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Mortality risk of surgically managing orthopaedic trauma during the COVID-19 pandemic

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Aims

It is imperative to understand the risks of operating on urgent cases during the COVID-19 (SARS-Cov-2 virus) pandemic for clinical decision-making and medical resource planning. The primary aim was to determine the mortality risk and associated variables when operating on urgent cases during the COVID-19 pandemic. The secondary objective was to assess differences in the outcome of patients treated between sites treating COVID-19 and a separate surgical site.

Methods

The primary outcome measure was 30-day mortality. Secondary measures included complications of surgery, COVID-19 infection, and length of stay. Multiple variables were assessed for their contribution to the 30-day mortality. In total, 433 patients were included with a mean age of 65 years; 45% were male, and 90% were Caucasian.

Results

Overall mortality was 7.6% for all patients and 15.9% for femoral neck fractures. The mortality rate increased from 7.5% to 44.2% in patients with fracture neck of femur and a COVID-19 infection. The COVID-19 rate in the 30-day postoperative period was 11%. COVID-19 infection, age, and Charlson Comorbidity Index were independent risk factor for mortality.

Conclusion

There was a significant risk of contracting COVID-19 due to being admitted to hospital. Using a site which was not treating COVID-19 respiratory patients for surgery did not identify a difference with respect to mortality, nosocomial COVID-19 infection, or length of stay. The COVID-19 pandemic significantly increases perioperative mortality risk in patients with fractured neck of femora but patients with other injuries were not at increased risk.

Cite this article: *Bone Jt Open* 2021;2-5:330–336.

Keywords: Morbidity, Mortality, COVID-19, Trauma, Surgery, Orthopaedics

Introduction

The pneumonitis triggered by SARS-CoV-2, responsible for the COVID-19 pandemic, can progress to acute respiratory distress syndrome.[1,2] The COVIDSurg Collaborative reported 30-day postoperative mortality in COVID-19-positive patients as 23.8%.[3] Studies reporting the 30-day mortality of patients with fractured neck of femur (NOF) and COVID-19 infection reported mortality rates of 30.5% to 35.5% and demonstrated that COVID-19 infection was an independent risk factor for mortality.[4,5]

Being one of the busiest managing COVID-19 ventilatory cases across Europe (University Hospitals Birmingham NHS Foundation Trust), the trust moved to an emergency plan to deal with the expected surge in COVID-19 patients in March 2020. Services were reconfigured to prioritize the treatment of viral pneumonia with a focus on maximizing intensive care capacity.[6] The orthopaedic service was reorganized so that the minimum number of patients were admitted to the major trauma centre (MTC) and district general hospital (DGH, a secondary care facility with diagnostic and therapeutic facilities); the majority of the cases were redirected to the local elective surgery site (ESS).

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doi: 10.1302/2633-1462.25.BJO-2020-0189.R1

Bone Jt Open 2021;2-5:330–336.

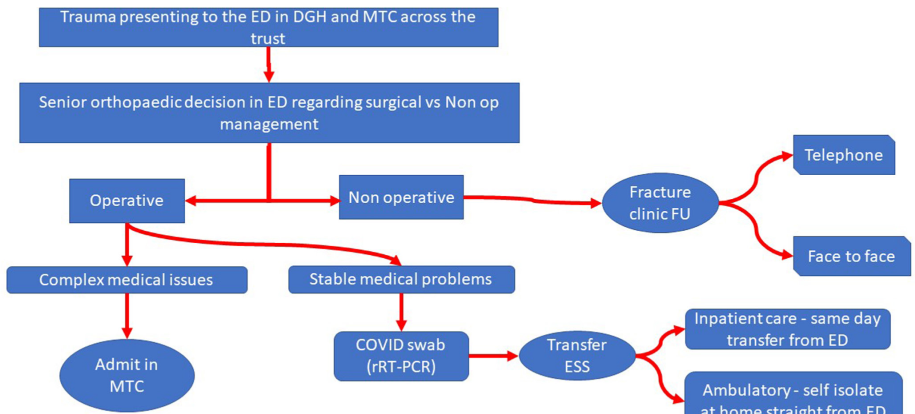

Fig. 1

Patient flow pathway during the COVID-19 first wave. DGH, district general hospital; ED, emergency department; ESS, elective surgery site; FU, follow-up; MTC, major trauma centre; rRT-PCR- reverse transcriptase-polymerase chain reaction.

