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GENERAL ORTHOPAEDICS

Catching the second wave: clinical characteristics and nosocomial infection rates in major trauma and orthopaedic patients during the COVID-19 pandemic

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Aims

The new COVID-19 variant was reported by the authorities of the UK to the World Health Organization (WHO) on 14 December 2020. We aim to describe the clinical characteristics and nosocomial infection rates in major trauma and orthopaedic patients comparing the first and second wave of COVID-19 infection.

Methods

A retrospective analysis of a prospectively collected trauma database was reviewed at a level 1 major trauma centre from 1 December 2020 to 18 February 2021 looking at demographics, clinical characteristics, and nosocomial infections and compared to our previously published first wave data (26 January 2020 to 14 April 2020).

Results

From 1 December 2020 to 18 February 2021, 522 major trauma patients were identified with a mean age of 54.6 years, and 53.4% (n = 279) were male. Common admissions were falls (318; 60.9%) and road traffic accidents (RTAs; 71 (13.6%); 262 of these patients (50.2%) had surgery. In all, 75 patients (14.4%) tested positive for COVID-19, of which 51 (68%) were nosocomial. Surgery on COVID-19 patients increased to 46 (61.3%) in the second wave compared to 13 (33.3%) in the first wave (p = 0.005). ICU admissions of patients with COVID-19 infection increased from two (5.1%) to 16 (20.5%), respectively (p = 0.024). Second wave mortality was 6.1% (n = 32) compared to first wave of 4.7% (n = 31). Cardiovascular (CV) disease (35.9%; n = 14); p = 0.027) and dementia (17.9%; n = 7); p = 0.030) were less in second wave than the first. Overall, 13 patients (25.5%) were Black, Asian and Minority ethnic (BAME), and five (9.8%) had a BMI > 30 kg/m^2. The mean time from admission to diagnosis of COVID-19 was 13.9 days (3 to 44). Overall, 12/75 (16%) of all COVID-19 patients died.

Conclusion

During the second wave, COVID-19 infected three-times more patients. There were double the number of operative cases, and quadruple the cases of ICU admissions. The patients were younger with less dementia and CV disease with lower mortality. Concomitant COVID-19 and the necessity of major trauma surgery showed 13% mortality in the second wave compared with 15.4% in the first wave. In contrast to the literature, we showed a high percentage of nosocomial infection, normal BMI, and limited BAME infections.

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Introduction

On 13 December 2020, a total of 1,108 cases infected with Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) VUI 202012/01 (variant under investigation (VUI), year 2020, month 12, variant 01) were reported.[1] On 14 December 2020, the UK authorities reported this to the World

Health Organization (WHO), indicating the variant may be more easily spread between people.

Due to a sudden rise in COVID-19 cases in South East England, an epidemiological and virological investigation was initiated in early December 2020, which resulted in the discovery of the new variant. On 29 December 2020, there were about 79 million confirmed cases of COVID-19, with approximately 1.7 million fatalities globally.[2]

Following the first wave, elective surgery was suspended, with emergency and trauma surgery continuing[3] in order to reduce the spread of the virus and impact on resources.[4] Trauma admissions at our centre (St George's University Hospitals NHS Foundation Trust, London, UK) decreased during the first wave, with nosocomial infections seen in 27/39 patients (69.2%) of those with COVID-19.[5]

Limited evidence on airborne spread led to controversial public health mandates on what was assumed to be a virus spread mainly by fomites. Despite mask wearing being precedent in Asian countries, many other countries did not adopt this policy due to their assumptions that a lack of evidence equated to no evidence. During the first wave, asymptomatic patients were also assumed to be COVID-19 negative on admission.

Evidence has since shown that people who are presymptomatic or asymptomatic can, in fact, transmit the virus to others.[6] On 24 June 2020, NHS England issued a statement on mandatory patient testing on admission to hospital in order to ensure patient safety, maintain the public confidence, and protect the wellbeing of NHS staff.[7]

The WHO advised that people maintain a two metre interpersonal distance from each other in order to minimize the risk of transmission through droplets from the nose and mouth. Recent studies have supported this hypothesis of virus transmission from an infected person, and also shown that Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) has a higher aerosol and surface stability compared with SARS-C0V-1, with the virus remaining viable and infectious in aerosol for hours.[8]

On 17 January 2021, data produced by the University of Oxford’s research platform, Our World in Data, showed that UK’s COVID-19 death rate was the highest in the world, with a mean of 935 daily deaths.[9]

According to figures from the Office for National Statistics, the second wave of COVID-19 peaked in England and Wales on 19 January 2021, with 1,404 deaths in one day.[10] At the time of the second wave, mandatory testing by NHS England of all patients on admission had commenced. This therefore gives a true diagnosis of nosocomial infection during hospitalization compared to our first wave report.[5]

The aim of this study was to analyze and compare the clinical characteristics of patients admitted under major trauma and orthopaedics in the first and second waves of COVID-19 in order to further elucidate hospital-acquired COVID-19 infection rates.

