



Increased 30-day mortality rate in patients admitted with hip fractures during the COVID-19 pandemic in the UK

Thomas Barker¹ · Joshua Thompson¹ · James Corbett¹ · Sim Johal¹ · Iain McNamara¹

Received: 18 June 2020 / Accepted: 15 March 2021 / Published online: 30 March 2021
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Abstract

Introduction Hip fractures are the most common traumatic injury in the UK's elderly population. Patients are often extremely frail with multiple comorbidities and so are at high risk of death should they contract COVID-19. This study aims to quantify the effects of COVID-19 on patients presenting with hip fractures to the Norfolk and Norwich University Hospital (NNUH).

Methods This is a single centre, prospective, observational cohort study of patients over the age of sixty admitted with a hip fracture to NNUH between March 24th and April 22nd, 2020 and comparing them retrospectively with controls in April 2019. Patients were followed up for 30 days; data collected includes demographics, COVID-19 PCR results, date/cause of death and other prognostic indicators.

Results 66 consecutive patients managed for hip fractures were included in the study. 30-day mortality increased from 8.5% in April 2019 to 18.2% in April 2020. The 30-day mortality rate was 80% for those patients who test positive for COVID-19 as an inpatient, and was 13.8% for patients COVID-19 negative and for those who were untested. Those admitted from a healthcare institution were more likely to test positive for COVID-19 and had a higher 30-day mortality ($p=0.04$ & $p=0.006$, respectively). Suspected COVID-19-positive patients at time of admission had a delayed time to theatre, 46.7 h versus 27.1 h ($p=0.007$), however this had no significant effect on mortality ($p=0.7$).

Conclusions The combination of fragility hip fracture and COVID-19 is associated with poor outcomes. COVID-19 has also indirectly increased mortality in this patient group.

Keywords COVID-19 · Hip fracture · Fragility hip fracture · Mortality

Introduction

Hip fractures remain the most common serious traumatic injury in the UK's elderly population, with around 65,000 people presenting per year, and a cost to the NHS of over £1-billion annually. Historically, hip fracture care has been associated with significant mortality, however since the formation of the National Hip Fracture Database (NHFD) in 2007, and the Best Practice Tariff (BPT) for hip fractures in 2010, these patients are universally accepted as a surgical priority, and the standard of care is an operation within 36 h of admission [1]. In the 2019 annual NHFD report, 30-day mortality from hip fractures in England, Northern Ireland and Wales had dropped to an all-time low of 6.1% [2].

The Norfolk and Norwich University Hospital (NNUH) is a large teaching hospital and trauma unit, it receives over 800 hip fracture patients per year and is within the top 5 hospitals in the UK for annual hip fracture volume. In 2019 the 30-day mortality for patients with hip fractures at NNUH was 7.2%.

The outbreak of the novel coronavirus (SARS-CoV-2), resulting in the disease COVID-19 [3] which originated in the city of Wuhan, China in December 2019 has spread rapidly across the globe [4, 5] resulting in a pandemic; and on March 23rd 2020 the UK government took the unprecedented action of ordering a nationwide lockdown in an attempt to curb its spread [6]. Despite this action, COVID-19 has had a profound effect on health and social care in the UK, and has caused over 40 thousand deaths [7] to date.

Early literature has shown that performing surgery on patients with a confirmed COVID-19 infection is associated with high rates of morbidity and mortality [8, 9]. With respect to hip fracture patients, European and American

✉ Thomas Barker
t.barker@doctors.org.uk

¹ Trauma and Orthopaedics Department, Norfolk and Norwich University Hospital, Norwich, UK

studies have all shown increased ‘early’ or ‘inpatient’ mortality for those with COVID-19 [10–14].

This study aims to quantify the effects of the COVID-19 pandemic on demographics, management, and 30-day mortality of patients presenting with a hip fracture to NNUH. To our knowledge, this is the first UK study reporting 30-day mortality for hip fractures during the COVID-19 pandemic.