The MTC continued as the major trauma centre for the region and also dealt with cases deemed medically unfit for the ESS. Even though changes were implemented to follow the British Orthopaedic Association (BOA) guidelines,[7] with an emphasis on using nonoperative management where possible,[6] this structure allowed for the timely surgical management of orthopaedic trauma.

This study primarily aimed to distinguish the mortality risk of undergoing urgent orthopaedic surgery during the first wave of COVID-19 pandemic in the UK. The secondary objective was to assess if there was a difference in outcome of surgery between sites, by diverting the orthopaedic trauma cases to an ESS to free up beds in a busy MTC and DGH. Our primary outcomes were 30-day mortality, and secondary measures were COVID-19 infection rate and length of stay (LOS).

Methods

A prospectively maintained trauma database identified all trauma and orthopaedic patients that were admitted and required surgery between 26 March and 20 May 2020 emergency plan during the first lockdown. The study was approved by the institutional review board. Trust audit policies were adhered to for this study and no patients were directly contacted.

Inclusion and exclusion criteria. Patients aged 18 years or over treated surgically across the trust were included. Spinal conditions and hand trauma treated by separate services were excluded.

Trauma pathway. Care was diverted away from DGH early in the primary stage of the pandemic due to capacity issues. The ESS is normally a specialist elective orthopaedic hospital (Royal Orthopaedic Hospital NHS Foundation Trust) which was only used for urgent surgery throughout the pandemic; it did not play a role in admitting patients who required treatment for non-orthopaedic respiratory COVID-19. The patient flow is shown in the Figure 1.

Data collection. Electronic patient records (EPR) was used to collect patient demographics such as: age; sex; ethnicity; BMI; dates of admission, surgery and discharge; comorbidities and Charlson Comorbidity Index (CCI);[8] American Society of Anesthesiologists (ASA) Classification;[9] and Clinical Frailty Scale (CFS).[10] The following injury and treatment factors were recorded: surgery performed; open or closed injury; mechanism, fracture type (NOF vs other trauma). Nottingham Hip Fracture Scores (NHFS)[11] were recorded for femoral neck fractures. All swab results for COVID-19 taken pre- and post-surgery were collected.

Statistical analysis. R software (version 4.0.2; R Foundation for Statistical Computing, Austria) with a pre-determined significance level of 0.05 was used. Continuous variables underwent a Shapiro-Wilk test for normality with subsequent univariate analysis with the outcome of interest (response), alive or dead within 30 days of surgery. Individual comparisons were made using the chi-squared test for categorical data and independent *t*-test for continuous data except where normality could not be assumed where a Mann-Whitney U test was used. To explore the influence of risk factors multiple logistic regression modelling was performed. The following variables were considered for inclusion in the modelling: age; sex; ethnicity; ASA; BMI; CFS; hip fracture diagnosis; hospital site; time to surgery; number of procedures; CCI;, preoperative COVID-19 status; and final COVID-19 status.

Two multiple logistic regression models were developed. Model 1 was based on variables known postoperatively, including the final COVID-19 status. Model 2 included variables known preoperatively to reflect risk assessment in preoperative patients. Model selection was performed on a training subset (60%) of the data, and the final, minimal adequate, models cross-validated against the remaining data. Models were assessed by receiver operating curve (ROC) analysis, Hosmer-Lemeshow

Table I. Multiple logistic regression models.

