechanisms

National Standards recommend that major trauma patients be treated in an MTC. However, only 45% of East of England patients are admitted to an MTC. This includes 24% directly admitted and 21% transferred in from a Trauma Unit. This trend has remained consistent over time even with increasing patient counts. About 55% of major trauma patients are treated entirely in TUs and this impacts certain demographics more than others. Note that in this section, transfers out from the MTC are included in the direct to MTC population. Transfers between Trauma Units are included as TU only.

Figure 15.1 shows that major trauma patients were more likely to be managed in a TU as age increased, with 70% of elderly patients managed entirely in a TU. Patients under 45 years old are the most likely to be admitted directly or transferred to the MTC. Proportionally, women are slightly more likely to remain in a TU at any age compared to men.

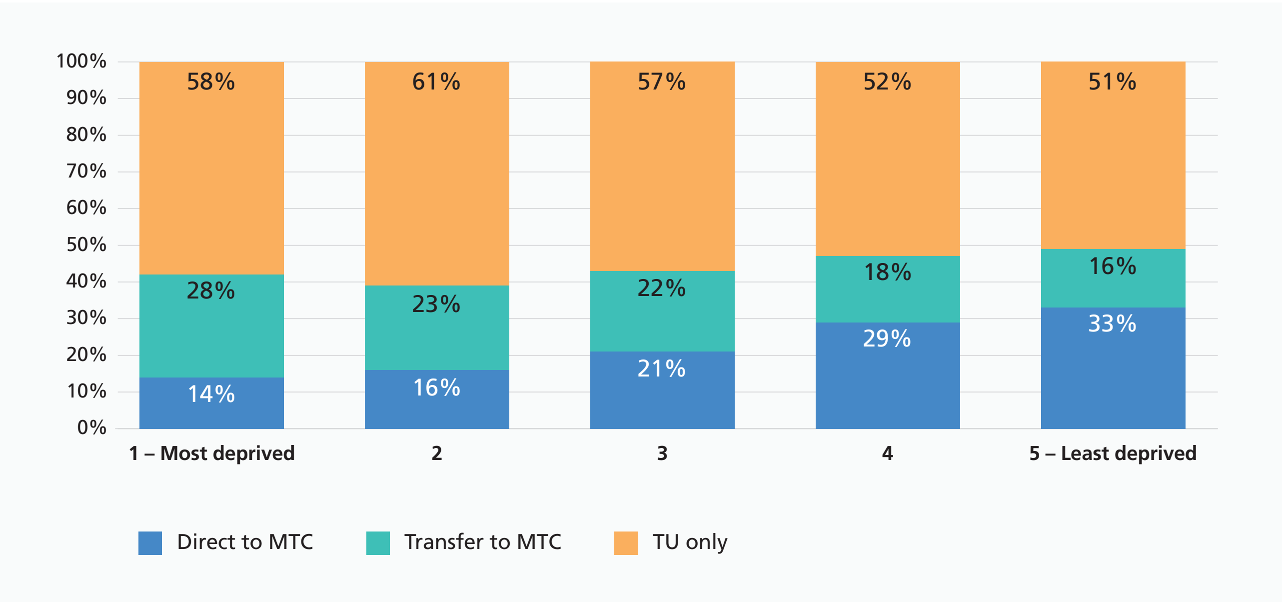
[1] Mackenzie, R., S. Lewis, B.F. Matta. 2013. Trauma care organisation. A. Gullo, ed., Anaesthesia, Pharmacology, Intensive Care and Emergency A.P.I.C.E.: Proceedings of the 25th Annual Meeting – International Symposium on Critical Care Medicine, chap. 5. Springer, 49–71. doi:10.1007/978-88-470-5516-2 5.

Figure 15.1 Proportion of major trauma movement to MTC or TU by age and sex (n=5,336), 2017/18 to 2019/20 pooled



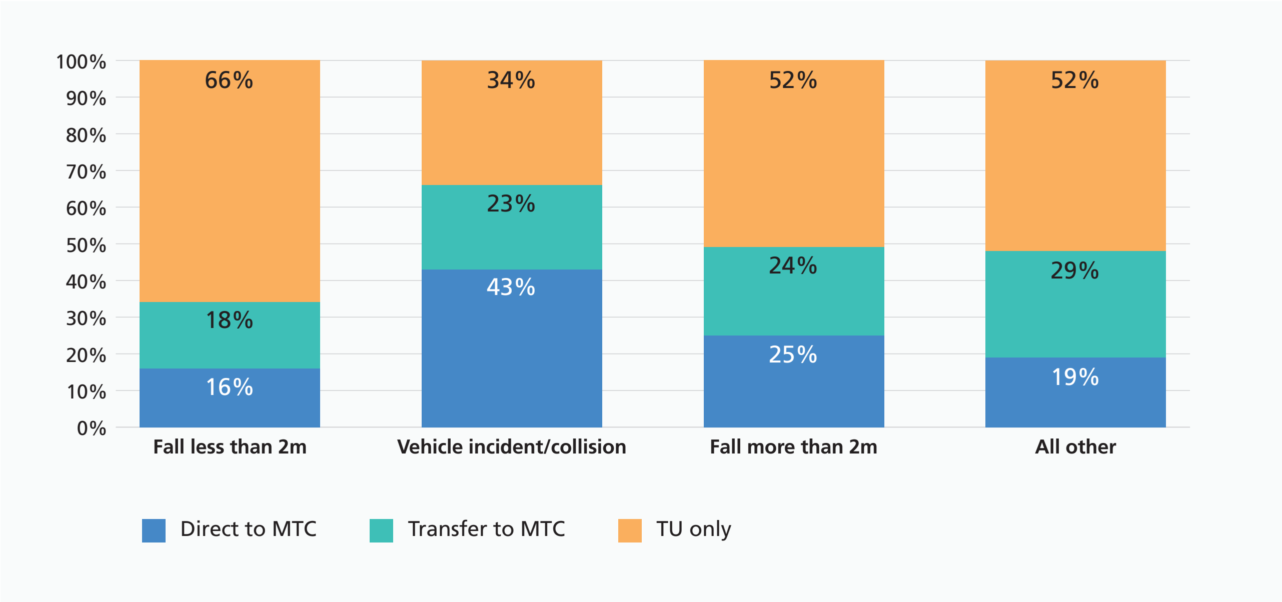
Major trauma patients living in the most deprived areas are the least likely to be admitted directly to the MTC. Only 14% of the most deprived quintile is directly admitted compared to 33% of the least deprived (Figure 15.2). This highlights the inequality resulting from different direct access of deprived communities to the MTC by drive time distance, as described in the next part of this section. This inequality is slightly compensated by the higher proportion of secondary transfers to the MTC this group receives, however, the most deprived major trauma patients are still more likely to remain and receive their entire care in a TU compared to the least deprived.

Figure 15.2 Proportion of major trauma movement to MTC or TU by IMD quintile (n=5,271), 2017/18 to 2019/20 pooled



By injury mechanism, patients of vehicle incidents are more likely to be admitted directly to the MTC than any other mechanism (Figure 15.3). Overall, 66% of patients with vehicle related injuries received treatment from the MTC. Patients with low falls were the most likely to remain at a TU with only 34% receiving treatment from the MTC.

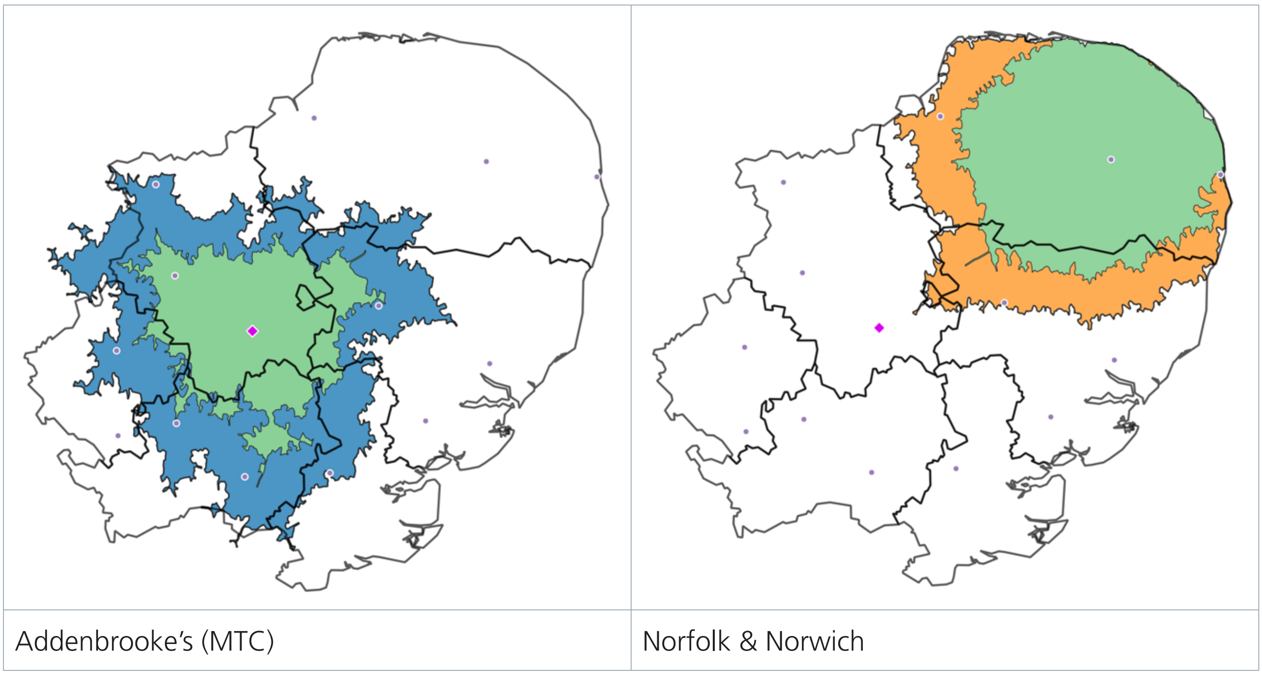
Figure 15.3 Proportion of major trauma movement by injury mechanism (n=5,336), 2017/18 to 2019/20 pooled

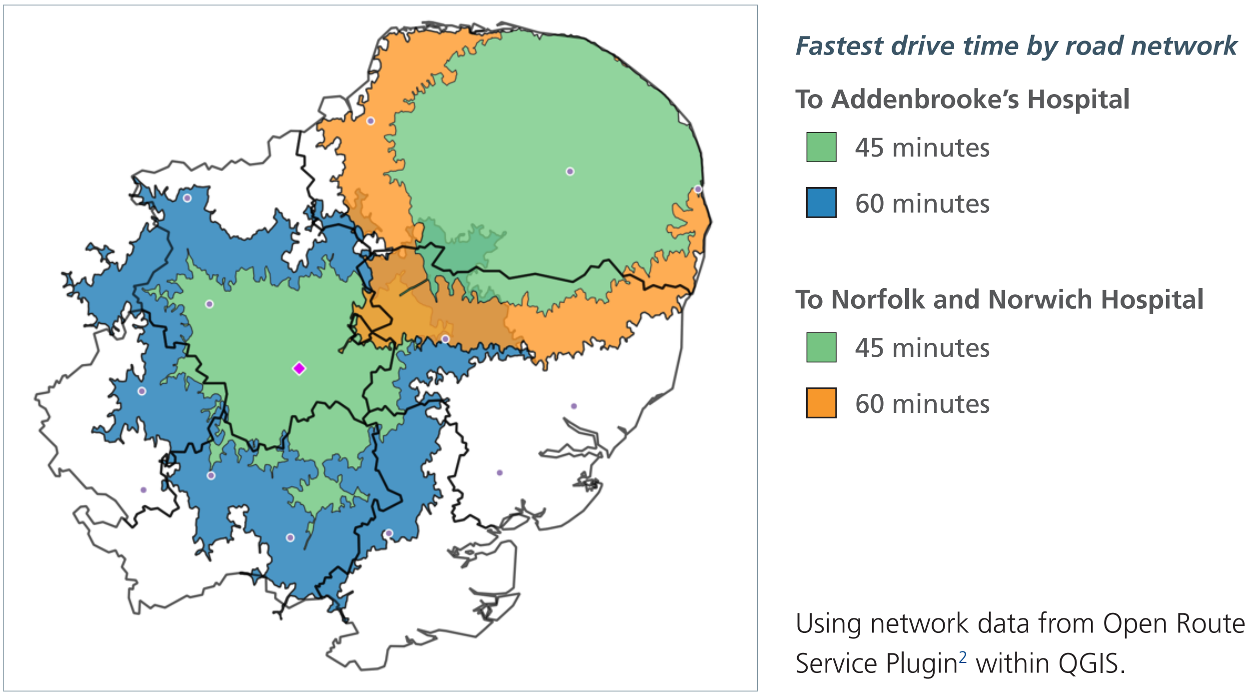


Equity of access by drive time

Figure 15.4 shows the catchment area that can be reached within a 45- or 60-minute drive from Addenbrooke's Hospital or Norfolk and Norwich Hospital. When the two catchment areas are overlaid, there is no overlap of the 45-minute reachable areas. However, there is an overlap of the 60-minute areas, mainly in West Suffolk.