Methodology

This was a single centre, prospective, observational cohort study. Data was analysed for those patients over the age of 60 admitted with a confirmed hip fracture, between 24th March and 22nd April 2020 inclusive (30-days). Patients sustaining an inpatient hip fracture were also included.

For comparison we retrospectively analysed the data for patients who presented in the same time period in 2019. Following identification of patients from our hospitals’ national hip fracture database submission, we interrogated the hospital’s electronic patient records as follows: Synapse PACS[®] for radiographs to define fracture type, Bluespир[®] for operation notes, ORSOS for surgical timings and ICE Desktop[®] for laboratory test results.

For patients presenting in 2020 the admission COVID-19 triage status (either suspected or not suspected), any subsequent COVID-19 Polymerase Chain Reaction (PCR) throat swab results were recorded. For those patients who had died within 30 days, the date and cause of death was recorded. 30-day mortality was taken relative to date and time of presentation (or from diagnosis for inpatient falls), as per NHFD guidelines.

During the study period, patients presenting to NNUH were triaged on arrival as being suspicious for COVID-19 or not. This was on the basis of symptoms or contact with other COVID-19 positive individuals. Admission from a nursing or residential home was not in itself a reason to be triaged as suspicious for COVID-19, unless there was a confirmed case at the home. Patients suspected of having COVID-19 were triaged to the ‘yellow’ emergency department and had a PCR swab sent immediately. Patients not suspected of COVID-19 were triaged to the ‘green’ emergency department and were not routinely swabbed. Any ‘green’ patients who developed signs or symptoms of COVID-19 were immediately tested for the virus and moved to a ‘yellow’ ward pending results. If at that point the result returned positive, they would remain on a ‘yellow’ ward, otherwise they would return to a ‘green’ ward. Towards the end of this study period, the hospital introduced a policy that all patients being discharged to a nursing home should have a negative COVID-19 swab prior to discharge regardless of signs or symptoms.

The study was given institutional approval: audit registration number ORT_20-21_A01 and conducted according

to STROBE guidelines for observational studies [8]. Statistical analysis was undertaken using RStudio 1.3.959. Continuous data were tested for distribution, with normal distributed data presented as mean and standard deviation, and differences between groups were tested using the unpaired *t* test. Fisher’s exact test was used for categorical data as appropriate. In order to ensure the cohorts contained comparable means and proportions of each demographic group, statistical tests as above were conducted.

Results

Cohort Demographics

66 patients were admitted with a proximal femoral fracture between 24th March and 22nd April 2020, there were 59 during the control period in April 2019. There was no statistically demographical difference between the two patient cohorts ($p \geq 0.4$, Table 1).

Table 1 Demographic data for hip fracture admission to NNUH, comparing April 2019 with April 2020

	2019 01/04–30/04 (30 Days)	2020 24/03–22/04 (30 Days)	<i>P</i> value
Total	59	66	
Sex			0.9
Female	39 (66%)	42 (64%)	
Male	20 (34%)	24 (36%)	
Age (Years) \pm SD	83.7 \pm 8.47	83.5 \pm 9.23	0.9
Residence			0.5
Nursing/Residential Home	11 (19%)	16 (24%)	
Family Home	48 (81%)	50 (76%)	
AMTS (Median / IQR)	9 / 3.5	9 / 7	0.4
Fracture Type			0.4
Intracapsular	38 (64%)	37 (56%)	
Intertrochanteric	11 (19%)	16 (24%)	
Subtrochanteric	10 (17%)	13 (20%)	
ASA Grade (Median)	3	3	0.4
ASA 2	13 (22%)	8 (12%)	
ASA 3	38 (64%)	50 (76%)	
ASA 4	8 (14%)	8 (12%)	

SD standard deviation, *AMTS* Abbreviated mental test score, *IQR* interquartile range, *ASA* American Society of Anesthesiologists physiological status

Values are given as the number of patients, with the percentage in parentheses

Management characteristics

Table 2 provides an overview of the management sub-grouped to > 30-day survivors and < 30-day mortality.

