Royal College of Surgeons of England
ADVANCING SURGICAL CARE

COVID-19

Ann R Coll Surg Engl 2021; **000:** 1–6
doi 10.1308/rcsann.2021.0218

The impact of COVID-19 on major trauma (ISS>15) in London, across its four Level 1 centres

R Bhattacharya[1], M Pearse[1], P Bates[2], R Tahmassebi[3], I El-Daly[3], L Jeyaseelan[2], P Sedgwick[4], A Trompeter[4], On behalf of London Major Trauma Collaborative*

[1]Imperial College Healthcare NHS Trust, UK
[2]Barts Health NHS Trust, UK
[3]King's College Hospital NHS Foundation Trust, UK
[4]St George's University Hospitals NHS Foundation Trust, UK

ABSTRACT

Introduction The COVID-19 pandemic has led to reconfiguration of healthcare resources to manage increased demand for acute hospital beds and intensive care places. Concerns were raised regarding continuing provision of critical care for non-COVID patients during the pandemic. The aim of this study was to assess the impact of the COVID-19 pandemic on patients admitted with major trauma (Injury Severity Score >15) across the four Level 1 trauma centres in London.

Methods Data were collected from all four major trauma centres (MTCs) in London using the Trauma Audit and Research Network database and from local databases at each centre. A 2-month period from 5 March to 5 May 2020 was selected and the same period during 2019 was used to compare changes due to the pandemic.

Results There was a 31% decrease in overall number of patients presenting to the four MTCs during the COVID-19 period compared with 2019. There was no difference in patient demographics or mechanism of injury between the two periods. Sports-related injuries and proportion of self-presentation to hospital were reduced slightly during the pandemic, although the differences were not statistically significant. The mortality rate and association between mortality and injury severity were similar. Proportion of patients requiring intensive care unit facilities also did not change.

Conclusion Despite diversion of critical care resources to deal with COVID-related admissions, we did not observe a change in mortality rate or proportion of severely injured patients requiring critical care. Our results suggest London MTCs were able to provide their usual standard of care for critically injured major trauma (Injury Severity Score >15) patients during the pandemic.

KEYWORDS
Injury – COVID – Level 1 – Major trauma centre

Accepted 4 June 2021

CORRESPONDENCE TO
Rajarshi Bhattacharya, E: rajarshi.bhattacharya@nhs.net

Introduction

The COVID-19 pandemic created an unprecedented global crisis affecting healthcare services across the world.[1] The UK has been one of the worst hit countries among the G7 nations[2] and London was particularly affected in the first wave compared with other areas of the UK. Measures were introduced to limit the spread of the virus in March 2020 and a national lockdown was commenced on 23 March 2020 as part of a national strategy to reduce the spread of the disease and decrease the impact on the NHS.[3]

Historically, the number of intensive care unit (ICU) beds in the UK has been low by international standards.[4] The number of beds has increased in recent years, but occupancy remains high, with 83% of the 4,123 adult critical care beds in England occupied in January 2020.[5] The immediate impact of the pandemic on the NHS was a huge increase in the demand for acute care and intensive care facilities, and healthcare resources were reconfigured to maximise NHS inpatient and critical care capacity to deal with the anticipated increase in COVID-related admissions. However, hospitals were expected to continue to manage non-COVID-related emergencies, including major trauma. NHS England (NHSE) and NHS Improvement (NHSI) stipulated that 'the ability to provide high quality care to major trauma patients should be maintained to the greatest possible extent during the coronavirus pandemic'.[6] Concern was expressed that the NHS may not have the capacity to manage the inevitable increase in demand for critical care caused by COVID-19, while maintaining critical care facilities for severely traumatised patients.[7]

The aim of this study was to investigate the impact of the COVID-19 pandemic on Level 1 major trauma centre (MTC) caseload across the four Level 1 MTCs in London, more specifically the effects of the pandemic on mortality of major trauma patients (Injury Severity Score (ISS) >15)

Co-author contributors: X Salter[1], I Drummond[2], P O'Hagan[2], KS Khor[2], B Ajayi[4], R Navratil[3], P Sangi[3].

and the ability of the MTCs to maintain a critical care service to major trauma.

Methods

Data were collected at the four Level 1 MTCs in London, using the national Trauma Audit and Research Network (TARN) database[8] in which all high-severity trauma cases are required to be registered, as well as local databases of cases from each MTC. Electronic inpatient medical records were accessed for data collection.