Methods

This single-centre, observational study was designed and reported according to STROBE guidance.[11] A retrospective analysis of a prospectively collected trauma database was performed at St George's University Hospitals NHS Foundation Trust, London, UK. Clinical notes of major trauma and orthopaedic patients from 1 December 2020 to 18 February 2021 were reviewed and compared to our previously published first wave data (26 January 2020 to 14 April 2020).[5] SARS-CoV-2 VUI 202012/01 was identified during this period of the second wave.

Inclusion criteria were all major trauma and orthopaedic admissions during this period. Diagnosis of COVID-19 was done by the standard nose and throat swabbing and laboratory RNA confirmation. All patients were swabbed on admission, as per the trust protocol.

Clinical records were analyzed for demographics, mechanism of injury (MOI), anatomical pattern of injury, premorbid state, comorbidities, intervention, BMI, ethnicity, COVID-19 status, hospital length of stay (HLOS), and mortality. Patients included in this study were contacted via telephone for vaccination status, employment status (key workers), and previous COVID-19 infection.

Statistical analysis. Following verification of distributional assumptions of normality, groups were compared in continuous variables using independent-samples *t*-test. Traditional statistical hypothesis testing with a two-sided alternative was employed, with a critical level of significance of $p < 0.05$. No adjustments were made for multiple hypothesis testing. Analyses were performed using SPSS v. 26 (IBM, USA).

Ethical approval. The Health Research Authority (HRA) decision tool was used in order to conform to ethical approval according to our trust research protocols. The study was registered as a service evaluation with the hospital clinical audit department.

Results

Over a one-year period from 1 March 2020 to 28 February 2021, 3,238 patients were admitted under trauma and orthopaedics. In all, 152 patients (4.7%) were COVID-19 positive. Of these, 111 (73%) were nosocomial infections (see Figure 1).

During the first wave between 26 January 2020 to 14 April 2020, 657 patients were admitted over an 80-day period. In contrast, 522 patients were admitted during the second wave from 1 December 2020 to 18 February 2021 over the same time period. There was a decline in admissions seen in the first wave, while the second wave showed a steady admission rate. Falls and RTA remained the most common mechanism of injury with