Figure 15.4 *Fastest travel time by car – catchment area within 45 or 60 minutes along the road network (Isochrones).*



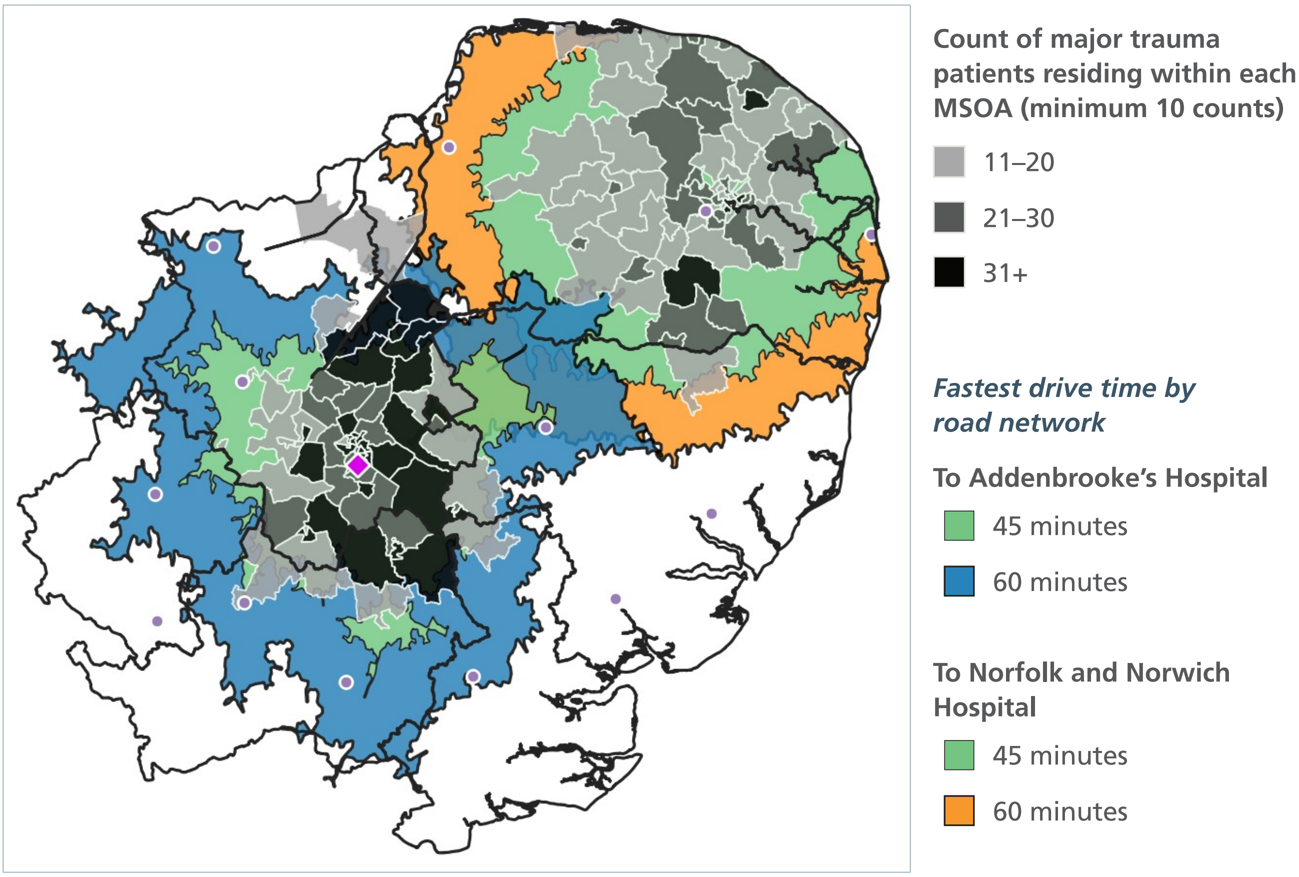


Using network data from Open Route Service Plugin[2] within QGIS.

[2] https://openrouteservice.org

The count of major trauma patients using Addenbrooke's or Norfolk and Norwich hospitals matches well with the 45-minute drive boundary of both hospitals (Figure 15.5). The exception is East Cambridgeshire (Ely) where there are high counts of patients despite being on the 45-to-60-minute boundary to Addenbrooke's Hospital.

Figure 15.5 Isochrones overlaid with count of major trauma patients attending Addenbrooke's or Norfolk and Norwich Hospital by Middle Super Output Area (MSOA)



Drive time from major trauma incidents

Data in this section on incident locations incorporates patients across ten years of TARN submissions (2012–2021). For patients whose incident location could not be determined, their residential postcode was used (20% of the eligible population). Drive time is estimated at midnight to replicate Blue Light travel conditions along the road network. Technical details are included in Appendix 6.

Up to a 25 minute drive time from an incident, over 90% of patients are likely to be directly admitted to the MTC (Figure 15.6). Between 25 and 35 minutes this drops to 60–70% of patients being directly admitted and after 35 minutes, the likelihood drops very sharply. After this time, about 65% of patients remain in TUs and a further 20% are transferred to the MTC from a TU. For the elderly, above the 35-minute cut-off results in around 80% of patients remaining in a TU.

Figure 15.6 *Proportion of patients by drive time from major trauma incident to MTC coded by movement type (off-peak)*

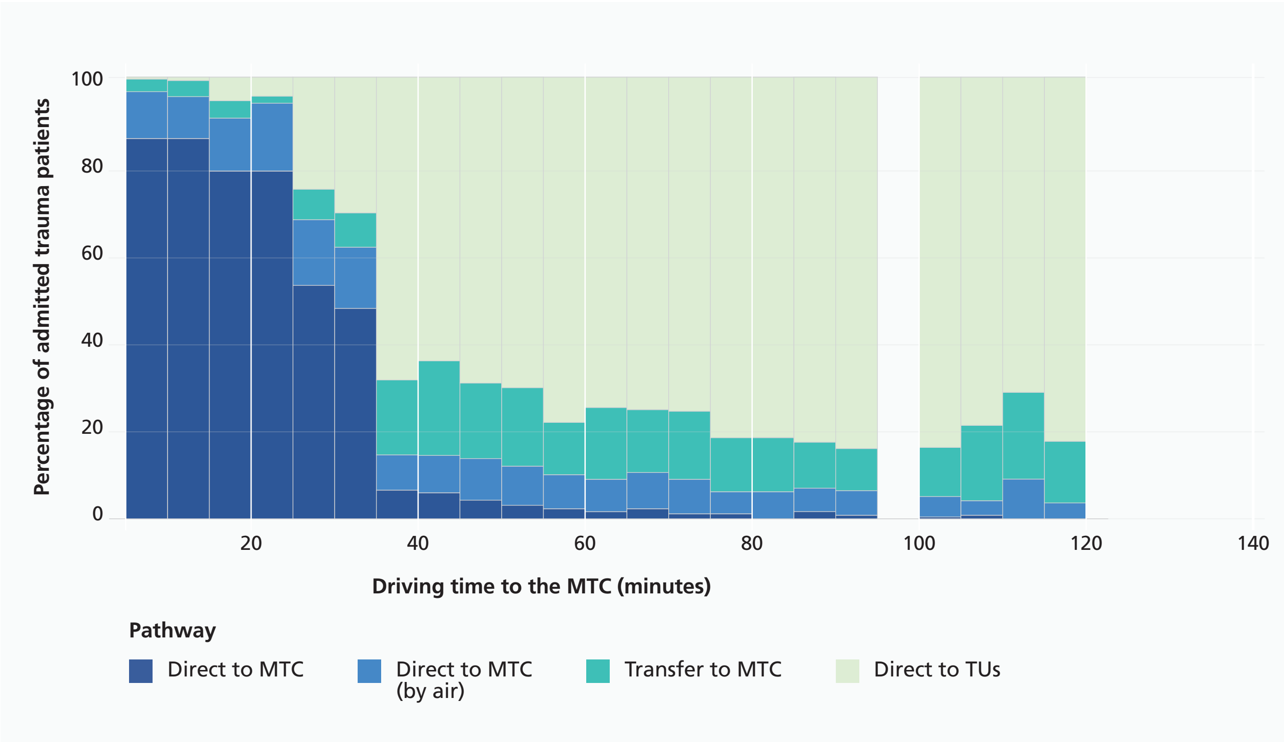
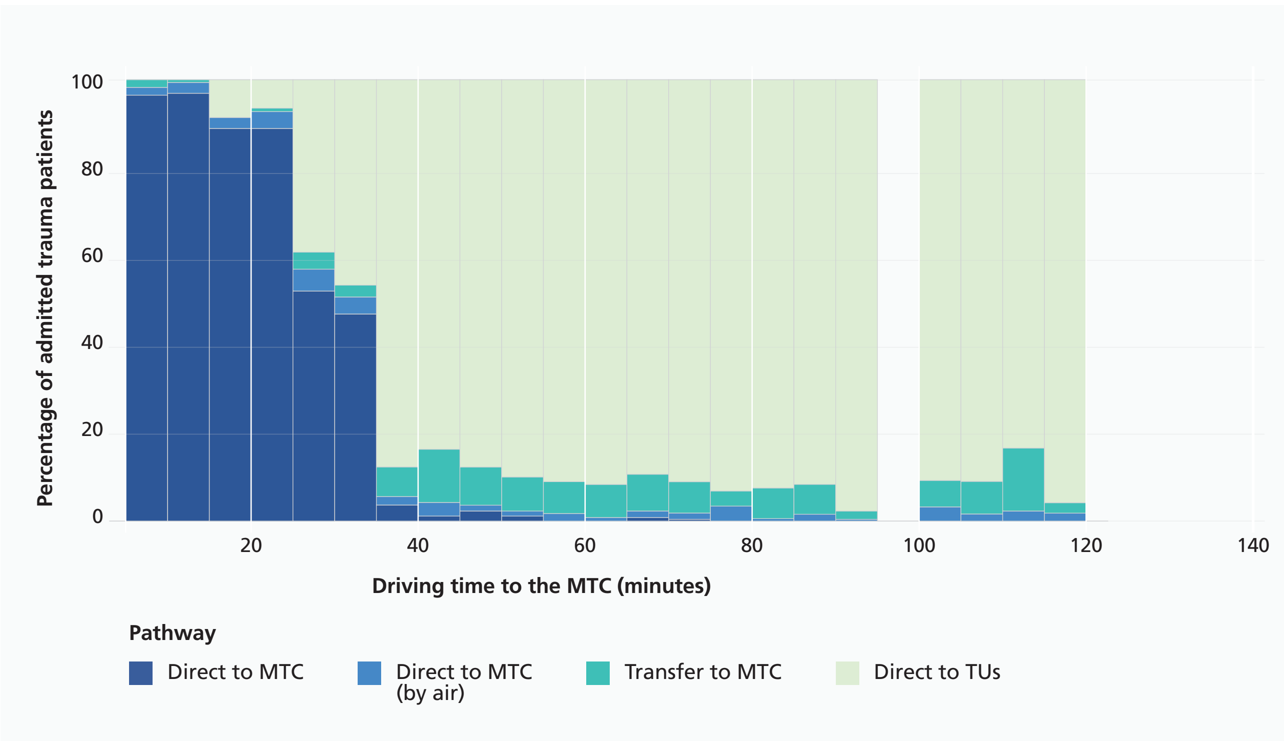


Figure 15.7 *Proportion of patients over 75 years by drive time from major trauma incident to MTC coded by movement type (off-peak).*



Equity of access by patient residence

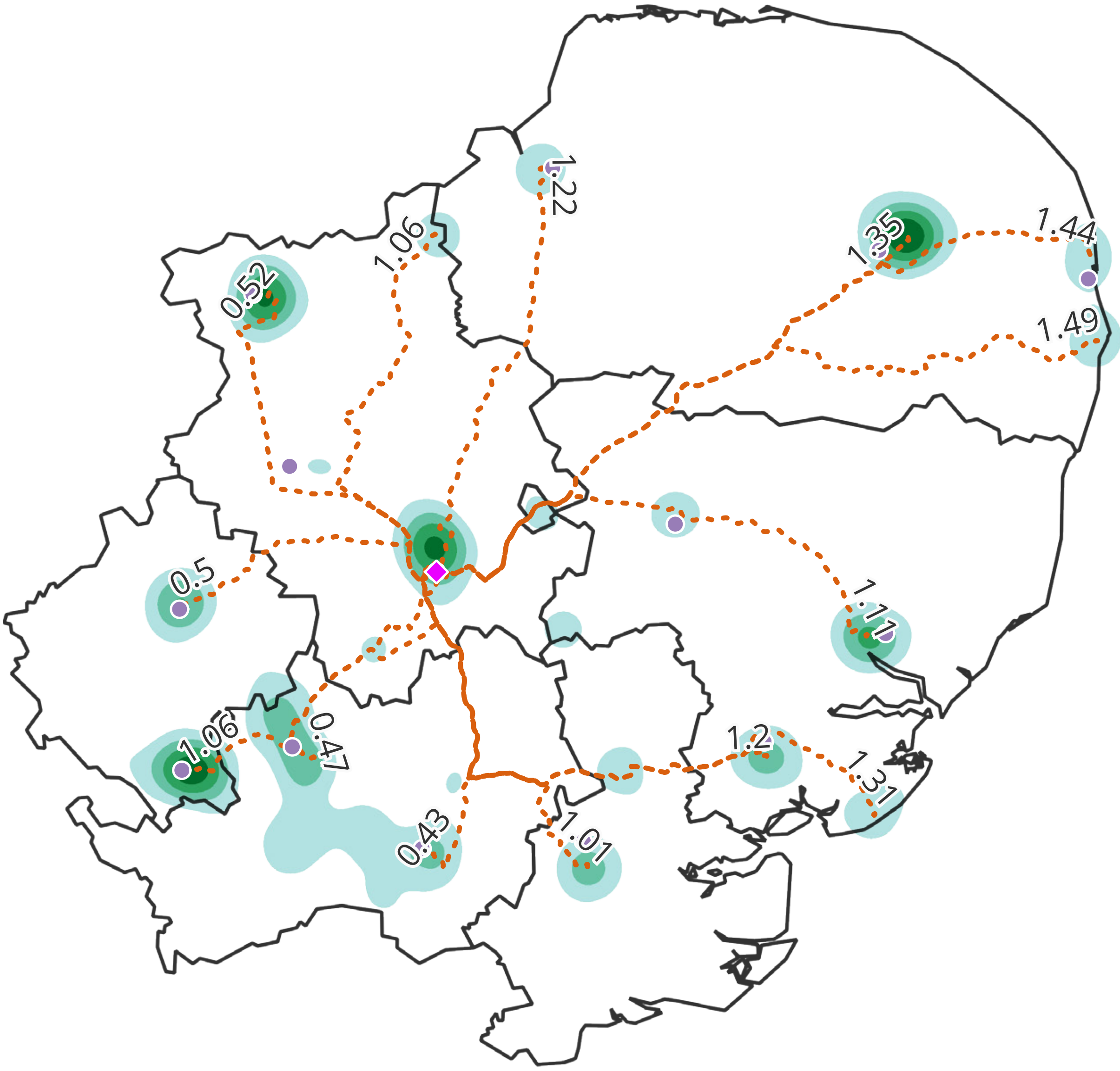
By ICB, the 45-minute boundary serves 62% of C&P, 19% of HWE, 14% of SNEE and 3% of BLMK major trauma patients by their location of residence. This equates to 20% of the East of England's major trauma population (Table 15.1). A similar proportion can be found for both older and younger age groups suggesting no inequity in access by age group. However, only 3% of the most deprived residents are within the 45-minute drive time.

Table 15.1 Proportion of major trauma patients in the East of England residing within and outside the 45-minute drive time of Addenbrooke's Hospital (MTC).