Variable	Coefficient*	95% CI	OR	95% CI	p-value†
Model 1					
(Intercept)	-12.31	-6.79 to -19.11			< 0.001
Age, yrs	0.08	0.16 to 0.02	1.09	1.02 to 1.17	0.018
Sex, male	0.70	1.77 to -0.36	2.02	0.70 to 5.87	0.189
Non-white	1.46	3.58 to -0.69	4.32	0.50 to 35.85	0.176
Clinical Frailty Scale 7 to 9	1.07	2.95 to -0.95	2.91	0.39 to 19.13	0.270
Femoral neck fracture	2.36	4.47 to 0.78	10.60	2.19 to 87.06	0.009
Hospital, MTC	-3.55	-1.44 to -6.05	0.03	0.00 to 0.24	0.002
Hospital, ESS	-2.91	-1.23 to -4.82	0.05	0.01 to 0.29	0.001
Charlson Comorbidity Index	0.48	0.76 to 0.24	1.62	1.27 to 2.14	< 0.001
Final COVID-19-positive status	2.50	3.66 to 1.46	12.13	4.29 to 38.90	< 0.001
Model 2					
(Intercept)	-11.70	-17.62 to -6.79			< 0.001
Age, yrs	0.09	0.03 to 0.15	1.09	1.03 to 1.16	0.005
Sex, male	0.45	-0.53 to 1.40	1.56	0.59 to 4.04	0.358
Non-white	2.34	0.63 to 4.07	10.39	1.88 to 58.64	0.006
Clinical Frailty Scale, 7 to 9	0.89	-0.98 to 2.62	2.45	0.38 to 13.78	0.317
Femoral neck fracture	2.41	0.86 to 4.51	11.09	2.37 to 90.68	0.008
Hospital, MTC	-3.91	-6.47 to -1.86	0.02	0.00 to 0.16	< 0.001
Hospital, ESS	-2.95	-4.64 to -1.47	0.05	0.01 to 0.23	< 0.001
Charlson Comorbidity Index	0.46	0.23 to 0.73	1.59	1.26 to 2.08	< 0.001
Preoperative COVID-19 suspected/positive	1.55	-0.41 to 3.56	4.71	0.66 to 35.02	0.114

*The coefficient quantifies the change in log odds corresponding to presence of, or a unit change in, the variable, while keeping the other predictors constant.
†Wald test from logistic regression model output in R.
CI, confidence interval; ESS, elective surgery site; MTC, major trauma centre; OR, odds ratio.

goodness of fit,[12] and McFadden R^2.[13] The final models were refit against the whole dataset.

The final minimal adequate model 1 had age, sex, ethnicity, CFS, NOF diagnosis, treating hospital, CCI, and final COVID-19 status as predictors (Table I). Sex, ethnicity, and CFS were individually not significant in the model. The final model had excellent discrimination on ROC curve analysis (area under curve (AUC) 0.958, 95% confidence interval (CI) 0.930 to 0.986), and excellent calibration (McFadden R^2 0.5429; p = 0.517, Hosmer-Lemeshow test). Model 2 had the same predictors as model 1 in the final model, except that COVID-19 status was included as known preoperatively and included suspected cases. This model also had excellent discrimination (AUC 0.935, 95% CI 0.905 to 0.965), and was well calibrated (McFadden R^2 0.4504; p = 0.9787, Hosmer-Lemeshow test).

Results

The study included 433 patients (Table II). CFS was recorded in 397 (93%) patients. The majority of cases were treated at the ESS (n = 308,72%), with the MTC treating 96 (23%).

Type of injuries and length of stay. Most of patients sustained low-energy injuries (n = 276; 64%), with the majority being femoral neck fractures (n = 189; 68.5%). There were 429 patients with 456 injuries, including 16 polytrauma. The cases are detailed in Table III. The majority of the patients had surgery within 24 hours of injury (n = 245,57%) with a median LOS of six days (interquartile range (IQR) 2 to 11). This increased for patients with a fractured neck of femur (nine vs three days, p < 0.001).

Overall mortality data. Overall, there were 33 deaths; the 30-day mortality rate was 7.6% (n = 33) (Table IV), with the majority of deaths occurring in patients who were treated for a fractured NOF (30/33, 90.9% of deaths). The 30-day mortality rate during the previous year for the same period was 2.7% with 8.1% mortality for NOFs and 1% for other trauma (259 cases with 62 NOFs in 2019).

Mortality data for NOFs. The mortality rates for patients with femoral neck fractures are shown in Table IV. The data are broken down by the hospital in which they were treated and the neck of femur patients are separated into whether they had a COVID-19 infection (pre- or postoperatively). In the 30 (15.5%) patients who died following treatment for a fractured NOF, nine died in hospital and 21 died following discharge.