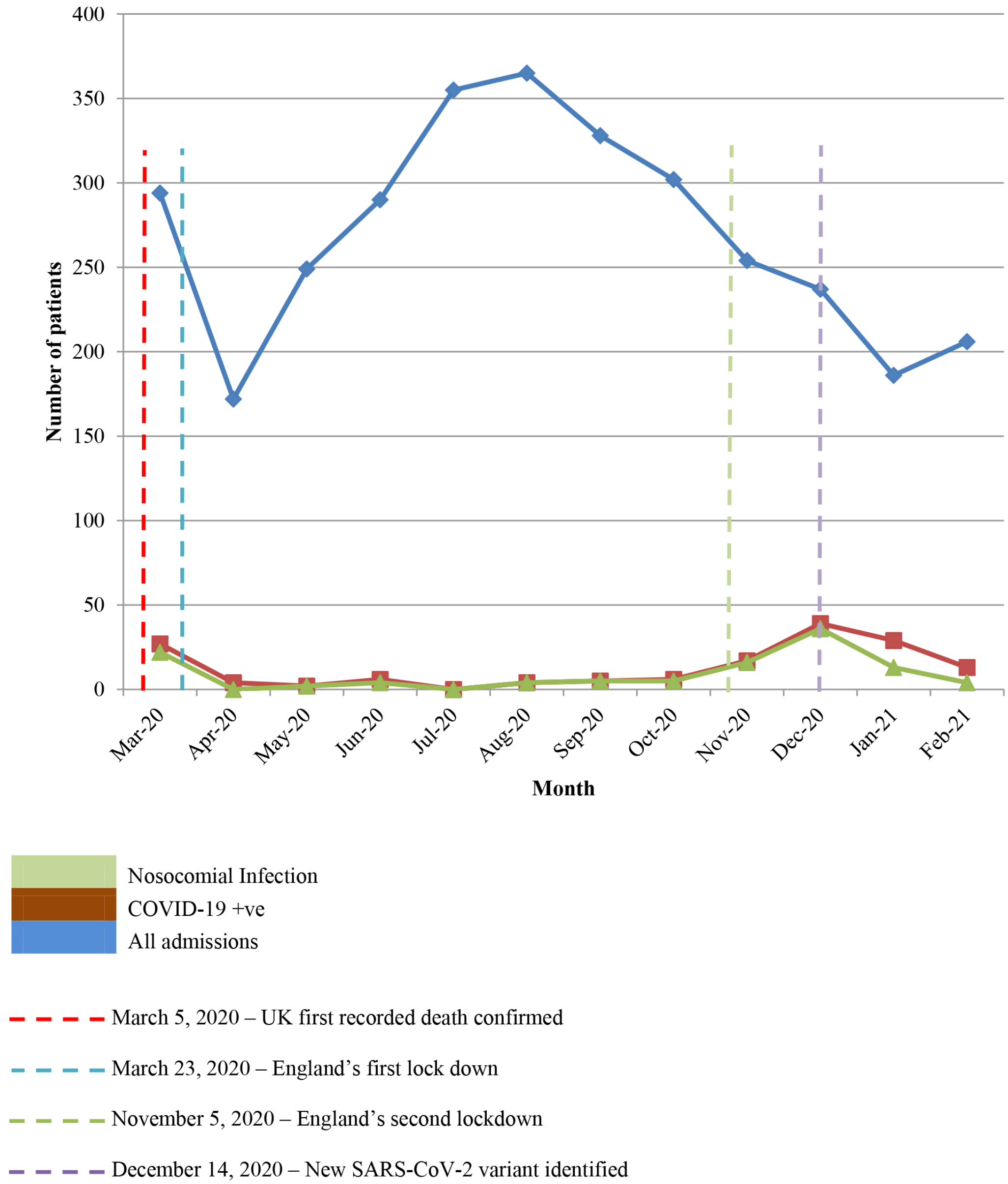

Fig. 1

Number of admissions, COVID-19 infections, and nosocomial infections of patients admitted on major trauma and orthopaedic wards over a one-year period.

a high incidence of lower and upper limb injuries. In the second wave cohort, 75 patients (14.4%) tested positive for COVID-19 infection by RNA swab test compared to 39 (5.9%) in the first wave ($p = 0.001$). There were 51 (9.8%) nosocomial infections in the second wave compared to 27 (4.1%) in the first wave ($p = 0.001$). ICU admissions were higher in the second wave (56; 10.7%) compared to first wave (31; 4.7%) ($p = 0.001$) (see Table I).

Table II shows the characteristics of patients with COVID-19 comparing the first wave cohort and second wave cohort. The mean age group was lower in the second wave with 60.1 years (6 to 98) versus 73.2 years (28 to 98) in first wave; $p < 0.001$. There was a similar male to female ratio in both waves. First wave patients had a higher percentage of comorbidities than second wave with hypertension (46.2% vs 35.9%, respectively) and cardiovascular (CV) disease (35.9% vs 16.7%, respectively) being the most common.

Surgical intervention was higher in the second wave, with 46 patients (61.3%) compared to 13 (33.3%) in first wave; $p = 0.005$. ICU admissions were higher in second wave with 16 patients (20.5%) versus two (5.1%) in first wave; $p = 0.024$. The mortality rate was lower in second wave (16%) compared to first wave (20.5 %).

Figure 2 shows the different categories of COVID-19 infection, based on the onset on admission. We define hospital acquired COVID-19 infection based on the following: hospital-onset hospital-acquired > 14 days

Table I. Population characteristics comparing the first and second waves of COVID-19.