	Residence within 45 minutes of MTC	Residence outside 45 minutes of MTC
All East of England residents	20.1%	79.9%
18–74 years	19.5%	80.5%
Elderly aged 75+	20.7%	79.3%
Core20 (IMD quintile 1)	3.4%	96.6%

Only 35% of patients who live outside of the 45-minute boundary gain access to services at the MTC (either directly or through transfer) compared to 81% of those who live within the boundary. Figure 15.8 shows the fastest driving time to the MTC against the occurrence density of major trauma patients' residences as a heatmap. The longest drive time is from Lowestoft in East Suffolk at 1 hour 49 minutes. Clacton-on-Sea has the longest drive time after Norwich at 1 hour 31 minutes. Luton and Ipswich are larger residential areas just outside the 60-minute drive time. The heatmap suggests the highest concentration of patients are in Cambridge, Norfolk, Luton, and Peterborough.

Figure 15.8 Fastest drive time along the road network in hours and minutes to Addenbrooke's Hospital from populated areas. Heatmap (green) shows the occurrence density of major trauma patients home location. (Heatmap radius: 8km at scale)



The map in Figure 15.9 shows the occurrence density of major trauma patients from the most deprived areas (IMD quintile 1 – Core20). It shows that denser areas of this population are outside of the 45-minute drive time from the MTC. The most densely populated of these Core20 patients reside in Peterborough, which is a 52-minute drive time to Addenbrooke's Hospital. Norwich is the furthest Core20 population from the MTC at 1 hour 35 minutes. This highlights the inequity for our Core20 populations for access to major trauma services in our region. A second Major Trauma Centre at Norfolk and Norwich Hospital will reduce travel times for underserved Core20 populations.

Figure 15.9 Fastest drive time along the road network in hours and minutes to Addenbrooke's Hospital from populated areas. Heatmap (pink) shows density occurrence of major trauma patients from deprived areas (IMD quintile 1). Isochrone (green) shows 45-minute driving distance from Addenbrooke's Hospital.

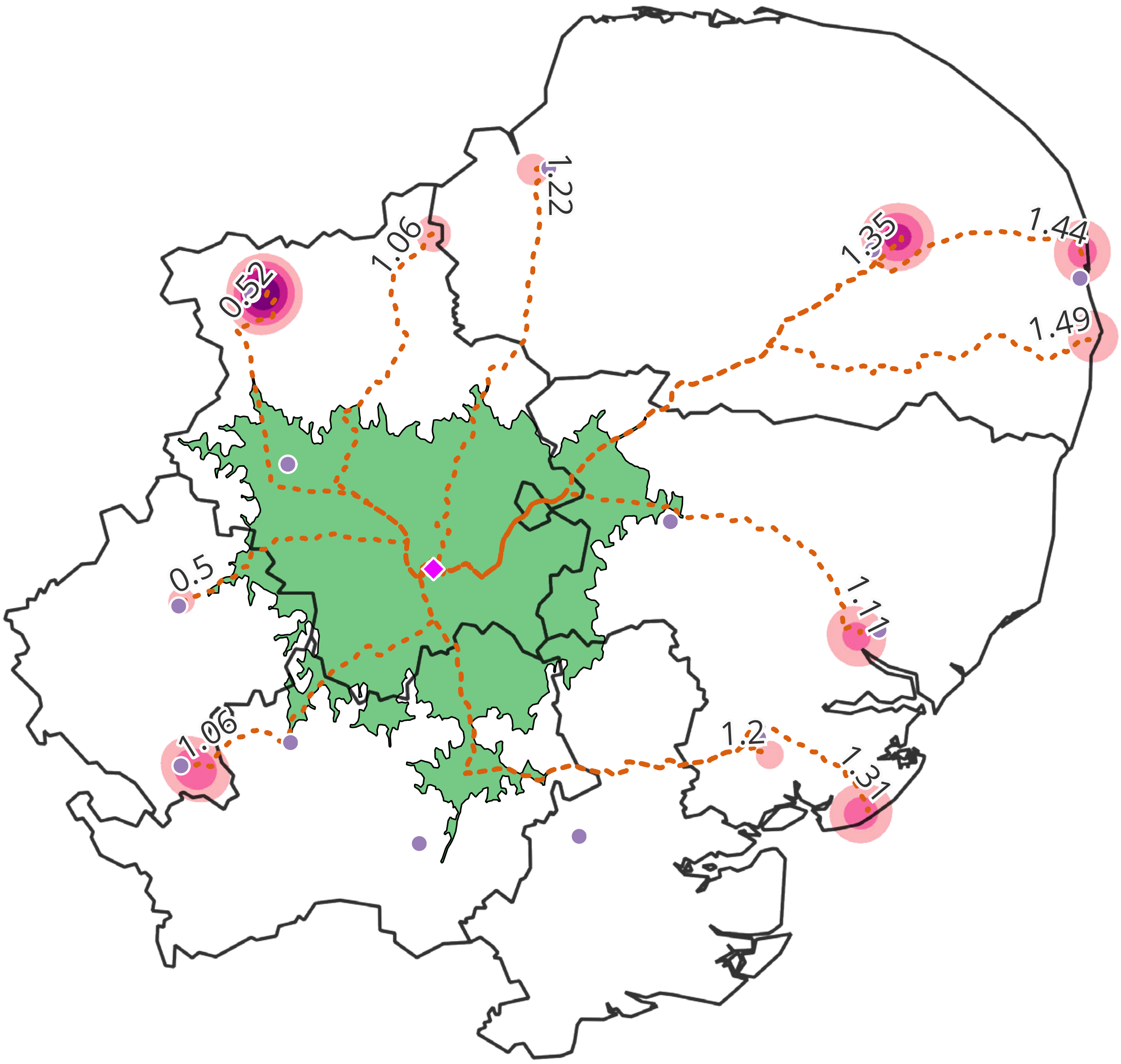
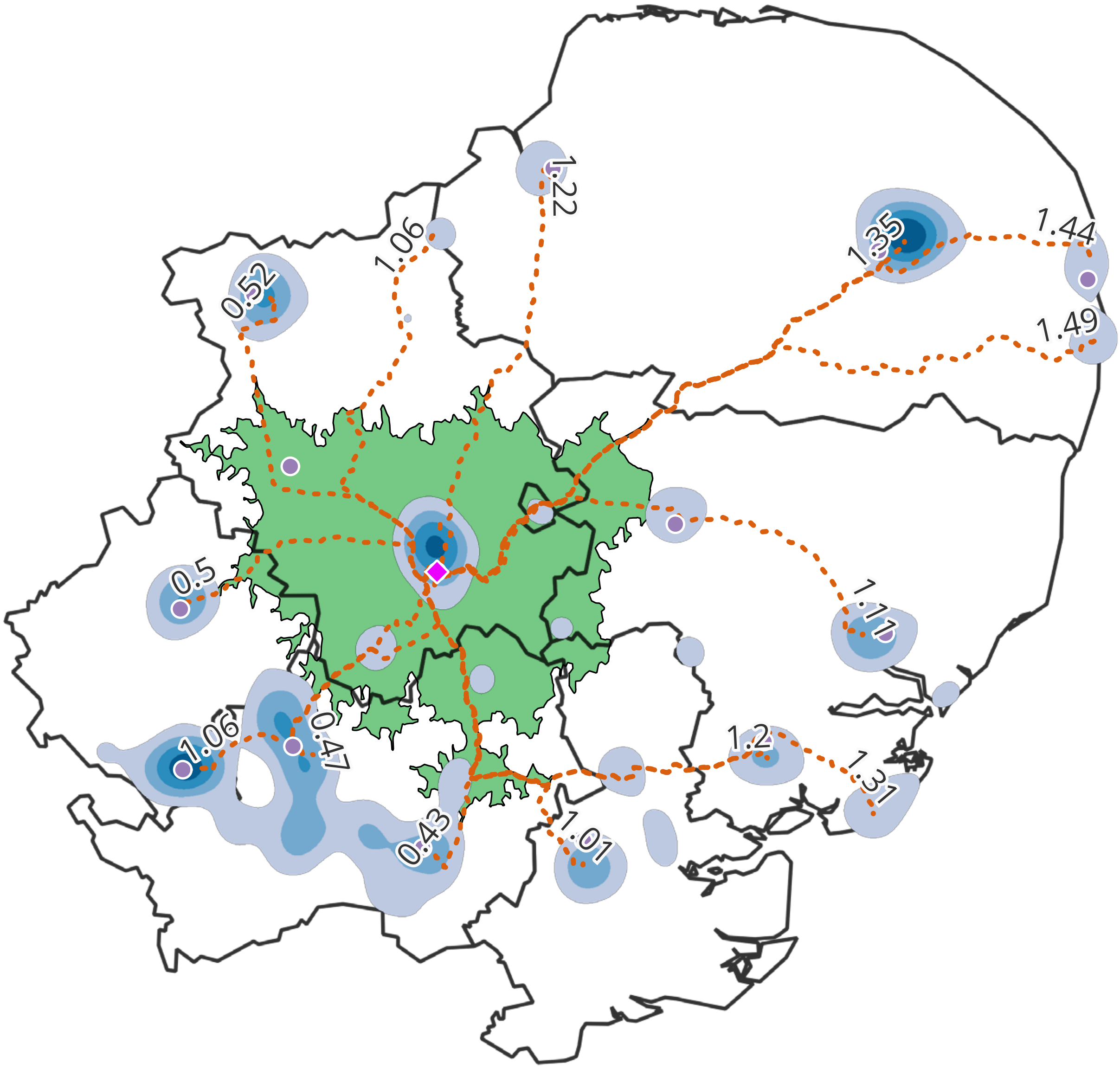


Figure 15.10 shows a similar map but for the occurrence density of major trauma patients aged 75+ years. This map shows that the MTC currently supports the concentration of older residents located in Cambridge. However, such residents are not supported in Luton and Norwich as they are both outside the 60-minute drive time to the MTC.

Figure 15.10 *Fastest drive time along road network in hours and minutes to Addenbrooke's Hospital from populated areas. Heatmap (blue) shows density occurrence of major trauma patients aged 75+ years. Isochrone (green) shows 45-minute driving distance from Addenbrooke's Hospital.*



16 Highlighted findings for Part Two

Admissions and transfers

- Just under half of major trauma patients in the East of England were admitted to the Major Trauma Centre at Addenbrooke's Hospital either directly or by transfer from a Trauma Unit (45%). The remaining major trauma patients were treated entirely in Trauma Units (55%).
- Direct admissions to the MTC are highest from patients residing in Cambridgeshire and Peterborough ICB and lowest from Norfolk and Waveney ICB.
- Peterborough City, Norfolk and Norwich and, Luton and Dunstable are the top three hospitals contributing to counts of transfers in to Addenbrooke's Hospital.
- Over time, patients have become slightly more likely to remain at their initially admitted hospital and less likely to be transferred to the MTC.
- Half of out of area major trauma patients using East of England trauma services come from the Midlands, and were admitted to Peterborough City Hospital or Addenbrooke's Hospital.

Hospital care

- Ambulance is the main mode of travel for admission across all sites and the use of ambulance increases with age.
- About a third of admissions to Addenbrooke's Hospital are by helicopter and this is most often used for road, farm, and industrial based injuries.
- Patients with a Glasgow Coma Scale of <13 are likely to receive a timely CT scan at Addenbrooke's Hospital (75%) but there are Trauma Units with performance below 50% including Norfolk and Norwich Hospital.
- Most major trauma patients at Addenbrooke's Hospital are seen by a doctor within 30 minutes of arrival (84%) but this decreases to less than 56% at Trauma Units.
- Most patients at Addenbrooke's Hospital are seen by a consultant (89%) but the likelihood of this decreases with age. Less than 36% of major trauma patients are seen by a consultant at Trauma Units.
- Only half of major trauma patients arriving at the ED at Addenbrooke's Hospital are seen by a trauma team and the likelihood of this decreases with age. Less than 30% are seen by a trauma team at Trauma Units including Norfolk and Norwich Hospital.

- The proportion of patients being seen by a doctor within 30 minutes of arrival, by a consultant or by a trauma team at the MTC has been on the decline since 2018/19.
- Elderly patients have a longer median length of stay at Trauma Units compared to patients under 75 years. However, younger patients stay for longer at the MTC compared to the elderly.
- Bed days have steadily increased across all sites with the MTC taking on more major trauma bed days over time accounting for about half of all major trauma beds.
- Most major trauma operations are performed at Addenbrooke's Hospital (83%) and are most likely to be on men under 75 years of age.

Outcomes

- Major trauma deaths increase with age and are more likely in men at any age. The proportion of deaths in patients over 75 years has increased over time compared to younger age groups.
- Major trauma deaths are more likely in those with comorbidities and correlate with a higher number of comorbidities by the Charlson Comorbidity Index.
- Falls less than two metres are the main cause of death for major trauma patients aged 45–74 and over 75 years. Vehicle incidents are the main cause of death in patients aged 18–44 years.
- Head injuries are the most severely injured body region in 75% of deaths.
- Over half of major trauma patients are discharged to their own home (57%), excluding transfers to further hospitals.
- Patient probability of survival (Ps) is lowest for major trauma patients sent to a Trauma Unit without a transfer to the MTC.

Equity of access

- The elderly and most deprived patients are more likely to be transferred to Addenbrooke's Hospital rather than through direct admission.
- Vehicle incidents are more likely to be directly admitted to the MTC compared to falls and are the main injury cause of transfers out of Addenbrooke's to another hospital.
- Only 20% of East of England major trauma patients resided within the 45-minute drive time to Addenbrooke's Hospital, the region's MTC.
- At over 35 minutes from the incident to the MTC there is a change in how patients are cared for, with most of these patients being managed in a Trauma Unit, particularly patients over the age of 75 years, rather than being sent directly to Addenbrooke's Hospital.
- Only 3% of patients residing in the most deprived areas of East of England (Core20) are located within the 45-minute drive time from Addenbrooke's Hospital (MTC).
- Only a third of major trauma patients outside of the 45-minute drive time to Addenbrooke's Hospital gain access to services at the MTC, either directly or by transfer.

PART THREE

Capacity and demand analysis

This Part describes the capacity and demand analysis for Norfolk and Norwich Hospital, which has been identified by the East of England Trauma Network and Specialised Commissioning team as the potential hospital to become a second Major Trauma Centre (MTC) for the region.

17 Capacity and demand model for Norfolk and Norwich Hospital as an MTC

This part provides the approach, model selection and analysis of twelve different scenarios and findings of the model for forecasting bed occupancy if Norfolk and Norwich Hospital were to become an MTC.

Norfolk and Norwich Hospital provides nearly all the major specialist services relevant to the care of major trauma, i.e., general surgery, emergency medicine, vascular, orthopaedic, plastic, thoracic, spinal, maxillofacial, specialist early/hyper acute rehabilitation and interventional radiology, along with appropriate supporting services, such as critical care. During the COVID-19 pandemic it was selected by the East of England Trauma Network and Specialised Commissioning Team to act as a second Major Trauma Centre (MTC) for certain injury profiles for the region to support network resilience.