Overall Mortality

All patients were followed up for 30 days. The 30-day mortality increased from 8.5% in April 2019 to 18.2% in 2020; however, a Fishers exact test did not show this to be statistically significant ($p=0.12$, Fig. 1).

Mortality data for the 12 patients dying within 30-days of diagnosis of hip fracture (Table 3) was as follows: Four deaths were recorded as COVID-19 being the primary cause of death. Five deaths were from illnesses that were not respiratory in nature and so were unrelated to COVID-19. There were 2 patients where the primary cause of death was listed as pneumonia; however, were never tested for COVID-19. The final patient died from Pneumonia which was confirmed not to be COVID-19.

Mortality by residence

In 2020, patients admitted from an institution (nursing or residential home) had a higher 30-day mortality than those admitted from their own home (44% and 10% respectively, $p=0.0056$). Of the patients with positive swabs either at

admission or within 7 days, 75% (3 out of 4) were admitted from institutions (nursing or residential homes) ($p=0.04$).

Time to surgery

The mean time to surgery was similar for both the 2020 and 2019 cohorts (30.8 and 30.2 h respectively). A higher proportion of patients missed the 36-h target for admission to theatre in 2020 compared to 2019 (31% & 20% respectively) however this was not statistically significant ($p=0.28$).

A comparison of mortality rates for patients undergoing surgery that achieved the 36-h target with those failing to; showed no significant difference between groups ($p=0.71$). Fewer patients managed surgically had a general anaesthetic in the 2020 cohort compared to 2019 (50% versus 68%, respectively). The mortality associated with a general anaesthetic was the same in both cohorts (12.5%).

The mean number of days to discharge for patients surviving 30-days was significantly shorter in the 2020 cohort than in 2019, at 8.2 (SD 5.4) and 14.3 (SD 9.9) respectively ($p<0.005$).

COVID triage status and mortality

In the 2020 cohort, 14 patients were triaged as potentially COVID-19 positive on admission and were swabbed immediately, however, only two patients had a positive admission

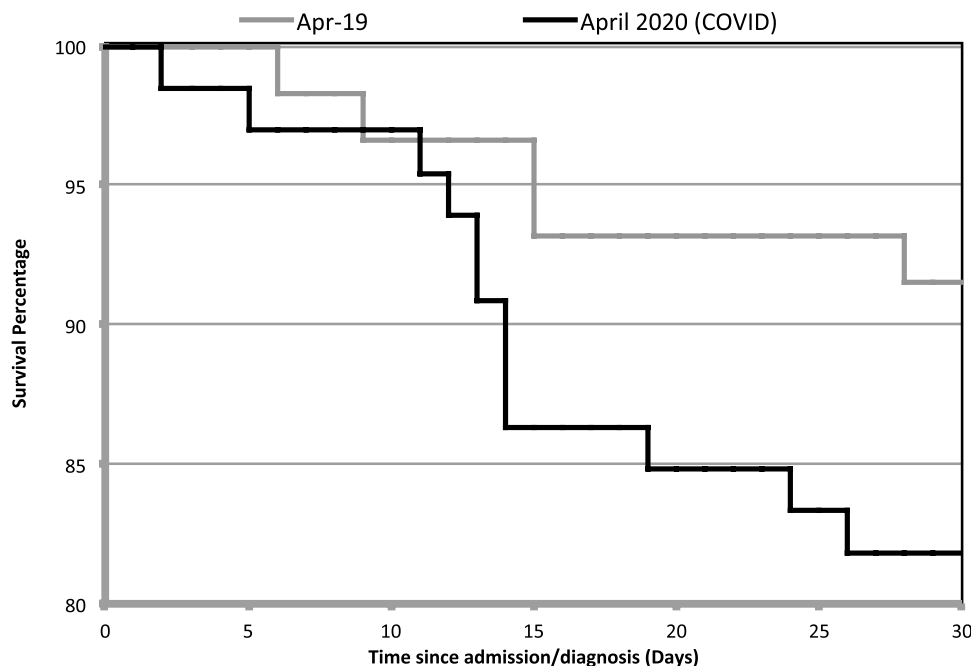
Table 2 An overview of management strategy, type of anaesthetic, and operative timings comparing April 2019 and April 2020 cohorts, sub grouped to > 30-day survivors and < 30-day mortality