Variable	First wave, n = 657	Second wave, n = 522	p-value
Mean age, yrs, (range)	55.3 (8 to 98)	54.6 (0 to 98)	0.613
Age, yrs, n (%)			
< 60	362 (55.1)	283 (54.2)	0.762
> 60	295 (44.9)	236 (45.2)	0.915
Sex, n (%)			
Male	393 (59.8)	279 (53.4)	0.028*
Female	264 (40.2)	243 (46.6)	0.028*
Admission type, n (%)			
Trauma	344 (52.4)	161 (30.8)	< 0.001*
Orthopaedic	313 (47.6)	361 (69.2)	< 0.001*
Mechanism of injury, n (%)			
Fall	351 (53.4)	318 (60.9)	0.010*
Road traffic accident	107 (16.3)	71 (13.6)	0.201
Assault	45 (6.8)	33 (6.3)	0.717
Pain	54 (8.2)	24 (4.6)	0.013*
Self-harm	24 (3.7)	12 (2.3)	0.179
Wound infection	17 (2.6)	23 (4.4)	0.087
Accidental	14 (2.1)	0 (0)	< 0.001*
Sport	11 (1.7)	3 (0.6)	0.083
Malignancy	3 (0.5)	7 (1.3)	0.100
Twisting	6 (0.9)	1 (0.2)	0.109
Other	25 (3.8)	30 (5.7)	0.116
Injury anatomy, n (%)			
Lower limb	173 (26.3)	157 (30.1)	0.155
Upper limb	162 (24.7)	123 (23.6)	0.663
Thorax and abdomen	138 (21.0)	70 (13.4)	< 0.001*
Pelvic	118 (18.0)	105 (20.1)	0.348
Head and neck	112 (17.0)	82 (15.7)	0.538
Spine	88 (13.4)	75 (14.4)	0.630
Intervention, n (%)			
Conservative	394 (60.0)	260 (49.8)	< 0.001*
Surgical	263 (40.0)	262 (50.2)	< 0.001*
COVID-19 positive, n (%)			
Community infection	12 (1.8)	24 (4.6)	0.006*
Nosocomial infection	27 (4.1)	51 (9.8)	< 0.001*
Total infection	39 (5.9)	75 (14.4)	< 0.001*
ICU admissions	31 (4.7)	56 (10.7)	< 0.001*
Mortality	31 (4.7)	32 (6.1)	0.284

*The test statistics are for the null hypothesis significance test for the comparison of first wave with second wave. Independent-samples *t*-test was conducted. Statsitically significant.
ICU, intensive care unit.

Table II. Characteristics of patients with COVID-19 infection admitted under orthopaedics.

Variable	First wave, n = 39	Second wave, n = 75	p-value
Age, yrs			
Mean (range)	73.2 (28 to 98)	60.1 (6 to 98)	< 0.001*
< 60, n (%)	7 (17.9)	34 (45.3)	< 0.001*
> 60, n (%)	32 (82.1)	41 (54.7)	< 0.001*
Sex, n (%)			
Male	22 (56.4)	38 (50.7)	0.560
Female	17 (43.6)	37 (49.3)	0.560
Comorbidity, n (%)			
Hypertension	18 (46.2)	28 (35.9)	0.362
Cardiovascular disease	14 (35.9)	13 (16.7)	0.027*
Arthritis	9 (23.1)	3 (3.8)	< 0.001*
Diabetes	8 (20.5)	10 (12.8)	0.319
Dementia	7 (17.9)	4 (5.1)	0.030*
Malignancy	6 (15.4)	7 (9.0)	0.335
COPD	4 (10.3)	4 (5.1)	0.329
Kidney disease	4 (10.3)	13 (16.7)	0.314
Asthma	2 (5.1)	8 (10.3)	0.321
Intervention, n (%)			
Conservative	26 (66.7)	29 (38.7)	0.005*
Surgical	13 (33.3)	46 (61.3)	0.005*
Onset of infection, n (%)			
Community infection	12 (30.8)	24 (32)	0.893
Nosocomial infection	27 (69.2)	51 (68)	0.893
Intensive care unit			
Admissions, n (%)	2 (5.1)	16 (20.5)	0.024*
Average LOS, days (range)	4 (2 to 6)	6.9 (1 to 47)	0.030*
Mortality, n (%)	8 (20.5)	12 (16)	0.548
Surgical mortality, n (%)	2 (15.4)	6 (13)	0.569

*The test statistics are for the null hypothesis significance test for the comparison of first wave with second wave. Independent-sample t-test was conducted. *Statsitically significant.
COPD, chronic obstructive pulmonary disease; LOS, length of stay.

from sample collection; hospital-onset probable hospital-associated > seven days and ≤ 14 days from sample collection; hospital-onset indeterminate hospital-associated > 48 hours and ≤ seven days from sample collection; and community-onset community-acquired ≤ 48 hours from sample collection.