Mortality in other trauma cases. The two patients who died and did not have a NOF were both COVID-19-positive; one was classed as moderately frail and had a prosthetic hip dislocation manipulated under anaesthesia, while the other was an 86-year-old male, classed as mildly frail who underwent reverse total shoulder arthroplasty.

Table II. Patient demographics, treatment variables, and outcome predictors for all patients, those suffering a traumatic injury, and those specifically with a fragility fracture of proximal femur.

Denographic	Variable	All patients	Trauma	NOF fracture
Age, yrs, mean (SD)		65 (22.21)	54 (21.34)	78 (12.43)
Socioeconomic status, median (IQR)		5 (5)	3 (5)	4 (5.25)
Sex, male , n (%)		193 (45)	129 (54)	63 (33)
Ethnicity, n	Caucasian	386	206	179
	Asian	33	23	10
	Afro-Caribbean	5	5	0
	Mixed	4	4	0
	Other	1	1	0
	Not specified	4	3	1
Clinical Frailty score, n (%)	Very fit	24	23 (9.5)	1 (0.5)
	Well	130	113 (46.9)	17 (9)
	Managing well	84	36 (14.9)	48 (25.4)
	Vulnerable	56	16 (6.6)	40 (21.2)
	Mild frail	38	9 (3.7)	29 (15.3)
	Moderately frail	52	13 (5.4)	39 (20.6)
	Severely frail	11	4 (1.9)	6 (3.2)
	Very severely frail	1	0	1 (0.5)
	Not recorded	32	24 (10)	8 (4.2)
ASA grade, median (IQR)		2 (1)	2(1)	3 (1)
BMI, kg/m^2, median (IQR)		28.6 (7.9)	27.6 (7.18)	24.2 (6.43)
Charlson Comorbidity Index, median (IQR)		3 (4)	2 (3)	5 (2)
Anaesthetic type, n (%)	General		99 (41.3)	26 (13.8)
	Regional		33 (13.8)	2 (1.1)
	Spinal		79 (32.9)	147 (77.8)
	Not recorded		29 (12.1)	14 (7.4)
Time to surgery, days, median (IQR)		1 (2)	1 (4)	1 (1)
Length of stay, days, median (IQR)		4 (9)	3 (7)	9 (7.75)
Chronic disease, n	Diabetes mellitus	26	16	10
	Hypertension	171	71	100
	Dementia	49	8	41
	COPD	28	8	20
	Chronic kidney disease	36	9	26

COPD, chronic obstructive pulmonary disease; IQR, interquartile range; NOF, neck of femur; SD, standard deviation.

Table III. Orthopaedic indication for surgery during COVID-19 pandemic.

Type of injury	n (%)
Clavicle fracture	5 (1.1)
Shoulder fracture/dislocation	15 (3.3)
Humerus fracture	14 (3.1)
Elbow fracture/dislocation	3 (0.7)
Olecranon fracture	5 (1.1)
Forearm fracture	7 (1.5)
Pelvic fracture	5 (1.1)
Distal radius fracture	26 (5.7)
Proximal femur low energy (NOF)	189 (41.4)
Proximal femur high energy	3 (0.7)
Femur fracture excluding proximal site	21 (4.6)
Patella fracture	3 (0.7)
Tibia plateau fracture	6 (1.3)
Tibia fracture excluding tib plateau site	24 (5.3)
Ankle fracture	26 (5.7)
Lisfranc fracture/ dislocation	2 (0.4)
Tendon injury (excluding hands)	9 (2.0)
Prosthetic joint dislocation	23 (5.0)
Soft tissue wound/infection	19 (4.2)
Periprosthetic fracture any site	16 (3.5)
Joint infection native/prosthetic	14 (3.07)
Soft tissue knee/shoulder injury managed arthroscopically	10 (2.2)
Revision fracture fixation (any site)	4 (0.9)
Other	7 (1.5)
Total	456 (100)

Comparison of NOF vs other trauma mortality. The mortality rate was significantly higher in patients with a femoral neck fracture compared to the those without (15.8% vs 0.83%, $p = 0.001$, chi-squared test). Table V shows the sub-group analysis used to investigate patient and treatment factors that influenced mortality. Increased age and higher estimates on validated prognostic tools were significantly different in these groups (ASA, NHFS, CCI, and CFS).