In this analysis, out of region patients are not included. Patients with incomplete submissions for all hospitals attended are also excluded (see Figure 3.2 flowchart in Section 3 – Methods and data quality).

Justification and approach

This capacity and demand model creates a hypothesis using scenarios and TARN patient data to estimate the impact of future increases in trauma cases on the major trauma demand and supply conditions at Norfolk and Norwich Hospital. This analysis captures the following factors that include demand, supply, and coverage or processes for trauma patients:

- **Demand:** different expectations of the population growth on admissions in the future
- **Supply:** different stages of MTC upgrading, resulting in varying lengths of stay reflective of the current MTC at Addenbrooke's Hospital
- **Coverage:** different catchment areas of the geographical distances by drive times

In the scenario analysis, we apply historical TARN data with created conditions where Norfolk and Norwich Hospital acts as an MTC (like Addenbrooke's Hospital), rather than a Trauma Unit to find out the following:

> What would Norfolk and Norwich Hospital's daily bed occupancy in January 2023 to December 2027 be if Norfolk and Norwich Hospital became an MTC instead of a TU, **under different scenarios defined by different demand, supply, and coverage conditions?**

Capacity and demand model: patient selection

- Patients who were admitted to TUs in 2012–2021 and would be treated at Norfolk and Norwich Hospital if it were an MTC (labelled NO* (MTC) in the model), instead of a TU (labelled (NO)).

We call this group of patients **G1**, which consists of two non-overlapping subgroups: (i) major trauma admissions and (ii) other existing Norfolk and Norwich (NO) trauma admissions. The criteria we use to determine the subgroups of **G1** are summarised in Table 17.1.

All major trauma admissions (subgroup (i)) that satisfy the following conditions are included in **G1**: patients who were admitted in 2012–2021, adults (aged 18 or above), ISS >15, within 45- or 60-minute driving distance to Norfolk and Norwich Hospital (Google Maps API was used to derive driving distance/time from incidence locations), not treated at Addenbrooke's Hospital, and treated in a TU other than Norfolk and Norwich (within the East of England).

Other existing Norfolk and Norwich (NO) trauma admissions (subgroup (ii)) that satisfy the following conditions are also included in **G1**: patients admitted between 2012–2021, adults (aged 18 or above), ISS can be > 15 and ≤ 15, no restrictions on driving time to Norfolk and Norwich, and treated at Norfolk and Norwich.

These selection criteria result in 6,436 existing trauma patients, and an additional 595 (1,208) major trauma patients in **G1** in 2012–2021 when coverage is within 45 (60) minutes from Norfolk and Norwich Hospital.

We acknowledge that some patients with lower ISS scores may need to be treated at NO* (MTC) or some ISS >15 patients outside the 45-minute range might be transferred to Norfolk and Norwich Hospital. It is, therefore, possible that this analysis would provide a more conservative estimation of the required bed occupancy at NO* (MTC). A sensitivity study at the end of section 18 looks at these underestimation aspects.

*Table 17.1 Criteria for selecting **G1** trauma patients at NO* (MTC)*

Inclusion criteria	Major trauma admissions	Existing trauma admissions
Admitted in 2012–2021	Yes	Yes
Age	Age ≥ 18	Age ≥ 18
ISS	ISS > 15	All
Driving time	Within 45 minutes or 60 minutes to NO* (MTC) from the incident location	All
Treated by Addenbrooke's Hospital	Not	Not
Treated hospital	In a TU other than NO	NO

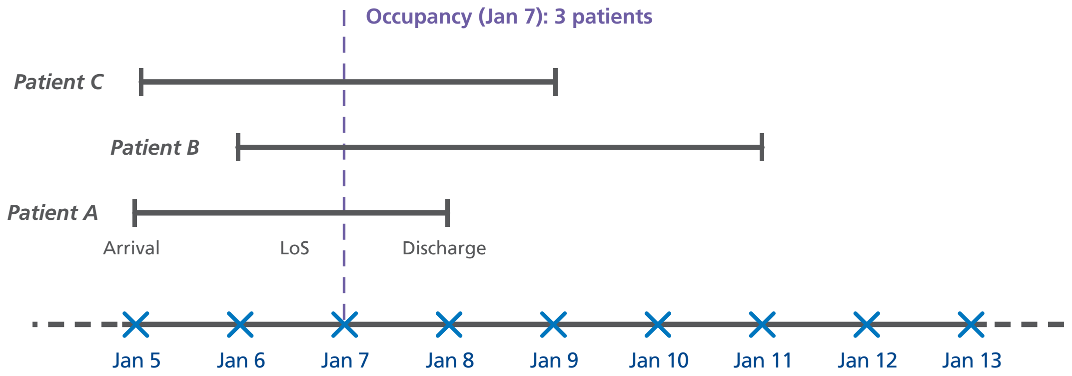
Capacity and demand model: scenario analysis

The scenario analysis consists of five main steps as illustrated in Table 17.2.

Table 17.2 Five major steps to conduct scenario analysis.

Step 1:	Step 2:	Step 3:	Step 4:	Step 5:
Predict LoS for all trauma patients	**Define a scenario**	**Select G1 trauma patients**	**Predict LoS for G1 trauma patients**	**Estimate resource requirements**
Build a linear regression model and an XGBoost model with all TARN 2012–2021 admissions in EoE and selected variables.	Define a scenario by the three factors: • Demand • Supply • Coverage.	Follow the inclusion criteria described in Table 17.1.	Using the linear regression model or the XGBoost model to predict LoS for all **G1** trauma patients.	Estimate daily bed occupancy at NO* (MTC) in 2023–2027. Estimate the number of beds needed at NO* (MTC) in 2023–2027. Estimate the requirements of other resources at NO* (MTC) in 2023–2027.

In Step 1, using all the TARN admissions in 2012–2021 and variables, we constructed predictive models (linear regression and XGBoost) to estimate Length of Stay (LoS) of all trauma patients. See Appendix 7 for the description detail of the prediction models. In Step 2, we chose a scenario, which will be defined in the rest of this subsection. In Step 3, we selected **G1** trauma patients based on the criteria specified in Table 17.1. In Step 4, we used the assumptions for the chosen scenario and the predictive models to estimate LoS of **G1** trauma patients, who would be treated at NO* (MTC). In Step 5, we estimated daily bed occupancy at NO* (MTC) in 2023–2027 by aggregating all trauma patients who would be treated at NO* (MTC) (see the diagram below for a visual illustration). Consequently, one can estimate other resources required at NO* (MTC).



Demand

Data from the five years between 2015 and 2019 was used as our baseline for demand projections of trauma patients to forecast future demand for 2023–2027. This period is used for the analysis as it provides the most complete years in the TARN data set and avoids pandemic years.

For demand, we considered three scenarios for the trauma patient demand in 2023–2027 based on different expectations of the population/admissions:

1. **Baseline:** TARN patient data from 2015–2019 in **G1**, keeping population size and population mixes the same in 2015–2019 and applying these directly to 2023–2027. This demand scenario could be understood as a baseline estimation of what would have been the number of beds required at Norfolk and Norwich Hospital if it were already an MTC in 2015–2019. This is also extremely conservative as it assumes 2015–2019 level of population size and demand.
2. **Rough projection:** we inflated 2015–2019 individual trauma admissions in **G1** by 4.4% to estimate individual trauma admissions for 2023–2027. This 4.4% is the overall average ONS estimated population increase rate from 2018–2019 to 2026–2027 for all East of England population, without stratification according to population age-sex bands.
3. **Granular projection:** we inflated 2015–2019 individual trauma admissions in **G1** by their cohort increase rate X_i% (by age and sex from ONS projections in Part One) to estimate individual trauma admissions for 2023–2027. Table 17.3 gives two examples of how to estimate an equivalent number of trauma admissions for all age-sex cohorts.

Table 17.3 Two examples to demonstrate how to estimate an equivalent number of admissions for 2023–2027 from an individual admission for 2015–2019.

			Population Growth Rate		Population Multipliers for N (2023–2027)		
Patient ID	**Age**	**Sex**	Rough projection	Granular projection	Baseline projection	Rough projection	Granular projection
1	75–79	Female	4.4%	50.9%	1	1.044	1.509
2	40–44	Male	4.4%	8.9%	1	1.044	1.089
...							

Supply

For supply scenarios, we considered two different stages of upgrading:

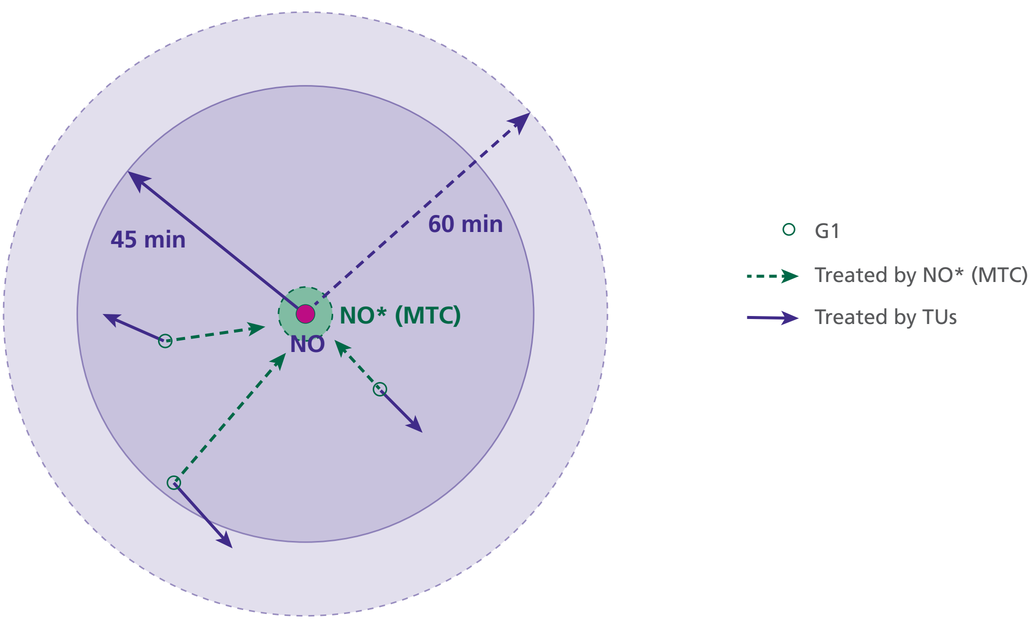
1. **Initial stage:** At the beginning of upgrading, Norfolk and Norwich Hospital serves the admitted trauma patients with TU level capabilities resulting in a similar length of stays to the historical length of stays (LoS) at Norfolk and Norwich as a TU. That is, the supply capacity from TARN Norfolk and Norwich historical LoS was directly applied to future LoS for NO* (MTC) for all **G1** patients.
2. **Mature stage:** As the upgrading matures, the model assumes NO* (MTC) capabilities will be as a fully-fledged MTC in the region, performing similarly to Addenbrooke's Hospital. For major trauma admissions and other existing trauma admissions in **G1**, we used the predictive model described in Step 1 of Table 17.2 to predict LoS for each patient admitted to NO* (MTC) when NO* (MTC) acted like Addenbrooke's MTC.

Coverage

Finally, for coverage scenarios, we considered two different serving spans:

1. **45-minute major trauma population coverage:** For this scenario, we used the inclusion criteria specified in the second column in Table 17.1 to select major trauma admissions, where driving time is within 45 minutes. See the diagram below for a visual illustration. Note that any major trauma patients who were treated in nearby hospitals such as James Paget Hospital, Queen Elizabeth Hospital, and other TUs could satisfy the inclusion criteria.

Admissions (coverage scenarios)



2. **60-minute major trauma population coverage:** For this scenario, we used the inclusion criteria specified in the second column in Table 17.1 to select major trauma admissions, where driving time is within 60 minutes. That is, we enlarged the coverage from 45 minutes to 60 minutes, which aligns with the national discussions around driving time distance for direct transfer for an MTC.

Based on the above three scenario factors (demand, supply, and coverage), we considered 12 different scenarios as summarised in Table 17.4.

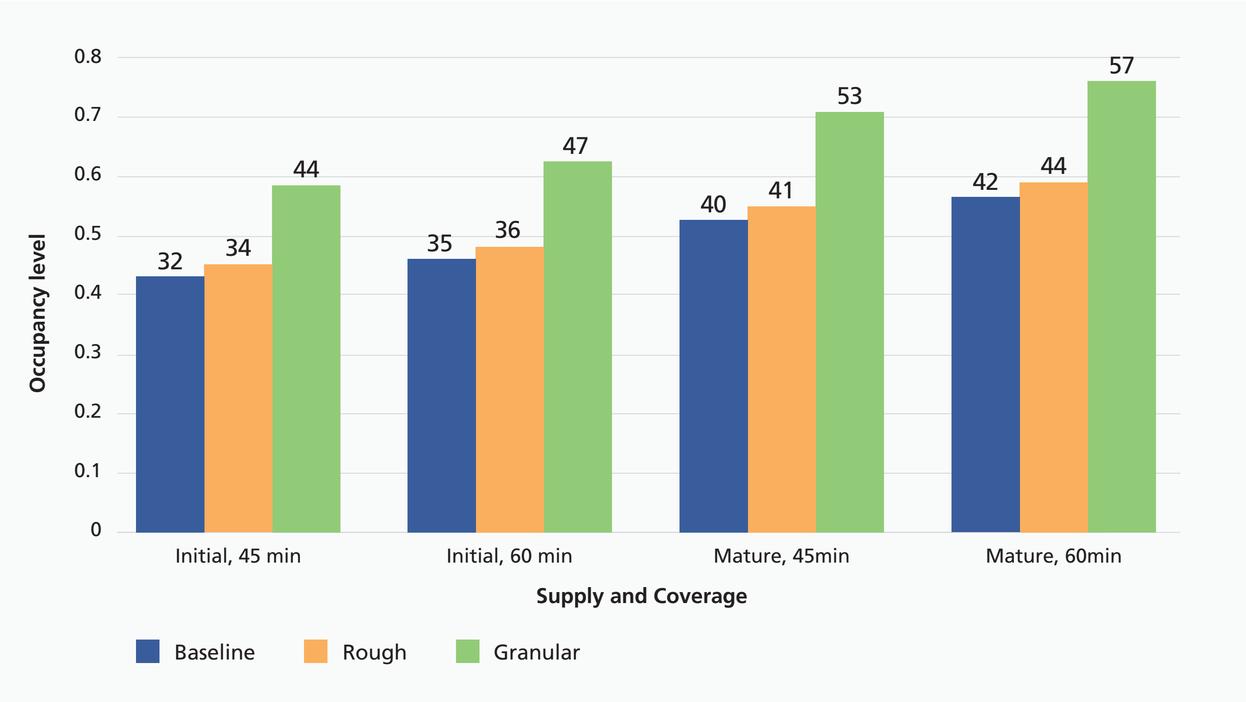
Table 17.4 Illustration of the scenarios: Demand × Supply × Coverage.