	2020 24/03–22/04 (30 Days)			2019 01/04–30/04 (30 Days)		
	Total	> 30D Survivor	< 30D Mortality	Total	> 30D Survivor	< 30D Mortality
Management						
Operative	64 (97%)	54 (84%)	10 (16%)	59 (100%)	54 (92%)	5 (8%)
Non-op	2 (3%)	0	2 (100%)	0	0	0
Time to surgery (hrs)	30.8	31.9	24.9	30.2	29.6	36.2
Anaesthetic type						
General Anaesthetic	32 (50%)	28 (87.5%)	4 (12.5%)	40 (68%)	35 (87.5%)	5 (12.5%)
Spinal	32 (50%)	26 (81%)	6 (19%)	19 (32%)	19 (100%)	0 (0%)
Operative Timings (mean, h:min:s)						
Anaesthetic Time	00:48:41	00:47:59	00:52:30	00:44:04	00:44:57	00:34:36
Operative Time	01:06:54	01:06:06	01:11:18	01:12:31	01:11:40	01:21:36
Total Theatre time	01:27:29	01:26:42	01:31:42	01:28:42	01:27:23	01:42:48
Total Anaesthetic + Theatre time	02:16:10	02:14:41	02:24:12	02:12:46	02:12:20	02:17:24
Days to Discharge		8.2			14.3	
Days to Death			14.3			15.2

The values are given as the number of patients, with the percentage in parentheses

Anaesthetic time: from arrival in theatre complex until completion of anaesthesia ready for surgery. Operative time: from initial incision to wound closure. Total theatre time: between entering and leaving the operating theatre

Fig. 1 Kaplan–Meier graph showing hip fracture patient survival in days, comparing April 2019 (grey) and April 2020 (black)



swab. In addition, one further patient who had symptoms highly suspicious for coronavirus was re-swabbed within 36 h of admission, with a positive result. Therefore, of the 14 patients triaged as suspected COVID-19 on admission, 11 (79%) were negative.

Conversely, 52 patients were triaged as not suspected of having COVID-19 on admission. Of these patients admitted to a ‘green’ ward, one had a positive swab result within seven days for persistent pyrexia, and another within ten days due to dyspnoea, hypoxia and low-grade pyrexia. These patients had no exposure to any confirmed COVID-19-positive patients from the time of admission until they tested positive, at which point they were moved to a ward for the treatment of patients with COVID-19. The 30-day mortality for the five patients testing positive during their admission was 80%. Two patients had their hip fracture treated conservatively and died at days 14 and 25 of admission.

Of the three patients treated operatively who subsequently tested positive for COVID-19 as an inpatient, two died within 30 days of admission, both due to the virus. The remaining one patient was asymptomatic and thus triaged as ‘green’ however did have an admission swab taken. He underwent a hemiarthroplasty within 12 h of admission prior to receipt of his screening results. This patient had no postoperative complications and was discharged on day 9 of admission.

The mean time from COVID-19 diagnosis to death was 12.0 days (SD 9.49 days). Three patients tested positive on a throat swab for COVID-19 after discharge, all remained alive during the follow-up period. One patient was re-admitted under the medical team 11 days after discharge

for ‘shortness of breath and reduced oral intake’, another patient was tested due to ‘pyrexia, cough and flu-like symptoms’ managed in a community rehabilitation unit. The final patient was routinely tested prior to discharge from a rehabilitation unit and remained asymptomatic.