Absent data. BMI and time to surgery had missing data , 23% and 21% respectively. Hospital site influenced proportion of missing data in these fields and therefore not included in the modelling. CFS was missing in 32 (10.4%) of the ESS cases; these were imputed with the median CFS for the site. CFS was grouped into those with CFS 7 to 9 and those less than 7. ASA and number of procedures did not significantly reduce deviance and were not included in the final models.

Modelling

Model 1 (postoperative COVID-19 status). Based on model 1, risks in individual perioperative circumstances can be estimated. For example, for an 82-year-old white male with a hip fracture and CFS score of 7, CCI score of 1, and negative final COVID-19 status operated on at MTC, the 30-day mortality risk based on the model was 1.10%. The same patient who became COVID-19 positive has an 11.93% 30-day mortality risk.

COVID-19 status. At surgery, only nine (2.1%) patients had tested positive for COVID-19 and eight (1.85%) were suspected of being infected but had tested negative. During the follow-up, 47 patients (10.9%) tested positive for COVID-19 (Table VI). In all, 19/47 patients (40.4%) died with mean age of 85 years (standard deviation 11.54). In these 19 patients, there were 17 (89.5%) femoral neck fractures, one (5.3%) periprosthetic hip dislocation, and one (5.3%) shoulder arthroplasty. One patient who died was aged 50 years and was BAME (Black Asian and Minority Ethnic), with hypertensive kidney disease, and considered vulnerable on the CFS.

The mean age of patients who developed COVID-19 postoperatively was 80 years, with three patients aged under 60 years. The rate of COVID-19 infection went up at all three sites in the 30-day postoperative period

Table IV. Mortality figures for all patients overall and broken down by the hospital in which they were treated.

Institution	Overall mortality, n (%)	All, n (%)	COVID-19-negative, n (%)	COVID-19-positive, n (%)	Mean age, yrs	CCI, median (IQR)
All patients	33/433 (7.6)	30/189 (15.9)	11/146 (7.5)	19/43 (44.2)	80	5 (4 to 6)
DGH	8/25 (32)	7/10 (70)	2/4 (50)	5/6 (83)	77	6 (4.75 to 7)
MTC	3/97 (3.1)	2/26 (7.7)	1/21 (4.8)	1/5 (20)	76	5 (3 to 5.25)
ESS	22/311 (7.1)	21/153 (13.7)	8/121 (6.8)	13/32 (40.1)	81	5 (4 to 6)

CCI, Charlson Comorbidity Index; DGH, district general hospital; ESS, elective surgery site; IQR, interquartile range; MTC, major trauma centre.

Table V. Data for patients with a femoral neck fracture comparing the survivors with those who died within 30 days of surgery.

Variable	Alive		Dead		Significance
	No	Data, median (IQR)	No	Data, median (IQR)	p-value*
Age, yrs	79	12.55 (75 to 83)	85	10.787 (81 to 89)	0.012†
ASA, grade	3	IQR 1	3	IQR 0	< 0.001†
BMI, kg/m^2	24	IQR 6.48	25	IQR 8	0.833
Index of multiple deprivation	4	IQR 5	4	IQR 7	0.577
Time to surgery, days	1	IQR 0	1	IQR 1	0.187
Length of stay, days	8	IQR 6	13	IQR 9	0.043†
NHFS 30-day mortality estimate	4.6	IQR 4.6	7.4	IQR 7.2	< 0.001†
Charlson Comorbidity Index	4	IQR 2.75	6	IQR 2.25	< 0.001†
Clinical Frailty Score	4	IQR 2	5	IQR 2	0.006†

**t*-test for age, Mann-Whitney for other variables.
†significant difference p < 0.05.
ASA, American Society of Anesthesiologists; IQR, interquartile range; NHFS, Nottingham Hip Fracture Score.

Table VI. COVID-19 status at time of surgery and in the subsequent 30 days.