A 2-month study period was selected from 5 March to 5 May 2020, to capture the full effects of the lockdown period and associated early days prior to this. The same period from the previous year (5 March to 5 May 2019) was also evaluated to provide baseline data for comparison.

The study included all TARN registry-eligible acute trauma patients who presented to the four MTCs in London. The study was conducted according to STROBE guidelines.[9] Any trauma admissions that were not eligible for inclusion in the TARN database were excluded from the analysis. The data set collected from each centre was registered as service evaluation within individual governance and audit departments, and formal ethical approval was not sought after assessment through the Health Research Authority research assessment tool.[10]

Demographic and diagnostic information was collected, including mode of presentation, mechanism of injury and ISS. Information on operative intervention and use of intensive care facilities was also collected. No patient-identifiable details were shared between the centres, in line with governance rules.

Statistical tests

Data from all centres were combined and analysed as a single data set. The years 2019 and 2020 were compared in categorical variables using the chi-squared test. Where distributional assumptions could be made, the years 2019 and 2020 were compared in continuous variables using the independent *t*-test with Satterwaite's approximation to the degrees of freedom if groups had unequal variances, otherwise the two years were compared using the Mann–Whitney *U*-test. The critical level of significance was set at 0.05 (5%).

A binary logistic regression model was used to model the effect of the explanatory variables year (2019 versus 2020) and categorised by ISS on the outcome of death. ISS was categorised as follows: 1 to 8, 9 to 15, 16 to 30, 31 to 50, and 51 to 75. The model incorporated an interaction term for year and categorised ISS.

Results

There were 496 cases presenting to the four MTCs during the 2020 study period, compared with 726 during the same period in 2019, a decrease of 31.7%.

There were no statistical differences between the two patient groups with regard to age, sex or the presence of comorbidities. There was a significantly higher proportion of patients with a history of psychiatric illness presenting to the MTCs in 2020 (14.3% versus 9.0% p=0.005).

The mode of presentation (whether brought in by ambulance, referred from an external hospital or self-presentation) was broadly similar during both study periods, with a slight reduction in self-presentation in 2020 (0.8% versus 1.7% in 2019). The mechanism of injury was also similar during the two periods. Despite lockdown, around one-third of all cases were as a result of road traffic accidents during both periods and another third were due to falls from height greater than 2m. There were a similar proportion of assaults (both penetrating and non-penetrating). Presentations due to sports injuries were reduced slightly during the lockdown (1.8% versus 2.8% in 2019). None of the differences noted achieved statistical significance (p>0.05).

Overall, ISS remained similar during both periods, with a median score of 16 (p=0.346, Table 1). There was no statistically significant difference in the incidence of head injury, chest injury, abdominal injury, pelvic and spine injury during the two periods, and there was a similar proportion of polytrauma and open fractures. There were slightly more upper limb injuries during the lockdown period (29.2% versus 23.6% in 2019, p=0.027). The proportion of patients treated nonoperatively or operatively were similar during the two periods.

There was a difference in American Society of Anaesthesiologists' (ASA) classification system grades of the patients presenting during the two periods, with a statistically significantly higher proportion of ASA 1 (ie, fit and healthy) patients seen during the pandemic period (45.1% versus 37.4% in 2019, p=0.006). However, the proportion of patients requiring ICU admission and the length of stay in ICU remained the same.

All the MTCs followed Public Health England (PHE) advice at the time regarding testing, isolation and patient flow. There was an initial period of rapid change in the PHE guidelines and thus no one policy was uniform throughout the study period in all four MTCs. Patients were mostly tested for COVID-19 at admission, but emergency code red cases and some other urgent cases were tested in the days after their admission. A total of 33 patients tested positive for COVID-19 during the 2020 period. Seven of whom (1.4%) were positive for COVID-19 on admission; only one of these seven cases underwent surgery. A further 26 cases (5.2%) tested positive on discharge. Around 3% of patients (16 cases) presented with features of COVID-19 on computed tomography scan during their admission period. The proportion of patients requiring respiratory support was similar during both periods and there was no difference in the proportion of fatalities (10.2% in 2020 versus 9.9% in 2019). The association between death rate and ISS category also did not differ across the two periods.

Detailed results are provided in Tables 1–4.