Therefore total 30-day mortality for COVID-19-positive patients diagnosed within the 30-day follow-up period from index injury was 50%.

For those patients who had negative COVID-19 swabs ($n = 29$), the 30-day mortality rate was 13.8% ($p < 0.05$).

29 patients did not have a COVID-19 swab taken throughout their admission or within the follow-up period. 30-day mortality in this group was 13.8%. It should be noted that two of these patients died from pneumonia, however were never tested for COVID-19.

There was no significant difference in mortality in patients triaged at admission as suspected COVID-19 (21% vs 17%, $p = 0.7$). However, the mean time to theatre was significantly longer than those patients not suspected of having COVID-19 on admission (46.7 versus 27.1 h, $p = 0.007$).

Discussion

Our results show that there was an increase in 30-day mortality for patients treated for a hip fracture at NNUH during the COVID-19 pandemic as compared to the same time period in the previous year, rising from 8.5 to 18.2%. This result is of concern, although a Fishers exact test did not show it to be statistically significant ($p = 0.12$), likely due to the small sample size in this cohort. We have also

Table 3 An overview of demographics and cause of death for hip fracture patients who died within 30 days of admission for hip fracture

Case	Sex	Age (years)	Residence	COVID-19 Swab	Admission AMTS	Fracture type	ASA	Time to Surgery (h)	Primary Anaesthetic type	Procedure	Time to death (Days)	Cause of Death
1	F	85	Own home	POS (IP)	0	IT	3	18.75	Spinal	DHS	14.43	COVID-19
2	F	90	Institution	POS (IP)	5	IT	3	20.45	Spinal	DHS	13.2	COVID-19
3	F	94	Institution	NEG (OP)	3	IT	3	12.43	GA	DHS	12.87	Unrelated
4	F	88	Own home	NOT TESTED	0	ST	3	49.35	GA	IMN	14.54	Unrelated
5	M	86	Institution	NEG (IP)	0	IT	3	31.18	GA	DHS	19.79	Unrelated
6	M	90	Institution	POS (IP)	10	IC	4	NA	NA	Cons	24.71	COVID-19
7	M	90	Institution	NEG (IP)	9	IC	4	14.63	Spinal	Hemi	11.03	Unrelated
8	M	70	Own home	NEG (IP)	9	ST	3	41.58	Spinal	IMN	5.13	Pneumonia (not COVID-19)
9	F	85	Own home	NOT TESTED	1	IC	3	21.85	Spinal	Hemi	26.14	Pneumonia
10	F	100	Own home	NOT TESTED	5	IT	3	20.22	Spinal	DHS	2.25	Pneumonia
11	M	85	Institution	POS (IP)	10	IC	4	NA	NA	Cons	14.44	COVID-19
12	F	80	Institution	NOT TESTED	1	ST	3	18.57	GA	IMN	13.07	Unrelated

NA not applicable, POS positive, NEG negative, IP tested as inpatient, OP tested as outpatient, AMTS Abbreviated mental test score, IC intracapsular, IT intertrochanteric, ST subtrochanteric, ASA American Society of Anesthesiologists physiological status, DHS dynamic hip screw fixation, IMN intramedullary nail fixation, Hemi/hemiarthroplasty of the hip, Cons non-operative Management, Unrelated unrelated to COVID-19

shown the risk of death for patients who present with a hip fracture significantly increases should they test positive for COVID-19 during their admission. Patients in this category had a 30-day mortality of 80%. It should be noted also that COVID-19 has indirectly increased mortality rate in this patient group even for those without the disease, to 13.8%.