Time of surgery		30-day postoperative period		Hospital
COVID-19 status	No.	COVID-19 status	No.	
Negative	363	Negative	298	
		Not suspected	29	
		Positive	40	DGH n = 2, MTC n = 1, ESS n = 37
Not suspected	53	Negative	7	
		Not suspected	41	
		Positive	5	DGH n = 4, MTC n = 1
Suspected	8	Negative	6	
		Positive	2	MTC n = 2
Positive	9			MTC n = 4; DGH n = 2; ESS = 3

DGH, district general hospital; ESS, elective surgery site; MTC, major trauma centre.

(Table VI); MTC n = 4 to a total of n = 8 (4 + 4; 4% to 8%), DGH n = 2 to n = 8 (2 + 6; 8% to 25%), and ESS n = 3 to n = 40 (3 + 37; 1% to 13%). In total, 37 of the positive results had femoral neck fractures, three periprosthetic fractures, three prosthetic hip dislocations, one periprosthetic hip infection, one proximal humerus fracture, and one abscess.

Discussion

This study is the largest series looking at surgically managed orthopaedic trauma during the first wave of COVID-19 pandemic. In patients without a NOF, the mortality rate was 0.7% compared to 1% the previous year, which is comparable to 0.95% in a pre-COVID-19 trauma series.[14] The mortality risk to patients without a proximal femoral fracture was no greater than in the pre-pandemic period, even if they were to acquire COVID-19 infection. This information is invaluable when counselling patients of the risks of urgent surgery when they cannot wait for negative swabs and two weeks of isolation, as has been suggested for elective surgery.

The majority of deaths were in femoral neck fractures and the overall mortality rate was higher than for the same period in 2019 when compared to the National Hip Fracture Database (NHFD) data (15.9% vs 6.1%).[15] Femoral neck fractures that were COVID-19-negative had a lower mortality than the previous year at the MTC (4.8% vs 8.4%), and were comparable to the national average at the ESS.[15] COVID-19 infection and mortality were found to be related to age and frailty; this could represent that those who died were already at a higher risk of mortality.[16]

Our data permits a direct comparison between patients treated under the same conditions with and without COVID-19. We found a higher overall mortality rate in COVID-19 patients than that reported by the

COVIDSurg collaborative;[3] this is likely due to the strong skew towards older age in our study, particularly from patients sustaining femoral neck fractures. In the COVIDSurg study cohort, 50% of patients were aged 70 years or over; in our study; 86% of COVID-19-positive patients were aged over 70 years. Our data corroborates that a COVID-19 infection was an independent risk factor for mortality in this group.[4,5] Increased age is an accepted risk factor for increased morbidity and mortality,[17] with the risk of contracting COVID-19 and mortality being associated with ethnicity, increased BMI, diabetes, and hypertension. Our analysis demonstrated that age and CCI were independent risk factors, but found the other conditions identified previously were not significant.

We found that CFS was not significant as a predictor in the modelling but it did add to the model performance, and was retained. By contrast, Hewitt et al[18] found that CFS 7 to 9 was a significant predictor of seven-day mortality in 1,564 heterogenous patients. In that study, lesser frailty was not a significant predictor of seven-day mortality, though there was an effect on time to mortality. In our study, relatively few patients (13/430, 3.0%) fell into that severe frailty group, which may account for the inability of our model to detect significance for CFS. This is important if health services need to utilize a differentiating score for rationalizing healthcare provision in any subsequent waves of the pandemic.

Concerns have been raised about potential harm to non-COVID-19 patients, such as delaying cancer treatment, due to the national prioritization to deal with COVID-19. An unforeseen finding was the relatively higher mortality rate in patients with femoral neck fractures operated on at the DGH. These patients were all operated on at the end of March 2020, just prior to the hospital closing to orthopaedic trauma due to the pressures to treat patients with COVID-19 pneumonia. While these patients did not die directly from COVID-19, it is likely that their mortality was contributed to by the requirement to divert services to the treatment of COVID-19. One contributing factor to this increased mortality rate may have been selection bias generated by the transfer process between DGH and the ESS. It was initially difficult for patients with multiple comorbidities to meet the criteria required for transfer. These criteria were relaxed as the COVID-19 pandemic progressed.