Table 1 Demographics, mode of presentation, mechanism of injury and ISS

	Year of presentation		
	2019 (*N*=726)	**2020 (*N*=496)**	
Sex, *n* (%)			
Female	210 (28.9)	146 (29.4)	χ^2=0.04; df=1; *p*=0.847
Male	516 (71.1)	350 (70.6)	
Age (years)			
n	726	496	*t*=0.40; df=1093.7; *p*=0.69; diff=0.6 (–2.17, 3.28)
Mean	51.7	51.2	
SD	24.49	23.43	
Min	0.7	0.0	
Max	100.5	100.3	
No. of Comorbidities			
Mean	1	1	*U*=168,537.5; *p*=0.093
Median	1	0	
LQ	0	0	
UQ	2	2	
Min	0	0	
Max	9	7	
Psych_Hx, *n* (%)			
No	658 (91.0)	396 (85.7)	χ^2=8.04; df=1; *p*=0.005
Yes	65 (9.0)	66 (14.3)	
Mode of presentation, *n* (%)			
External referral	182 (25.2)	124 (25.1)	χ^2=1.66; df=1; *p*=0.436
LAS	529 (73.2)	367 (74.1)	
Self-presentation	12 (1.7)	4 (0.8)	
Mechanism, *n* (%)			
RTC	229 (31.6)	159 (32.3)	χ^2=2.47; df=6; *p*=0.872
Assault (blunt)	22 (3.0)	13 (2.6)	
Assault (penetrating)	76 (10.5)	52 (10.5)	
Fall <2m	237 (32.7)	153 (31.0)	
Fall >2m	110 (15.2)	86 (17.4)	
Sports	20 (2.8)	9 (1.8)	
Other	31 (4.3)	21 (4.3)	
Injury Severity Score			
Mean	17.6	18.4	*U*=185,224.5; *p*=0.346
SD	10.70	11.11	
Median	16.0	16.0	
LQ	9	9	
UQ	24	25	
Min	4	1	
Max	75	75	

LQ = Lower Quartile; UQ = Upper Quartile; LAS = London Ambulance Service; RTC = Road Traffic Collision.
Psych Hx - presence of any previous psychiatric history as documented in patient's notes.

Table 2 Injury type and distribution, and number of surgeries performed

	Year of presentation		
	2019 (*N*=726)	**2020 (*N*=496)**	
	***n* (%)**	***n* (%)**	
Head injury			
No	448 (61.7)	296 (59.7)	χ^2=0.51; df=1; *p*=0.475
Yes	278 (38.3)	200 (40.3)	
Chest injury			
No	411 (56.6)	295 (59.5)	χ^2=0.99; df=1; *p*=0.320
Yes	315 (43.4)	201 (40.5)	
Abdominal injury			
No	615 (84.7)	415 (83.7)	χ^2=0.24; df=1; *p*=0.623
Yes	111 (15.3)	81 (16.3)	
Pelvis injury			
No	626 (86.2)	411 (82.9)	χ^2=0.26; df=1; *p*=0.107
Yes	100 (13.8)	85 (17.1)	
Spine injury			
No	531 (73.2)	358 (72.2)	χ^2=0.17; df=1; *p*=0.682
Yes	194 (26.8)	138 (27.8)	
Upper limb injury			
No	554 (76.4)	351 (70.8)	χ^2=4.90; df=1; *p*=0.027
Yes	171 (23.6)	145 (29.2)	
Lower limb injury			
No	511 (70.4)	361 (72.8)	χ^2=0.83; df=1; *p*=0.363
Yes	215 (29.6)	135 (27.2)	
Polytrauma			
No	404 (55.6)	259 (52.3)	χ^2=1.31; df=1; *p*=0.252
Yes	322 (44.4)	236 (47.7)	
Open fracture			
No	623 (85.8)	442 (89.1)	χ^2=2.87; df=1; *p*=0.09
Yes	103 (14.2)	54 (10.9)	
No. of operations			
0	375 (51.7)	267 (53.8)	χ^2=1.39; df=6; *p*=0.966
1	250 (34.4)	165 (33.3)	
2	57 (7.9)	39 (7.9)	
3	21 (2.9)	11 (2.2)	
4	10 (1.4)	5 (1.0)	
5	2 (0.3)	2 (0.4)	
>5	11 (1.5)	7 (1.4)	

Values are shown as *n* (%).