NO* (MTC)	Scenario				
Demand	Baseline		Rough projection		Granular projection
Supply	Initial (TU level)			Mature (MTC level)	
Coverage	45 min			60 min	

18
Capacity and demand model findings

Figure 18.1 displays the number of beds needed at NO* (MTC) in 2023–2027 under all twelve scenarios we analysed. Blue bars reflect the baseline projection, that is, if demand remained at 2015–2019 levels. Orange bars represent rough projections for population increase and resulting change in demand. Green bars represent granular projections of population increase and resulting granular change in demand. On the horizontal axis, supply is split into initial and mature stages of MTC capabilities and coverage is shown for 45 minutes and 60 minutes. The numbers in Figure 18.1 show that the average number of beds needed at NO* (MTC) ranges from 32 to 57 beds, which is equivalent to 40% ~ 75% of the capacity, 75 beds, at the current MTC at Addenbrooke's Hospital. For the most established scenario, where we assume the granular projection for demand, the NO* (MTC) supply capability is at the mature stage, and coverage is at 45 minutes or 60 minutes, the number of trauma beds required at NO* (MTC) is 53 and 57 beds, respectively. Note that the historical number of beds used for trauma patients at Norfolk and Norwich Hospital in 2015–2019 was around 27. Thus, the number of trauma beds required at NO* (MTC) in 2023–2027 could be double the number of trauma beds at NO (TU) in 2015–2019.

***Figure 18.1** The trauma bed requirements at NO* MTC in 2023–2027 under different scenarios.*



Relative impact on bed occupancy at NO* (MTC)

by the three scenario factors: demand, supply, and coverage

Figure 18.1 shows that the number of beds needed at the new Major Trauma Centre (MTC) in the East of England is most affected by changes in the demand factor, followed by the supply factor, and then the coverage factor.

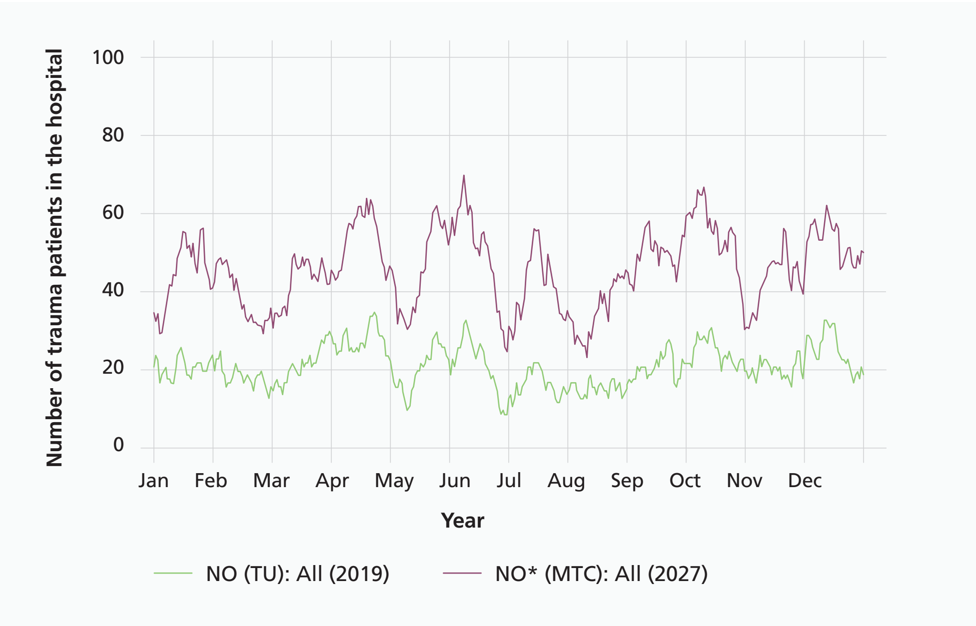
Specifically:

- The number of beds needed increases by 2 to 4 beds if the coverage factor increases from 45 to 60 minutes.
- The number of beds needed increases by 7 to 10 beds if the supply factor increases from initial stage to mature stage.
- The number of beds needed increases by 12 to 15 beds if the demand factor increases from the baseline projection to the granular projection.

The demand factor is driven by changes in the population, such as an ageing population, driving subsequent demand for elderly trauma care.

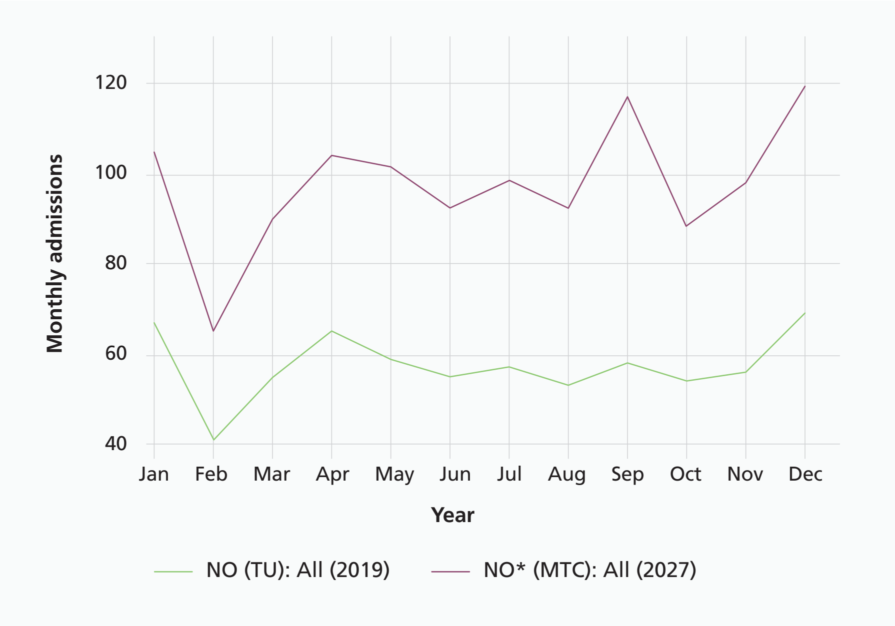
Figure 18.2 shows the daily bed occupancy (the purple line) at NO* (MTC) in 2027 for the most established scenario, where we assume the granular projection for demand, NO* (MTC) supply capability is at the mature stage, and coverage is 60 minutes. For comparison, we also include the historical daily bed occupancy (the green line) at NO (TU) in 2019.

Figure 18.2 The bed occupancy at NO (TU) in 2019 and at NO (MTC) in 2027 under the most established scenario with granular demand, mature supply, and 60 minutes coverage.*



The projected total number of trauma admissions at NO* (MTC) in 2027 (approximately 5,450 admissions) will be approximately 167% of the historical total number of trauma admissions (approximately 3,270 admissions) at Norfolk and Norwich in 2015–2019. This is based on the most established scenario with granular projection demand, mature supply, and 60-minute coverage. Figure 18.3 shows the corresponding monthly historical and scenario admissions.

Figure 18.3 The monthly admissions at NO (TU) in 2019 and at NO (MTC) in 2027 under the scenario with granular demand, mature supply, and 60 minutes coverage.*



The figures below show the projected distribution of trauma admissions at NO* (MTC) by patient clinical characteristics under the most established scenario (granular demand projection, mature supply, and 60-minute coverage):

- Figure 18.4 shows the distribution by ISS. Major trauma (ISS > 15) admissions will account for more than 40% of all trauma admissions.
- Figure 18.5 shows the distribution by age band. Elderly patients, 75 and above, will account for more than half of all trauma admissions.
- Figure 18.6 shows the distribution by mechanism of injury. Falls less than two metres will account for more than two-thirds of all trauma admissions.
- Figure 18.7 shows the distribution by the most severely injured body region. Around 60% of all trauma patients will have the head or limb region as the most injured body region.
- Figure 18.8 shows the distribution by the most severely injured body region by ISS. Of those admitted with the head as the most injured region, more than 90% of these patients will have an ISS > 15 and of those where limbs are the most injured region, more than 90% will have an ISS of 1–15.

The figures show that NO* (MTC) can expect to see a diverse group of trauma patients with a range of clinical characteristics, with the elderly and falls less the two meters being the key patient group and mechanism of injury.

Figure 18.4 The number of estimated trauma patient admissions based on ISS bands and the corresponding distribution at NO (MTC) in 2023–2027.*

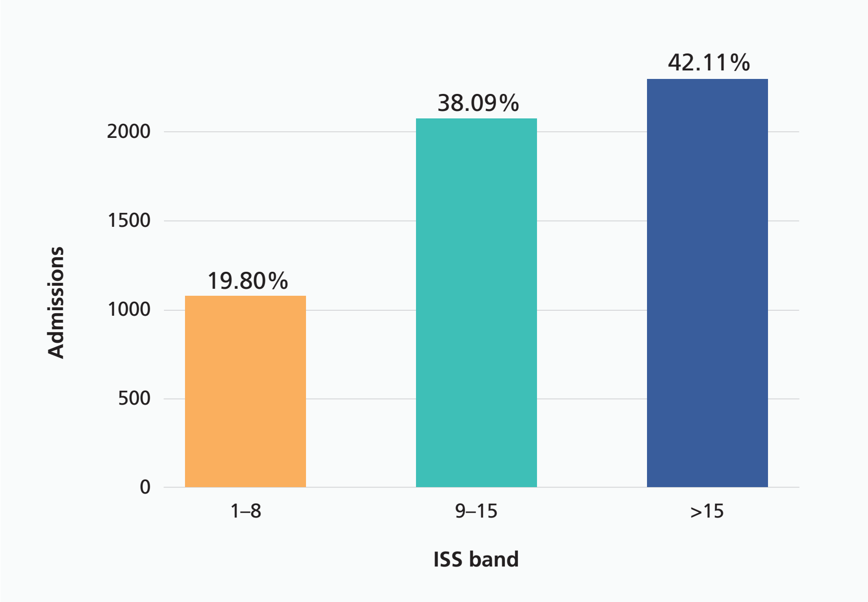


Figure 18.5 The number of estimated trauma patient admissions based on age bands and the corresponding distribution at NO (MTC) in 2023–2027.*

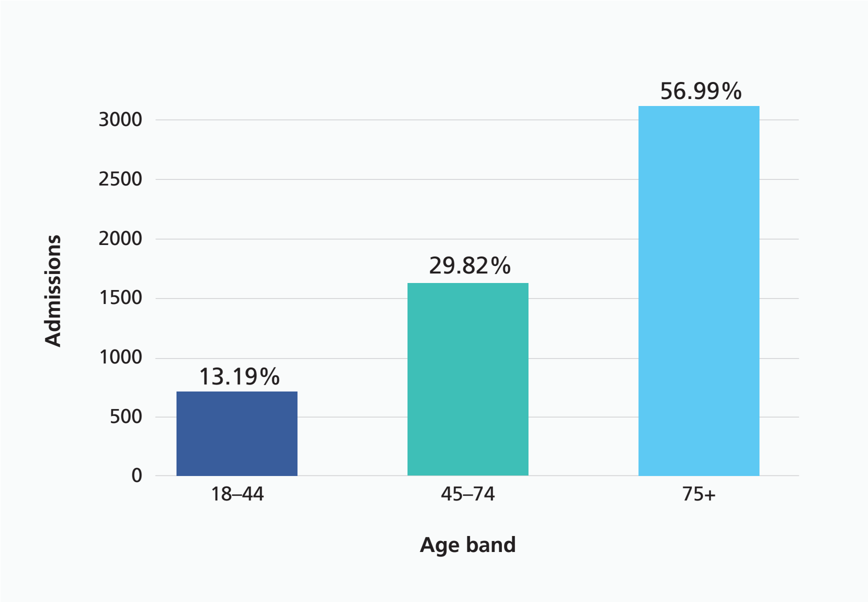


Figure 18.6 The number of estimated trauma patient admissions (all ISS) based on mechanism types and the corresponding distribution at NO* (MTC) in 2023–2027.

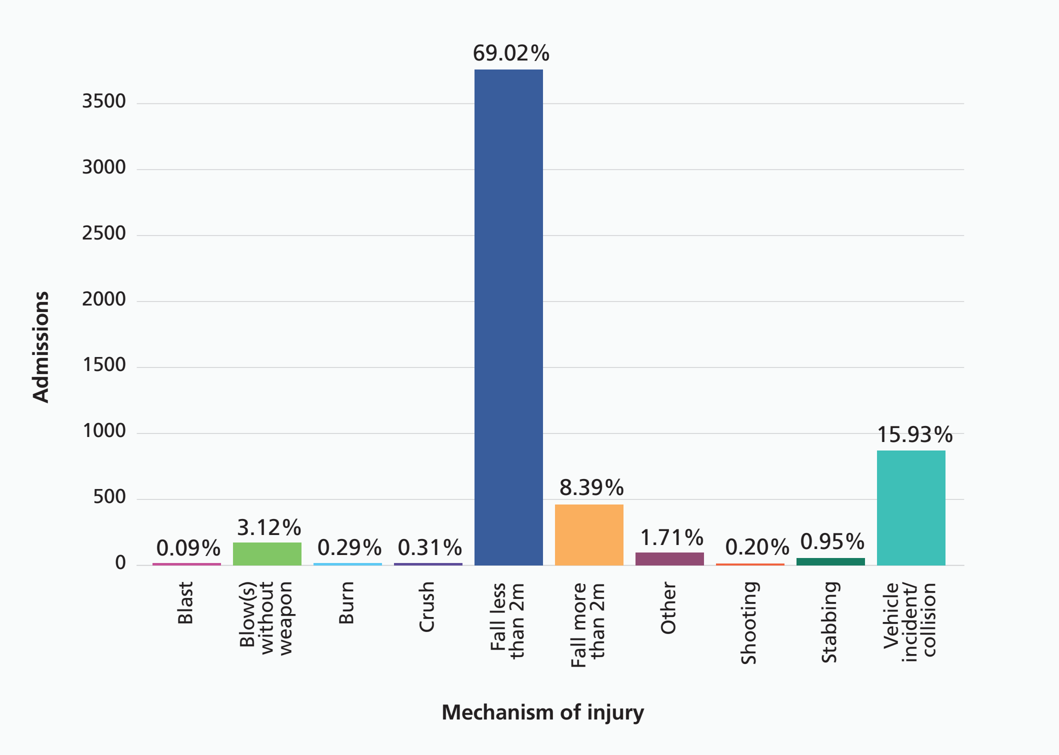


Figure 18.7 The number of estimated trauma patient admissions (all ISS) based on most severely injured body region and the corresponding distribution at NO* (MTC) in 2023–2027.