The COVID-19 outbreak peaked in mainland Europe prior to the UK, this provided clinicians and surgeons worldwide with an opportunity to analyse the impact of the virus on healthcare systems and provide key insight into evolving surgical practice. One Spanish study of 136 hip fractures during the pandemic reported 14-day mortality rates of 9.6%, with associated COVID-19 positive 14-day mortality rates of 30.4% [9]. Hip fracture mortality in Italy was also high, with one paper reporting 21-day mortality of 14.0% and 44% if complicated by COVID-19 [15]. A hospital in Portsmouth, UK published their findings for early femur fracture mortality [16], and showed it to be between 42.9% and 55.6% for femur fracture patients with COVID-19. More recently 2 studies from New York hospitals have been published. Egol et al. [14] quote a 30-day mortality rate of 35% for confirmed COVID-19-positive patients as well as increased morbidity generally, whilst LeBrun et al. [13] quote an inpatient mortality rate of 56% in COVID-19-positive hip fracture patients. Our findings are in keeping with these studies, with increased total mortality, particularly in those infected with a COVID-19 infection. Where our study differs is we have followed up patients long enough to capture the outcome for those with nosocomial infection of COVID-19, which we have shown to be poor. This is the first UK study showing 30-day mortality.

At the time of writing, Norfolk had a relatively low prevalence of COVID-19 as compared to other parts of the UK (234 cases per 100,000 population [7]), which is reflected in this study. Only 3 of 66 patients tested positive on admission. Two 'green' patients tested positive for COVID-19 during their admission and both subsequently died of the disease. The first developed symptoms within 7 days of admission. The clinical course of COVID-19 in the general population is variable, but there is a recognised asymptomatic incubation period (estimated mean 7.1 days) [10], so this patient could have been carrying the virus asymptotically from the outset. The second patient had a negative test on admission but subsequently developed dyspnoea, hypoxia and low-grade pyrexia requiring increased oxygen supplementation on day 10 of admission and was re-tested. This patient likely had a nosocomial transmission of the virus. During the study period there was no consensus among hospitals on whether to test asymptomatic people for COVID-19. Our findings we feel, support a policy of testing all patients regardless of symptoms, a policy NNUH has now adopted.

In our study, wait time to surgery (over or under 36 h from admission) had no effect on 30-day mortality. This is

in contrast to previous studies that have shown increased mortality for those waiting longer for theatre [17–19]. It is accepted that a reduced time to theatre will improve mortality rates for some patients, however this must be considered in the context of dramatically increased morbidity and mortality for patients undergoing surgery whilst infected with COVID-19 [9, 15].

Since the rate of COVID-19 in the Norfolk population has dropped, patients are now managed differently according to COVID status. Confirmed positive patients still wait until they are clinically and biochemically safe to undergo an operation. Confirmed COVID-19 negative patients can be anaesthetised in the anaesthetic room without full personal protective equipment (PPE) as they would have been prior to the pandemic. Patients without a negative swab however are treated as suspected COVID and so are anaesthetised in the main operating theatre with staff wearing full PPE (glove, gown, visor, FFP3 mask), this has implications for theatre utilisation, PPE stocks, and potential exposure of theatre staff to COVID-19. In the event of a patient being admitted with a hip fracture and with signs and symptoms suggestive of COVID-19 infection, a decision is made on a case by case basis as to whether surgery should be delayed for a COVID swab or not. For these patients, our data suggests it is reasonable to wait for a swab result prior to surgery as it will effect whether surgery goes ahead or not. In addition, should there be another peak in COVID-19 cases as many predict, it may become necessary to await test results for all patients, to reduce the risk of inadvertently operating on an infected patient and running the risk of causing morbidity or mortality.

We observed a significantly higher mortality rate for patients admitted from nursing homes in comparison with those admitted from their own homes, in keeping with other European studies [8]. This is likely due to a combination of the well-established higher risk early mortality for patients with neck of femur fractures living in an institution [11] but also the higher risk of viral spread within the nursing home environment. In our study, 19% of patients admitted from institutions were diagnosed with COVID-19 within 7 days, significantly higher than only 2% of patients admitted from their own homes ($p = 0.01$). These patients had a mortality rate of 75%.