Discussion

Aside from the expected reduction in the number of patients presenting to the MTCs during the initial period of the UK COVID-19 pandemic in 2020 compared with the same period in 2019, this study did not demonstrate any significant difference between the patient populations in the two study periods. Mode of presentation, incidence and range of

Table 3 ASA scores, ICU stay, death rates

	Year of presentation		
	2019	**2020**	
	***n* (%)**	***n* (%)**	
ASA Score			
Patient is completely healthy and fit	272 (37.5)	223 (45.1)	χ^2=14.43; df=4; *p*=0.006
Patient has mild systemic disease	245 (33.7)	145 (29.3)	
Patient has severe systemic disease that is not incapacitating	153 (21.1)	99 (20.0)	
Patient has incapacitating disease that is a constant threat to life	52 (7.2)	20 (4.0)	
A moribund patient who is not expected to live 24 hours with or without surgery	4 (0.6)	8 (1.6)	
ICU			
No	549 (75.6)	379 (76.7)	χ^2=0.20; df=1; *p*=0.658
Yes	177 (24.4)	115 (23.3)	
ICU length of stay (days)			
n	176	112	U=9562.5; *p*=0.669
Mean	9.6	9.3	
SD	11.30	10.71	
Median	5.5	5.0	
LQ	3	2	
UQ	12	14	
Min	1	1	
Max	69	60	
Death			
No	652 (89.8)	447 (90.1)	χ^2=0.03; df=1; *p*=0.858
Yes	74 (10.2)	49 (9.9)	
Infection			
No	594 (81.9)	401 (80.8)	χ^2=0.23; df=1; *p*=0.632
Yes	131 (18.1)	95 (19.2)	
Respiratory support			
No	522 (72.0)	367 (74.0)	χ^2=0.59; df=1; *p*=0.442
Yes	203 (28.0)	129 (26.0)	

LQ = Lower Quartile; UQ = Upper Quartile.

Table 4 Frequency of deaths by categorised ISS for each year

	Categorised ISS					
	≤8	**9–15**	**16–30**	**31–50**	**51–75**	**Total**
2019 (*n*=724)	5 (11.6%)	15 (14.9%)	39 (12.5%)	12 (21.4%)	3 (33.3%)	74 (10.2%)
2020 (*n*=496)	2 (6.1%)	13 (6.7%)	23 (11.1%)	9 (16.7%)	2 (33.3%)	49 (9.9%)

Percentages represent the death rates for each year.

injuries, and the need for respiratory support were similar and no difference was observed in the frequency and length of ICU admissions or in the fatality rate in the two groups.

We did not notice any difference in the proportion of polytrauma cases presenting to our units, as reported by other authors.[11,12] Although the lockdown resulted in

some inevitable changes, with a smaller proportion of patients presenting with sporting injuries, the overall range of injury patterns did not vary greatly for our combined volumes. Despite minor variations in the mechanism of injury and the presenting health of the patients, our combined MTCs did not see any large differences with regard to the overall presentation of major trauma patients compared with the pre-COVID-19 period.

The London MTCs rapidly developed similar internal protocols to assess, triage and manage trauma patients during the lockdown period.[13] There were no specific policy decisions among the MTCs with regard to reserving beds for Level 1 trauma patients during this time. However, local trauma units were asked to help with the initial management of some of the complex trauma work that traditionally would have been referred primarily to their network MTC. This did not affect the overall TARN data as these were mainly isolated intra-articular injuries that traditionally would have been brought in to the MTCs in the first instance, but during this period they received initial temporary stabilisation in their local trauma units before being transferred in a more controlled environment to the MTCs. The reduction in the total number of cases presenting to our combined MTCs of 31% was smaller than in other trauma centres, who reported a bigger reduction in volumes, varying from 43% to 50%.[11,12,14]

Because of the huge pressures on NHS services due to COVID-19, critical care beds were clearly going to be at a premium during the crisis and it was expected that there would be competing requirements for this capacity from the severely injured polytrauma patients presenting to the Level 1 centres. Our results confirm that the proportion of patients requiring ICU admission and the length of stay in ICU remained the same between the study periods, which suggests the critical care facilities maintained an appropriate service for severely injured patients. In addition, the overall survival rate of our trauma patients during the COVID-19 pandemic was not altered significantly, despite a large proportion of each hospital's resources being diverted towards treating COVID-19 patients.

The COVID-19 pandemic affected the presentation and management of trauma patients across the UK.[12] Despite the significant number of publications related to the effect of COVID-19 on different aspects of healthcare around the world, very few have looked at the effects of COVID-19 on Level 1 MTCs and these have all been single-centre studies.[13,15–17] The ICON Trauma Study[18] set up to look at this effect in more detail, is also from a single major trauma network in the UK. Our report is the first multicentre study on the effect of the COVID-19 pandemic and associated lockdown on MTCs.