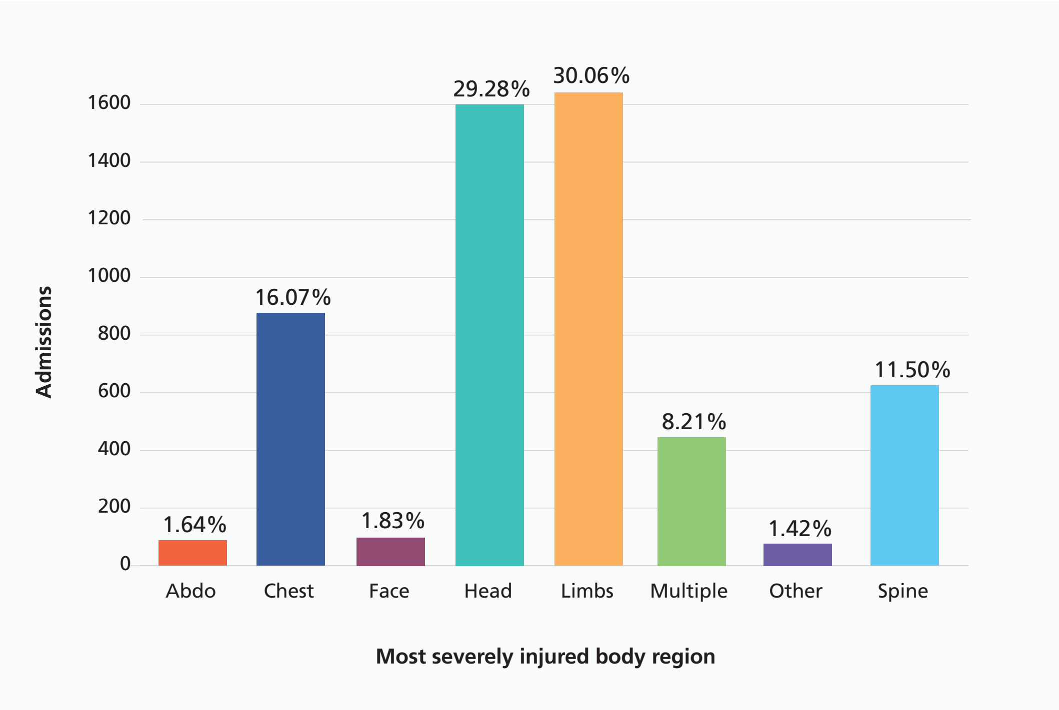
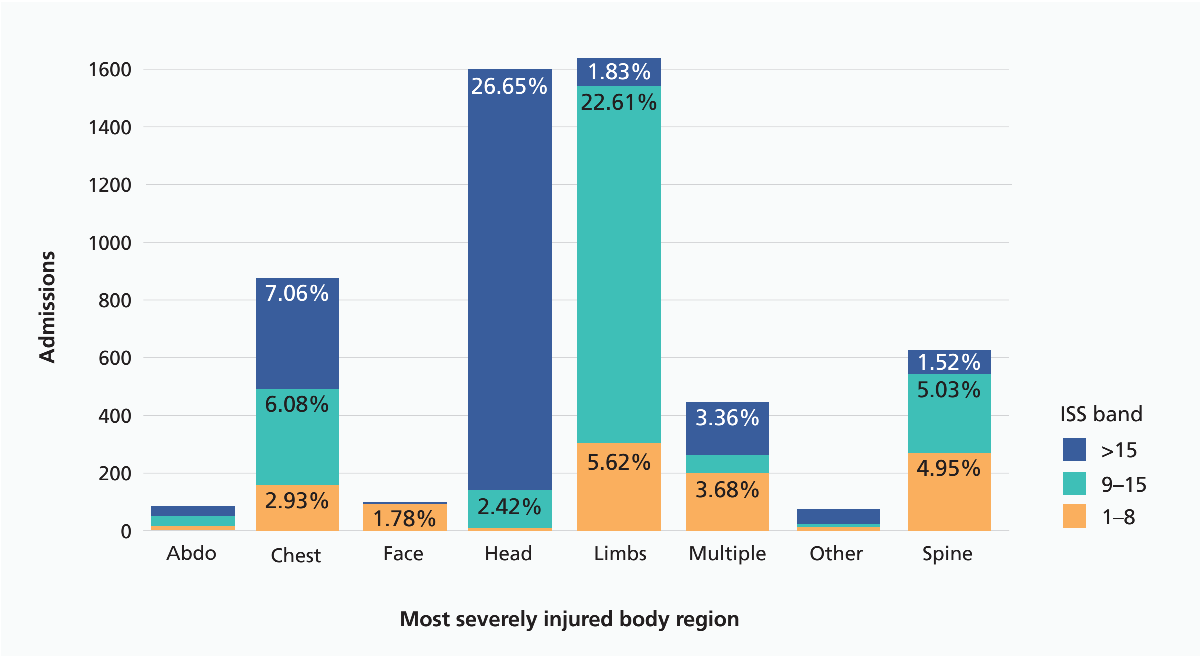


Figure 18.8 The number of estimated trauma patient admissions based on most severely injured body region and the corresponding distribution at NO (MTC) in 2023–2027. For each injury body region, the bar also includes ISS distribution.*



Sensitivity analyses

The patient selection for the model only included **G1** patients which may have underestimated the true future demand at the new MTC (NO* (MTC)), depending on other factors. Thus, a sensitivity analysis was performed to provide supplementary reference points to how the number of trauma beds needed at NO* (MTC) could change depending on different assumptions.

One sensitivity analysis explored the impact of including patients who were historically treated at Addenbrooke's MTC into **G1**. This would have resulted in an additional 272 major trauma patients who would be treated at NO* (MTC) between 2012–2021 when coverage is within 45 minutes, and an additional 560 major trauma patients for 60 minutes driving time from NO* (MTC). For the most established scenario (granular projection demand, mature supply, and 60 minutes coverage), this would imply an additional 56 admissions of major trauma patients each year and an approximate additional three trauma beds at NO* (MTC) if the average length of stay for these patients is around 20 days.

Another sensitivity analysis explored the impact of NO* (MTC) taking on secondary transfers of trauma patients from other TUs in the East of England instead of Addenbrooke's MTC. A naïve triage model (described in Appendix 8) was built to investigate this question. For the most established scenario (granular projection demand, mature supply, and 60-minute coverage), the naïve triage model predicted an additional 314 trauma patients in 2012–2021, or approximately 30 patients per year. Assuming the average length of stay for these patients is around 20 days, then an additional two trauma beds would be needed to treat these secondary transfer patients.

In summary, the sensitivity analysis shows that the number of trauma beds needed at NO* (MTC) could increase by three to five beds if **G1** patients who were historically treated at Addenbrooke's MTC were included in the model, or if NO* (MTC) takes on secondary transfers of trauma patients from other TUs in the East of England instead of Addenbrooke's MTC.

19 Highlighted findings for Part Three

- Norfolk and Norwich Hospital was selected by the East of England Trauma Network and Specialised Commissioning Team as a potential hospital to establish a second Major Trauma Centre (MTC) for the region. It acted as a second MTC to support network resilience during the COVID-19 pandemic.
- Capacity and demand modelling was used to determine the bed capacity required for five years (2023–2027) to support future trauma patient needs.
- Twelve scenarios were developed accounting for variations in population growth (demand), expected length of stay (supply) and travel time from the hospital (coverage).
- The average number of beds needed at Norfolk and Norwich Hospital, if it were an MTC, ranges from 32 to 57 beds depending on the scenario. This is the equivalent to 40% to 75% of the capacity at the current MTC at Addenbrooke's Hospital (75 beds).
- The number of beds needed was most impacted by projected population increase (demand).
- The most established scenario, with granular projection for demand, supply capability at the mature stage, and coverage at 60 minutes, the number of trauma beds required at Norfolk and Norwich Hospital as an MTC is 57 beds. This is more than double its current capacity (27 beds).
- In the most established scenario, it is projected that major trauma will account for 42% of trauma admissions at Norfolk and Norwich Hospital as an MTC.

Conclusion and Recommendations

This public health needs assessment for major trauma in the East of England has reviewed the needs of this population by assessing trends in trauma over ten years of TARN patient data.

Changing population needs and demand

Over the past decade, all trauma demand have increased and a sizeable proportion are major trauma patients (ISS > 15). In 2021/22, a third of all trauma patients experienced major trauma, requiring services to treat life-threatening injuries.

Part One showed that the population in the East of England has changed and is on the increase with a ten-year growth of 487,500 persons. The ONS forecasts this trend to continue in all adult age groups. Compared to other age groups, there was a significantly greater population expansion over the past decade in persons over 75 years, with a growth rate of 20%. Injuries in the elderly now account for half of all major trauma. The mathematical model that forecasts future demand concurs with this trend of increase. This has implications for the capacity of the major trauma network services in the East of England both in terms of absolute quantity and the composition of major trauma services provided going forward. The capacity and demand model in Part Three found that population growth had the largest impact on the number of beds required to support future trauma demand.

The needs assessment showed that in the past decade, there has been a significant increase in the rate of low falls as a mechanism of injury for major trauma in both middle-aged and elderly patients. In persons aged 75 and over, the crude low falls rate has increased from 60 to 132 major trauma incidents per 100k persons, therefore exceeding the rate of population growth within this group. This could partly be a result of better recognition of major trauma caused by low falls in the elderly, or a result of a genuine increase in falls amongst our elderly population who may be increasing in frailty as our populations live longer with more ill health. As there has been no growth in the rate of other injury mechanisms for major trauma, this implies that increasing network capacity should also focus on the service needs of low falls injuries.

Major trauma patients who are younger or from deprived areas are more likely to have violent injuries such as stabbings, blows and shootings as well as being injured on roads or public areas as a cause of their major trauma. However, there is no evidence of a higher incidence of major trauma in more deprived populations compared to the least deprived over the last decade in the East of England.

Major trauma services: capacity, access and performance

Part Two of this health needs assessment used TARN patient data to understand trends in the major trauma services that patients received and reflected on whether current services were meeting the population’s needs. The current East of England Major Trauma

Centre (MTC) at Addenbrooke's Hospital has been working at full capacity since the pre-pandemic years. Modelling of the data for the past decade has highlighted that the occupancy of trauma services at the MTC plateaued at 72 beds around 2018, occasionally exceeding the original 75 bed capacity for Addenbrooke's Hospital. Major trauma performance metrics (Part Two: Hospital Care) for Addenbrooke's Hospital have also been on the decline since this period. The East of England's inclusive model for its major trauma network has allowed this over-capacity to be absorbed by Trauma Units (TUs) and through a combination of differential patterns in the selection of patients admitted to Addenbrooke's Hospital. This includes younger patients, those with certain patterns of trauma injury receiving care at the MTC, and a higher proportion of major trauma patients retained and treated at the network's Trauma Units over time.

The East of England is a heterogeneous region with widely dispersed vulnerable communities such as the elderly, coastal communities, and those from the most deprived areas (Core20 population). To be equitable, trauma service needs should be designed with access for these populations in mind. Currently over half of major trauma patients do not receive services from the MTC. The current capacity limit, coupled with varying drive time distances and coverage of the MTC by geographical location, has created differences in terms of equity of access, as well as differences in major trauma services processes and outcomes between different population groups in the region.

Elderly major trauma patients are more likely to be treated only at a TU and less likely to receive MTC care. Patients with an injury mechanism by low falls have the lowest probability of receiving MTC care at only 34% compared to all causes (58%). Even at the MTC, elderly major trauma patients are also less likely to receive a CT scan for those with GCS <13 within one hour, be reviewed by a consultant, be seen within 30 minutes of arrival, or be seen by a trauma team compared to younger patients. Elderly major trauma patients are also less likely to be transported to the hospital by air ambulance. The median length of stay for elderly patients at the MTC is shorter than for younger patients at 10 days versus 12 days. This may be related to older patients having fewer procedures and operations than younger patients as part of their admission spell.

Low falls are the main cause of major trauma death in elderly patients with 81% of deaths in persons aged over 75 years and half of middle-aged deaths due to low falls. Major trauma resulting in head injuries can be particularly life-threatening with head injuries the most common injury associated with death at all ages. Major trauma deaths are also higher in those with more co-morbidities (a higher CCI score). Major trauma deaths significantly increased in persons aged 45–74 years and over 75 years between 2012/13 and 2016/17. However, in younger patients, trauma death rates have not risen.

The likelihood of admission to the MTC either directly or by secondary transfer for major trauma patients is related to residential location and incident distance away from Addenbrooke's Hospital, moreover, this is also differential by age. For the elderly, there is a steeper decline in the likelihood of being admitted to the MTC directly by increasing incident distance with 80% of elderly patients more likely to remain in a TU after 35 minutes of drive time from the MTC. Given where Addenbrooke's Hospital is located in the region and the road networks within the East of England, many of our coastal populations also have the longest drive times to the current MTC in the entire region (Part Two: Equity of Access).

There are also other notable differences between various population groups. Female major trauma patients are more likely to receive their care in a TU rather than the MTC which could be associated with the fact that women also experience more low falls. The most deprived major trauma patients (Core20) within the East of England are more likely to receive their care in a TU rather than at the MTC. They are also more likely to be transferred than directly admitted to the MTC. This may be because the most deprived major trauma patients are also more likely to live outside of the 45-minute triage drive time from the MTC.

Key Recommendations

Demand for major trauma services has increased incrementally since the network's establishment and is predicted to continue to increase. There is rising demand and inequity of access based on geographical location. Data suggests the capacity at Addenbrooke's Hospital, the region's sole MTC plateaued in 2018, and without additional capacity, it will pose a challenge to fully manage the projected continuing increase in demand for major trauma care.

The establishment of a second Major Trauma Centre at Norfolk and Norwich Hospital, proposed by the East of England Trauma Network and the NHS England Specialised Commissioning Team, would enhance the resilience of the major trauma network and significantly address equity of access issues. Patients from Norfolk and Waveney ICB represent nearly a quarter of our major trauma patient base and yet are outside of the 45-minute travel time of the current MTC at Addenbrooke's Hospital. Patients from Norfolk and Waveney ICB are the least likely to be directly admitted to the current MTC. Norfolk and Norwich Hospital currently has the second largest admittance of major trauma patients after Addenbrooke's Hospital.