Shortly after the lockdown was announced, clinical guidance was published jointly by the Association of Anaesthetists and the British Orthopaedic Association, on the perioperative care of patients with fragility fractures during the pandemic [12]. It made recommendations on resource use, timing of surgery, type of anaesthetic, surgical considerations, and the use of personal protective equipment, however they accepted that there was little good evidence to directly support any of their recommendations.

At NNUH the surgical management of hip fracture patients has changed in a number of ways. In keeping with initial guidance [12], all operations were conducted by senior (ST8 + or consultant) surgeons and anaesthetists in a drive for consultant-led operations, and a higher proportion of surgeries were performed under spinal anaesthetic. However, NNUH diverged from guidance in one key way; we adopted a policy early on that in patients suspected of COVID-19, it was reasonable to delay surgery. This decision was made due to pressure on resources and the high risk associated with operating on COVID patients [16]. These patients would wait until the diagnosis had either been excluded by a negative test, or if positive, they had improved clinically and biochemically to the point that they could reasonably be expected to survive an anaesthetic and surgery. This accounts for the longer wait for theatre for patients triaged as ‘yellow’.

The medical management of hip fracture patients has changed significantly. Previously, these patients were cared for by a multi-disciplinary team lead by ortho-geriatricians. This is recognised as best practice by the Royal College of Physicians. During the study period, medical and surgical teams at NNUH, guided by NHS England, have moved to ward based care with specialist advice being given remotely, in an attempt to limit movement of personnel around the hospital and prevent nosocomial infections. As such, patients continued to have their care lead postoperatively by their surgical team with less direct input from ortho-geriatricians. It is possible that this move away from multi-disciplinary management could account in part for the higher mortality rates we have seen in patients without COVID-19.

It was expected that lockdown would lead to a reduction in patients presenting with traumatic injuries, this has subsequently been shown to be the case in Glasgow [20] with the number of operative trauma cases reducing by 23.2% compared to the previous year. However, the frequency of hip fractures did not change, probably since they are typically fractures that occur in the home, and so will not be prevented by social isolation. Our study in fact showed there was a 10% increase in the number of hip fractures in April 2020 compared to April 2019, but the demographics were comparable.

Our study had limitations. Firstly, due to the unprecedented nature of this disease and the effect of lockdown meant that the time period of analysis was short, thereby limiting the number of patients, which has had an effect on the reliability of statistical analysis. Secondly, the incompleteness of COVID-19 testing on our cohort of patients due to the lack of national, regional or local consensus on testing protocols for hospitalized patients, increases inaccuracies in impact analysis of the disease. Finally, the geographical variance in incidence of COVID-19 and associated demand

on healthcare resources will likely alter the impact on patient specific neck of femur fracture outcomes in different regions.

Conclusions

The COVID-19 pandemic has had untold effects on the UK and the NHS. We aimed to quantify its effects on the hip fracture population. We have shown that despite no change in patient demographics, 30-day mortality has increased both directly and indirectly as a result of COVID-19. The impact of the pandemic on the health care system as a whole could explain this, particularly loss of the multi-disciplinary team model.

In addition, this study highlights the importance of mass testing of hospitalised patients, not only to improve outcome understanding but also to protect patients and staff by limiting viral spread, and by providing early appropriate treatment of COVID-19.

Finally, we have provided a justification for delaying surgery in high-risk patient groups or in the event of another peak in COVID-19 infections.

Further research should be directed towards using well powered, multicentre, matched data sets to identify the significance of specific prognostic factors on neck of femur fracture mortality rate, as well as help answer the question posed, is it safest to delay surgery for a negative result while COVID-19 is prevalent.

Transparency declaration

The lead author* affirms that this manuscript is an honest, accurate and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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