We found a decreased LOS in femoral neck fracture patients compared to the NHFD data from 2019 (nine vs 17 days), and also in contrast to the London, UK, pandemic experience.[5,18] In preparation for, and during, the surge, the trust promoted a culture of facilitating discharge of patients to decrease the risk of acquiring COVID-19 and to provide care for new admissions. This was supported by trust policies of daily consultant reviews to ensure prompt decision-making and that barriers to treatment and discharge were addressed. Despite a number of patients dying after discharge, there was no increase in mortality, except where patients contracted COVID-19. Data was unavailable on any complications other than mortality that occurred in the community that did not require hospital treatment.

The initial BOA guidance was to reduce the surgical management of orthopaedic trauma.[19] While this, in part, owed to concerns over surgical capacity it was also due to the uncertain risk to patients which this study has helped to quantify. The findings from our study will assist in risk-assessing patients for surgery during subsequent surges in COVID-19, including the preoperative model, which can be used to calculate mortality risk.[20] The risk of being admitted with an undetected infection is estimated at one in 7,000.[21] Our study highlights the risk of nosocomial infection for COVID-19 in those requiring urgent surgery who need to be admitted without prior isolation. These data support the segregation of urgent and elective surgery.

During the COVID-19 surge, there were concerns over how to treat patients who were negative or suspected of COVID-19 when they went for surgery; initially, patients were not tested unless they had symptoms, and this moved to full screening as more testing became available.[22] The rates of acquiring a COVID-19 infection postoperatively was 11% for those who initially had had a negative test, 9.4% in those who had not been suspected and so were not swabbed, and 25% in those who had tested negative despite displaying symptoms consistent with COVID-19. As it is unlikely that patients had an undetected infection, it is likely that postoperative infections were nosocomial. The group that were not suspected had a postoperative infection rate of 10%, which is much higher than the 0.3% reported in the community,[23] suggesting that they acquired their infection while in hospital. Patients were not isolated unless they became symptomatic, risking patient-to-patient transfer. This may have increased the rate of nosocomial infection, and will need to be considered when planning resources for future surges.

Patients were presenting to the MTC with non-respiratory conditions and were subsequently identified as having COVID-19 infections, as well as their presenting condition; these included, but were not limited to, orthopaedic patients.

In this study, there was no significant difference in the mortality or COVID-19 postoperative infection rate when comparing a site acutely dealing with COVID-19 patients and the site that was not. There was a significant difference in these two measures between these two hospitals, and the DGH that had to close to orthopaedic trauma. The use of a separate site to perform the majority of cases proved invaluable to continuing patient flow and contributed to allowing the MTC to function as the major trauma centre. These data have implications on planning services for a second wave.

The main limitation of this paper was the heterogeneity of the population and the evolving nature of policies within the trust, but this is also a pragmatic review of how the busiest hospital in Europe for COVID-19 continued to provide urgent orthopaedic care during unprecedented times. This was not a prospective study and is therefore limited by the data that could be obtained from electronic records.

This paper has demonstrated a number of key lessons to inform clinicians and patients on the risks of operating during the COVID-19, principally that any increase in mortality appears limited to femoral neck fracture patients and is related to age, coexisting medical conditions, and contracting COVID-19. The majority of urgent orthopaedic surgery can be carried out with little increase in risk to patients. There are also important messages for strategic planning for any subsequent surges with regards the utility using separate sites for surgery away from hospitals focused on treating COVID-19, the risks of hospital acquired infections and the risk of prioritising one group of patients over another. The majority of urgent orthopaedic patients were at no increased risk of mortality.

Take home message

- There was no increase in mortliaty in those operated on who did not have a fractured neck of femur. There is therefore no need to rationalise othoapaedic surgery on this basis.
- The risk of nosocomial infection needs to be taken into account when planning services for any future surges in the COVID-19 pandemic.

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Funding statement:
- No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

ICMJE COI statement:
- A. Mahmood reports consultancy for Stryker CMF, which is unrelated to this article.

Acknowledgements:
- The authors would like to directly thank Miss Caroline Plant, Mr Krishnakumar Subbaraman, Mr Robert Jordan, and Dr Deborah Mortiboy for their assistance in data collection. We would also like to acknowledge the collaborative work of the staff within the trauma and orthoapedic departments of University Hopsitals Birmingham NHS Foundation Trust and the Royal Orthopaedic Hospital NHS Foundation Trust for all of their work during the COVID-19 pandemic.