The capacity and demand model in Part Three used sophisticated mathematical modelling on 2012–21 data for the East of England Trauma Network to estimate future patient demand. This model takes into account future population growth and the capabilities of Norfolk and Norwich Hospital to model the capacity requirements required to be upgraded to a Major Trauma Centre, the second in the region. This model suggests for the most established scenario with the granular demand projection, mature MTC supply, and 60 minutes coverage, Norfolk and Norwich MTC would require around 57 trauma beds. This more than doubles its current number of beds used and is roughly 70% of Addenbrooke's Hospital's 2015–2019 capacity.

The model predicts over the next five years (2023–2027) that more than 40% of these admissions will be major trauma patients and 60% of the patients will be 75 years and above. Falls less than two meters will account for two-thirds of all trauma admissions. Of the patients admitted, the model suggests the most injured regions will involve head and limb followed by chest trauma.

As the capacity and demand model for a second MTC at the site of Norfolk and Norwich Hospital is modelled on the capabilities of the current MTC at Addenbrooke's Hospital, there is an inbuilt assumption and expectation that through upgrading, Norfolk and Norwich Hospital as an MTC will perform similarly to Addenbrooke's Hospital.

This includes the bed capacity required for the longer LoS needed to treat the complexity of major trauma injuries. A continued focus on quality improvement and investment at Norfolk and Norwich Hospital to meet major trauma quality and Best Practice Tariff standards is also required. Norfolk and Norwich Hospital has ranked amongst the lowest on key major trauma metrics within the East of England; particularly on CT scans for GCS <13 within one hour, reviewed by a doctor within 30 minutes, reviewed by a consultant on admission, and being seen by the trauma team (Part Two: Hospital care). Currently, secondary transfers into Norfolk and Norwich Hospital represent only 20% of its major trauma patient load compared to around half of admissions at Addenbrooke's Hospital, however it is likely that this pattern will change in the future if Norfolk and Norwich Hospital becomes an MTC.

The entire East of England Trauma Network should consider future population increases and changes and the likely resulting impact on the demand for major trauma services across the entire region. This is true not only for MTCs but also for the existing capacity and capabilities of the Trauma Units. Consideration should be made on further equipping trauma services for elderly trauma, with associated patterns of injury such as low falls and head injuries likely to be factors on the increase. Improving the timely identification of elderly trauma patients, from triage to secondary transfer planning could improve access to MTCs, and lead to timelier CT scanning, increasing the proportion of consultant reviews, and reviews by a trauma team for the elderly injured. Although outside of the direct scope of this needs assessment, given our model's forecasts on population changes and the resulting increase in demand for major trauma services, consideration should also be given to the likely increase in capacity and demand requirements of other comparable conditions in the elderly that would lead to acute admissions. This includes conditions requiring similar resources as patients on a major trauma pathway, for example traumatic and fragility hip fractures, stroke, and other specialised rehabilitation pathways.

The network will benefit from improving and increasing the capacity and skillset mix for the TUs; in particular, for those TUs that are outside of the 60-minute coverage from current and proposed MTCs. This includes Ipswich Hospital, Colchester General Hospital and Luton and Dunstable Hospital. If current patterns of triage and secondary transfers are maintained in the region, then TUs outside of the 60-minute coverage are likely to continue to be treating and retaining their elderly ISS >15 patients. This demand is also likely to increase given future population growth for this age group and the likely need for major trauma care within the existing TUs.

The trauma network will benefit from a holistic assessment of the distribution of major trauma patients who receive their care completely in TUs and in relation to their equity of access to MTCs. Patients from MSE, although the smallest group of patients by ICB, are the least likely to receive services from the MTC with 72% remaining at TUs. Areas outside of the 45-minute drive time are also where most of our Core20 populations are located. Only 5% of the most deprived patients in the region receive treatment from the MTC, compared to 45% across all groups. Some of these populations remain the furthest away from accessing an MTC within the region even when a second Major Trauma Centre at Norfolk and Norwich Hospital is established, such as Ipswich and Clacton-on-Sea (Tendring).

Encouraging timely data submissions to TARN ensures accurate patient trends and characteristics to which the services are monitored and designed. It is recommended that rehabilitation data be made more widely available through a linkage project between the UK Rehabilitation Outcomes Collaborative (ROC) and TARN. Specialised and general rehabilitation needs for major trauma patients will likely increase along with major trauma demand growth. Therefore, the region would benefit from a review of the capacities and availability of these services for trauma patients.

An upstream population health approach is imperative to reduce and prevent common causes of major trauma and will help stem the tide of rising demand. Primary and secondary falls prevention should be prioritised by ICBs and encouraged within the East of England Trauma Network. There should also be ongoing support and linkage with the NHS England regional Falls Working Group and working with Local Authorities and Public Health teams on increasing awareness and interventions to prevent, reduce and minimise injuries from falls across the region. This needs assessment also highlights the need to address the root causes of the higher prevalence of violent injury and trauma experienced by those who are younger and more deprived in our region. This highlights a public health issue that requires a cross-sector approach with a continued focus on addressing violence reduction.

Appendices

Appendix 1
TARN inclusion criteria

TARN Inclusion criteria (any age)

- Direct admissions whose length of stay is 3 days or more or whose combined hospital stay at both sites is 3 days or more.
- Injury patients admitted to a High Dependency Area regardless of length of stay.
- Injury patients transferred to other hospitals for specialist care or for an ICU bed.
- Deaths of trauma patients occurring in the hospital including the Emergency Department (even if the cause of death is medical) within 30 days.

Isolated closed limb fractures and neck of femur fractures in patients aged over 65 are excluded from TARN. Patients transferred in for rehabilitation only are not submitted to TARN.

Appendix 2
Data quality

Note these figures were obtained in November 2022 and may have been updated as more cases have since been confirmed.

Data coverage (case ascertainment)

Ascertainment measures all trauma cases entered into TARN against the overall expected number of cases based on HES data. TARN aims for 80%. Coverage has been consistently above target for Addenbrooke's since 2018/19. Some hospitals have reduced coverage since the COVID-19 years including Colchester, James Paget, and Queen Elizabeth hospitals. The figures in this report are not adjusted for missing submissions. Values above 100 are from where more submissions are meeting the criteria than originally predicted.

Table A2.1 Ascertainment by hospital and year

Hospital	Year									
	2021/22	2020/21	2019/20	2018/19	2017/18	2016/17	2015/16	2014/15	2013/14	2012/13
Addenbrooke's	121	102.3	109.2	113.3	97.4	90.8	80	76.4	80.4	77.8
Bedford	108.4	52.8	24.9	47.9	73.8	81.6	90.5	88.8	73.4	70.5
Broomfield	83.8	85.4	76	87.7	100	35.9	52.3	62.2	68.6	70.8
Colchester	47.3	45.7	70	80	100	88.7	76.3	66.8	63.2	66.8
Ipswich	87.3	84.7	87.8	70.1	97.7	100	87.1	100	73.6	64.2
James Paget	69.6	57.5	78.8	76.6	73.5	77.9	72.2	64	52.9	74.8
Hinchingbrooke	94.4	90.2	111	100	15	6	-	-	-	-
Lister	88.5	77.5	82.3	86	47	61.5	100	87.8	100	100
Luton & Dunstable	94.1	95.6	99.7	79.8	95.2	82.7	68.6	60.7	77.7	84.8
Norfolk & Norwich	113.1	99.6	82.6	70.7	94.1	100	100	99.9	82	83.8
Peterborough	88.1	79.7	88.1	100	100	95.6	100	96.4	80.2	69.4
Princess Alexandra	97.4	97.7	101.2	91.4	100	100	92.5	76.3	100	55.5
Queen Elizabeth	70.9	67.8	87	81.4	92.2	86.2	85.2	81	97	91.6
West Suffolk	113.2	115.4	93.6	94.7	100	90.8	80.3	68.1	73.8	82.6

Data accreditation by hospital

Accreditation measures the completion of key data fields. The TARN aim is 95%. Most hospitals are close to or above this target with only Bedford, Colchester and West Suffolk hospitals showing issues in recent years.

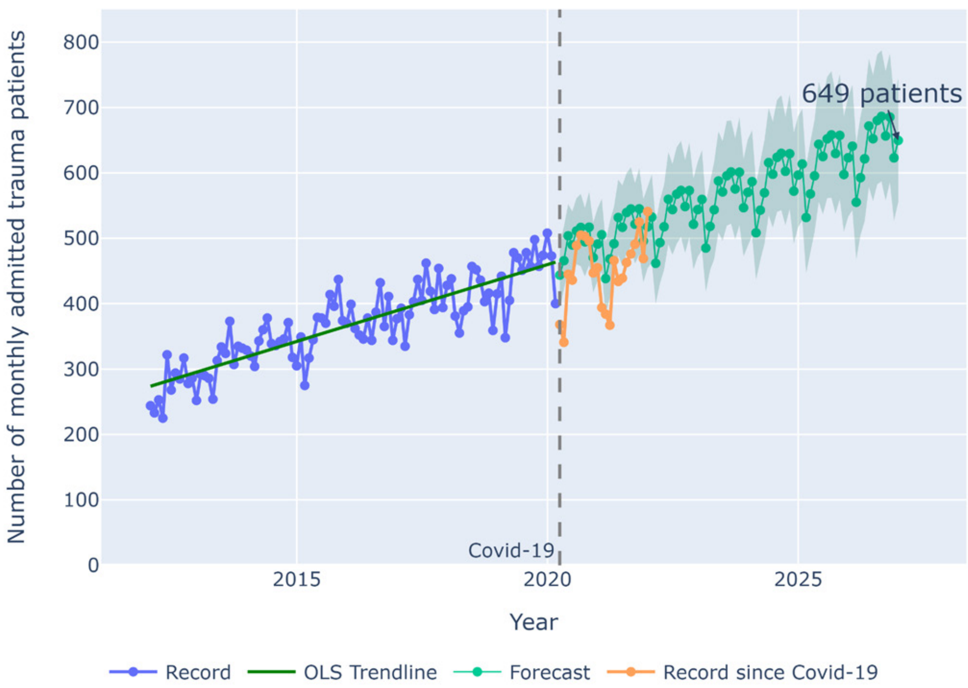
Table A2.2 Accreditation by hospital and year

Hospital	Year									
	2021/22	2020/21	2019/20	2018/19	2017/18	2016/17	2015/16	2014/15	2013/14	2012/13
Addenbrooke's	96.9	97.3	97.2	95	95	91.4	81.1	79.5	83.1	81.8
Bedford	91.9	69.9	71.7	90.6	86.8	87.2	87.2	81.1	83	83.3
Broomfield	96	97.8	93.4	58.2	70.9	72.4	85.2	83.5	72.4	55
Colchester	93	92.2	86.2	82.6	89.2	88.1	88.1	84.5	85.6	79.5
Ipswich	92.4	94	94	89.7	86.5	87.9	87.5	85.5	77.8	70.2
James Paget	92.7	90.9	90.9	87.7	90	89.8	90	83.3	81.5	75.8
Hinchingbrooke	96.8	97.8	97.2	96.9	97.3	98.6	-	-	-	-
Lister	95.9	95.6	96.8	96.9	96.5	96.4	95.9	94.9	92.4	85.8
Luton & Dunstable	92	91.8	92.6	93.8	93.9	93.8	92.5	91	83.7	76.4
Norfolk & Norwich	92	92.1	92.7	92.1	89.7	90.3	88.1	86.8	87.6	81.1
Peterborough	96.9	98.1	97.7	97.3	96.9	93.7	96	95.8	96	87.6
Princess Alexandra	98.8	91.6	92.6	86.6	86.7	88.7	86.9	84.3	85.5	80.6
Queen Elizabeth	96.5	94.7	96.4	90	90.6	93.2	95.7	96.2	94.3	86.5
West Suffolk	87	94.7	96.5	96.3	95.7	94.3	90.3	87.6	89	81.8

Appendix 3
Forecast future trauma patients and incidence rates using the triple exponential smoothing method

The chart in Figure A3.1 displays the historical number of monthly admitted trauma patients (blue curve) and the predicted number of monthly admitted trauma patients (green curve) with the 95% reference range (shaded area) based on the triple-exponential smoothing method. Figure A3.1 shows that the predicted number of monthly admitted trauma patients from March 2020 to December 2026 steadily increases, reaching approximately 7,715 (with the reference range of (6,575, 8,872)) trauma patients annually in 2026.

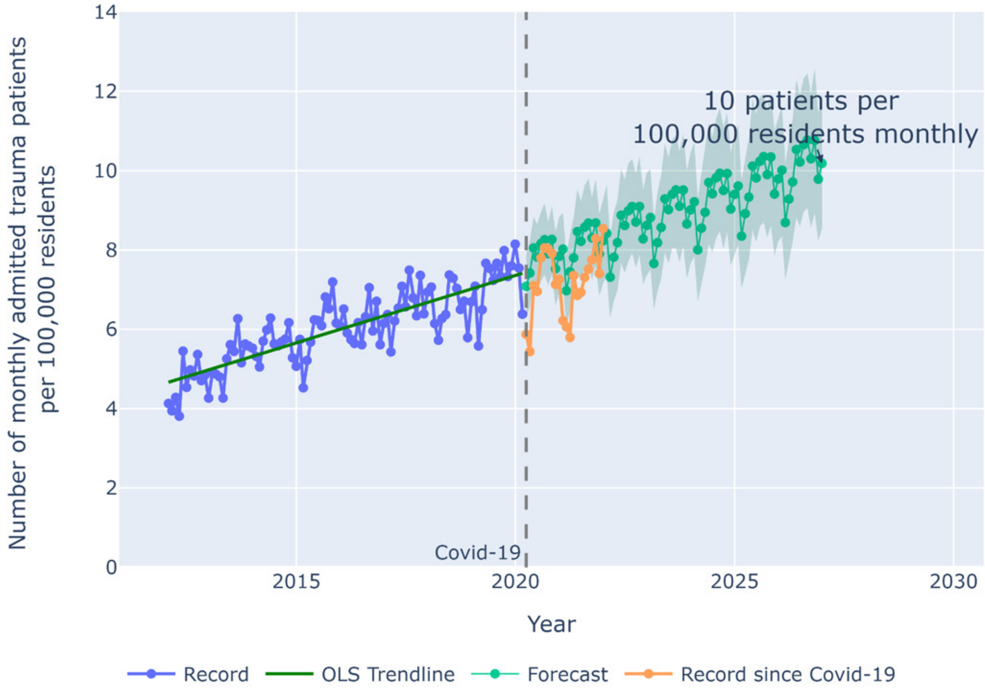
Figure A3.1 Forecasts for the number of trauma patients using the triple exponential smoothing method.