Our analysis used a retrospective population cohort and we did not take account of potential regional variations in care delivery. Because of the rapidly changing nature of PHE guidance during the early days of the pandemic, the testing and reporting systems for hospital admissions were not as robust during this period. However, our study still shows the overall resilience of the MTC healthcare system during the early COVID-19 pandemic.

Conclusion

Our results provide reassurance that despite the diversion of resources towards dealing with COVID-19 patients, the London MTCs were able to perform to their normal high standards and were able to deliver care to major trauma patients in an appropriate and timely fashion.

References

1. Wu F, Zhao S, Yu B *et al.* A new coronavirus associated with human respiratory disease in China. *Nature* 2020; **579**: 265–269.
2. Islam F. Coronavirus: UK hardest hit by virus among leading G7 nations. BBC News 2020. https://www.bbc.co.uk/news/business-53222182 (cited June 2021).
3. UK Government. Guidance: Oral statement to and away from others (social distancing). https://www.gov.uk/government/publications/full-guidance-on-staying-at-home-and-away-from-others (cited June 2021).
4. Rhodes A, Ferdinande P, Flaatten H *et al.* The variability of critical care bed numbers in Europe. *Intensive Care Med* 2012; **38**: 1647–1653.
5. NHS England. Critical care bed capacity and urgent operations cancelled 2019-20 data. https://www.england.nhs.uk/statistics/statistical-work-areas/critical-care-capacity/critical-care-bed-capacity-and-urgent-operations-cancelled-2019-20-data/ (cited June 2021).
6. NHSE & NHSI. Publications approval reference: 001559. Specialty guides for patient management during the coronavirus pandemic Clinical guide for the management of major trauma patients during the coronavirus pandemic 26 March 2020 Version 1 National major trauma system. https://madeinheene.hee.nhs.uk/Portals/0/Major%20Trauma%20Clinical%20Guide%2027%20March.pdf (cited June 2021).
7. Illman J. Coronavirus response could create 'very serious unintended consequences'. HSJ, https://www.hsj.co.uk/policy-and-regulation/coronavirus-response-could-create-very-serious-unintended-consequences/7027321.article (cited June 2021).
8. TARN Database. The Trauma Audit and Research Network. https://www.tarn.ac.uk/ (cited June 2021).
9. Elm EV, Altman DG, Egger M *et al.* The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Int J Surg* 2014; **12**: 1495–1499.
10. Health Research Assessment Tool. UKRI Medical Research Council. http://www.hra-decisiontools.org.uk/research/ (cited June 2021).
11. Fojut R. How coronavirus is affecting trauma systems in Italy. Trauma System News March 21, 2020. https://www.trauma-news.com/2020/03/how-coronavirus-is-affecting-trauma-systems-in-italy/ (cited June 2021).
12. Park C, Sugand K, Nathwani D *et al.* Impact of the COVID-19 pandemic on orthopedic trauma workload in a London level 1 trauma center: the 'golden month'. *Acta Orthop* 2020; **91**: 556–561.
13. Scott CEH, Holland G, Powell-Bowns MFR *et al.* Population mobility and adult orthopaedic trauma services during the COVID-19 pandemic: fragility fracture provision remains a priority. *Bone & Joint Open* 2020; **1**.
14. Tahmassebi R, Bates P, Trompeter A *et al.* Reflections from London's level-1 major trauma centres during the COVID crisis. *Eur J Orthop Surg Traumatol* 2020; **30**: 951–954.
15. Christey G, Amey J, Campbell A, Smith A. Variation in volumes and characteristics of trauma patients admitted to a level one trauma centre during national level 4 lockdown for COVID-19 in New Zealand. *N Z Med J* 2020; **133**: 81–88.
16. Way TL, Tarrant SM, Balogh ZL. The effect of COVID-19 social restrictions on major trauma volumes and resource utilisation at a level 1 trauma centre. Med J Aust 2020. https://www.mja.com.au/journal/2020/effect-covid-19-social-restrictions-major-trauma-volumes-and-resource-utilisation (cited June 2021).
17. Rajput K, Sud A, Rees M, Rutka O. Epidemiology of trauma presentations to a major trauma centre in the north west of england during the COVID-19 level 4 lockdown. *Eur J Trauma Emerg Surg* 2021; **47**: 631–636.
18. Adiamah A, Moody N, Blackburn L *et al.* ICON trauma (impact of COVID-19 on major trauma workload). *Br J Surg* 2020. doi:10.1002/bjs.11855