OLS Trendline is based on the ordinary least squares (OLS) regression fit.

The chart in Figure A3.2 displays the historical number of monthly admitted trauma patients per 100k residents (blue curve) and the predicted number of monthly admitted trauma patients per 100k residents (green curve) with the 95% reference range (shaded area) based on the triple-exponential smoothing method. The monthly admitted trauma patients and the corresponding incidence rates forecasted by ARIMA, and the triple exponential smoothing method are comparable in terms of trends and variations.

Figure A3.2 *Forecasts for the incidence rates using the triple exponential smoothing method.*



OLS Trendline is based on the ordinary least squares (OLS) regression fit.

Appendix 4
Major trauma spinal injuries (ISS>15, AIS 1–6)

Data in this appendix refers to ISS >15 and spine AIS 1–6 (all). Patients accepted to Spinal Cord Injury Centres (of which there are none in the East of England) are transferred to a hub bed at either Addenbrooke's, Ipswich or Norfolk and Norwich hospitals depending on their home location.

Table A4.1 shows that admissions of major trauma patients with spinal injuries to the MTC have steadily increased, with a temporary spike in counts in 2018/19. The proportion of major trauma patients admitted to Addenbrooke's Hospital with spine as their most severely injured area has increased to about a third of patients.

Table A4.1 Count of major trauma patients with spine injuries over time – first admitted hospital. % is the proportion of patients where spine was their most severely injured area. Annual bed days derived from LoS.

	Addenbrooke's			Norfolk & Norwich	Ipswich	All other TUs	Bed days for all TUs
Year	**n**	**%**	**Bed days for MTC**	**n**	**n**	**n**	**n**
2012/13	90	16	3,567	42	<5	86	2,885
2013/14	124	20	4,315	27	9	89	2,051
2014/15	139	12	4,974	33	17	117	2,876
2015/16	131	17	5,102	60	18	152	3,976
2016/17	144	20	5,669	50	12	142	3,490
2017/18	147	14	5,652	48	21	145	3,697
2018/19	190	38	5,919	30	13	140	2,514
2019/20	169	36	6,104	28	13	176	3,240
2020/21	175	36	7,354	49	10	171	2,498
2021/22	185	32	5,753	52	11	137	2,794
Total	**1,494**			**419**	**129**	**1,355**	

Total annual bed days for such injuries have been increasing at Addenbrooke's Hospital but have been declining for all TUs since 2015/16. The median LoS for 2017/18 to 2019/20 was 17 days at Addenbrooke's Hospital, 11 days at Norfolk and Norwich Hospital and 10 days at Ipswich Hospital. Median ICU LoS at Addenbrooke's Hospital was three days.

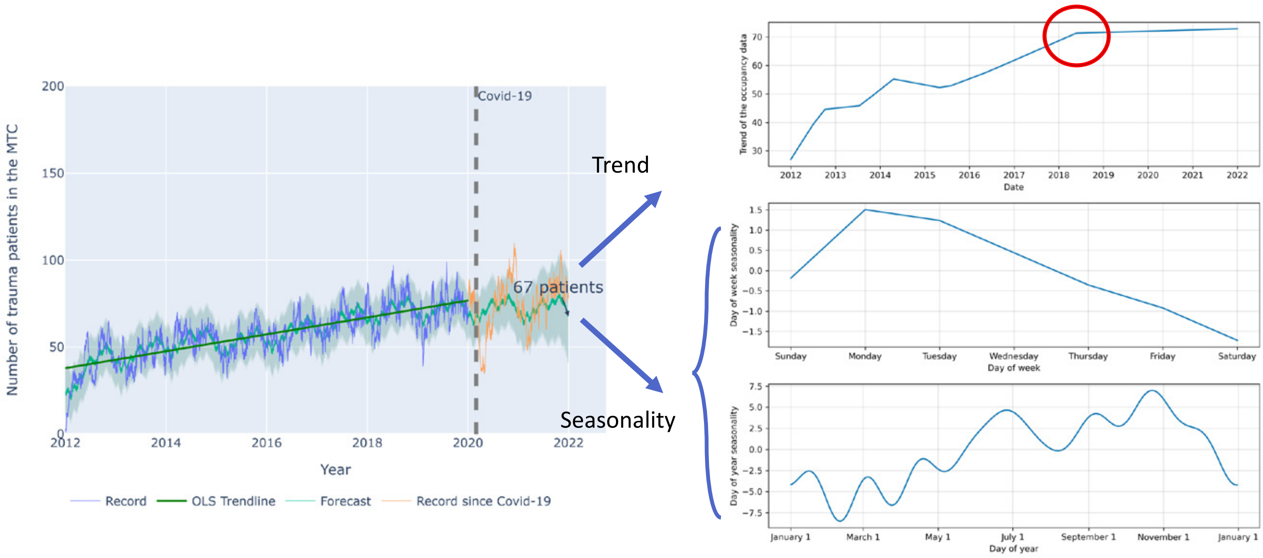
For patients where spine was most severely injured region, 46% were due to low falls with similar proportions at the MTC and TUs. Patients were more likely to be discharged home from TUs (59%) compared to the MTC where patients had a higher chance of being discharged to rehabilitation (17%) or another acute hospital (21%) compared to home (45%).

Appendix 5
Bed occupancy

We use daily data to study bed occupancy. To understand the dynamics of the daily time series data, we decompose it using Facebook Prophet, an open-source forecasting tool[1]. Prophet uses an additive regression model, which includes trend to model non-periodic changes, seasonality (daily, weekly, and yearly) to model periodic changes, and holiday effect to model irregular schedules. Although Prophet may have limitations as a forecasting tool, it effectively detects the 'change points' in the trend of the time series data and finds the best curve to fit it[2]. As such, it is useful in understanding the dynamics of the data. We implement the tool using the Python API[3]. For the decomposition, we did not include the data during the pandemic to not confound the analysis and for the potential concern that Prophet may not be sufficiently robust for large shocks.

Figure A5.1 *Number of trauma patients in the MTC and TUs and associated trend and seasonality analysis for a) b) and c) .*

a Addenbrooke's Hospital

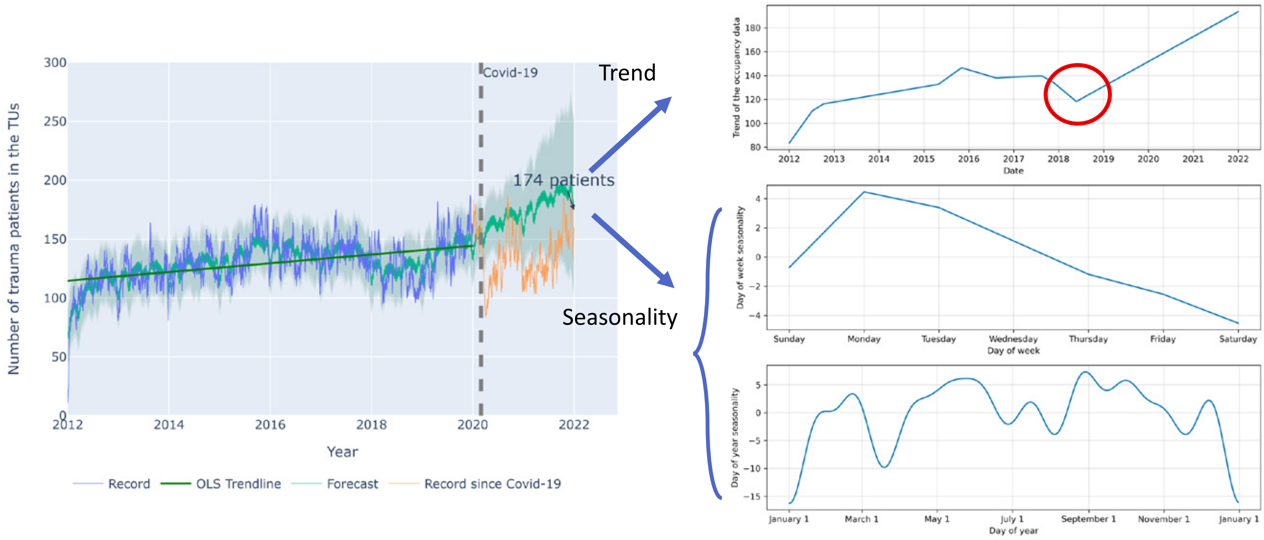


1 Taylor, S.J., B. Letham. 2017. Prophet: forecasting at scale. URL https://research.facebook.com/blog/2017/2/prophet-forecasting-at-scale

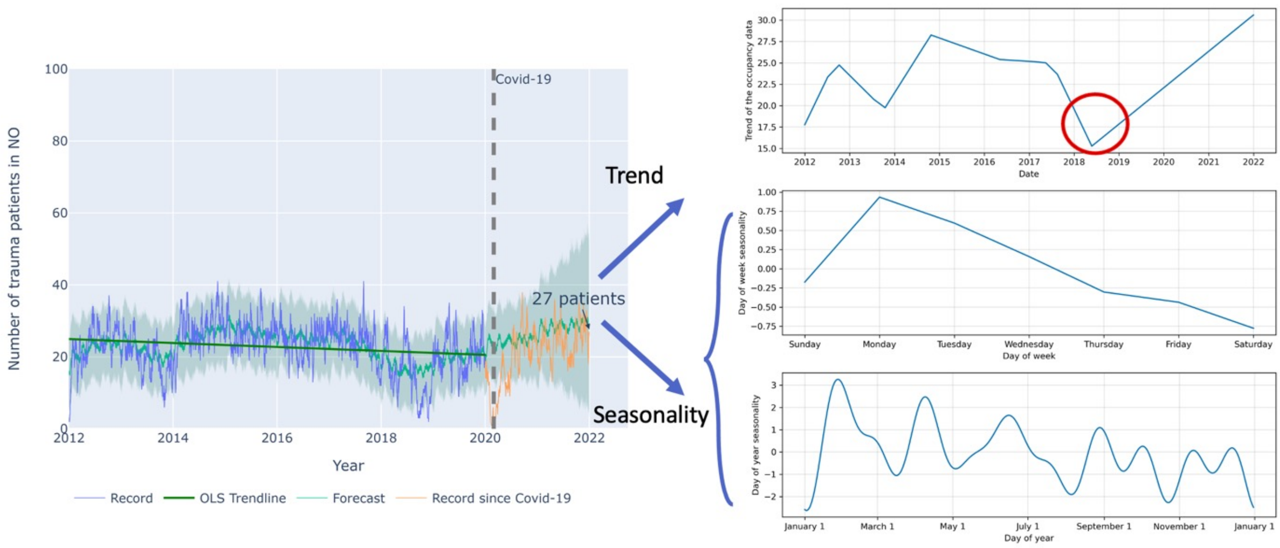
2 Goled, S. 2021. Why are people bashing Facebook Prophet. URL https://analyticsindiamag.com/why-are-people-bashing-facebook-prophet

3 Prophet. N.A. Quick start. URL https://facebook.github.io/prophet/docs/quick_start.html

b all TUs



c Norfolk and Norwich Hospital



Appendix 6
Drive time methods

For the section 'Drive Time from Major Trauma Incidents', Google Maps Distance Matrix API was used to estimate the travelling distances and times[4]. The input 'origin' of the API calls are the incident postcodes of each medical journey record, and we set 'Addenbrooke's Hospital, Hills Rd, Cambridge CB2 0QQ' (the address of the sole MTC in EoE) as the input 'destinations'. The 'duration in traffic' returned by the API is extracted to estimate driving time considering the traffic condition. We estimate the times on 22 March 2023, which is a Wednesday.

Appendix 7
Prediction model for LoS

To determine the scenario LoS, we assume that the NO* (MTC) will provide trauma services at a similar quality level as the NO (TU) at the initial stage of upgrading and at a similar quality level as Addenbrooke's Hospital at the mature stage of upgrading. For patient $\boldsymbol{i}$ with characteristics $\boldsymbol{X_i}$, there exists a function $\boldsymbol{f}()$ predicts the LoS of $\boldsymbol{i}$ in the hospital H_i :

$$LoS_i = \boldsymbol{f}(X_i, H_i)$$

Using the historical TARN data, we estimate $\boldsymbol{f}$. The actual LoS of patient $\boldsymbol{j}$ in his/her actual hospital $H_j{=}TU$ is:

$$LoS_j = \boldsymbol{f}(X_j, H_j = TU)$$

For the initial stage of upgrading, the scenario $\widetilde{LoS}$ of j if he/she were treated in hospital $\widetilde{H_j} = \boldsymbol{NO}$ would be:

$$\widetilde{LoS}_j = \boldsymbol{f}(X_j, \widetilde{H_j} = \boldsymbol{NO})$$

For the mature stage of upgrading, the counterfactual and scenario $\widetilde{LoS}$ of j if he/she were treated in hospital $\widetilde{H_j} = \boldsymbol{AD}$ would be:

$$\widetilde{LoS}_j = \boldsymbol{f}(X_j, \widetilde{H_j} = \boldsymbol{AD})$$

4 Distance Matrix API. N.A. URL https://developers.google.com/maps/documentation/distance-matrix/overview

Appendix 8
A naïve prediction model for secondary transfers at NO* (MTC)

For the sensitivity analysis on potential secondary transfers to NO* (MTC), we build a naïve triage model by assuming secondary transfers to NO* (MTC) are similar to the historical transfers at Addenbrooke's MTC. It would be a challenging task to build a comprehensive model that captures secondary transfers when there are two MTCs in EoE as the hub-and-spoke trauma network with two MTCs is much more complicated to analyse than the hub-and-spoke trauma network with one MTC. The following contains the main steps in the naïve triage model for secondary transfers.

1. Train a triage model to predict the pathway choice with 2012–2021 TARN data and Addenbrooke's Hospital as the MTC. The pathway choices are: (a) direct admissions to Addenbrooke's MTC, (b) secondary transfers to Addenbrooke's MTC, and (c) direct admissions to TUs and never transferred out.
2. With the above prediction model and assuming NO* (MTC) is the only MTC in EoE, predict the counterfactual pathway choice for all EoE trauma patients in 2012–2021.
3. Count the number of trauma patients who use pathway (b) (secondary transfers to NO* (MTC)) and were not treated in the Addenbrooke's MTC.

NHS England

Healthcare Public Health Team, NHS England – East of England
Victoria House, Capital Park, Fulbourn, Cambridge, CB21 5XB
Contact: england.eoehealthcarepublichealth@nhs.net