Table III depicts the characteristics of patients admitted under trauma and orthopaedics with nosocomial COVID-19 infection during the second wave. The mean age was 64.8 years (18 to 94) with similar ratio of sex. In all, 41 patients (80.4%) were independent prior to admission; 30 patients (58.8%) had a physical status score (ASA) of < 3; 23 patients (45.1%) were of white ethnic background, and 25.5% (n = 13) were Black, Asian, and minority ethnic (BAME); 20 patients (39.2%) had a BMI of between 18.5 kg/m^2 and 24.9 kg/m^2, with two patients (4%) having a BMI < 18.5 kg/m^2 and 10% (n = 5) haivng a BMI > 30 kg/m^2.

The mean LOS from diagnosis of COVID-19 infection was 13.9 days (3 to 44). No patients had COVID-19 infection prior to admission, and no patients had the vaccine at the time of this study. In total, one patient (2%) was a key worker.

Table IV shows the characteristics of hip fracture patients with COVID-19 infection in the second wave cohort. The mean age group was 80.6 years (55 to 98), with a male to female ratio of 10:6. Overall, 13 (81.2%)

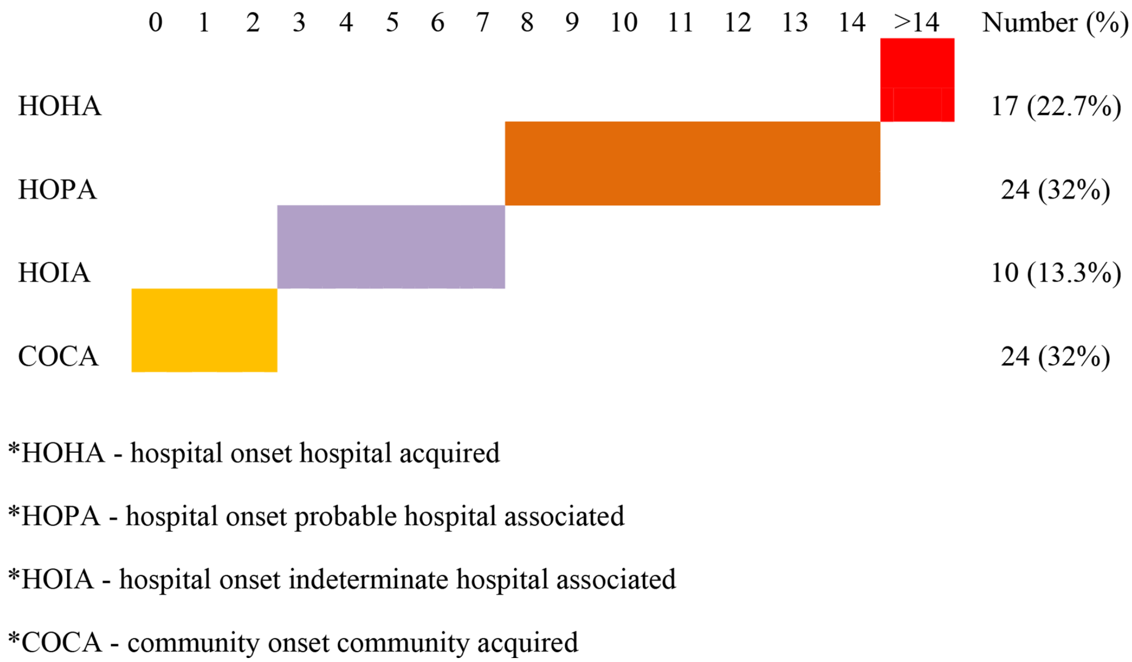

Fig. 2

Number of days between admission and positive COVID-19 infection.

Table III. Characteristics of nosocomial COVID-19 patients.

Variable	Nosocomial (n = 51)
Age, yrs, mean (range)	64.8 (18 to 94)
Sex, male:female	25:26
Pre-morbid state, n (%)	
Independent	41 (80.4)
Supported housing	2 (3.9)
Family support	4 (7.8)
Home carer	4 (7.8)
ASA score, n (%)	
<3	30 (58.8)
>3	21 (41.2)
Ethnicity, n (%)	
White	23 (45.1)
Black	2 (3.9)
Asian	10 (19.6)
Mixed	1 (2)
Unrecorded	15 (29.4)
BMI, kg/m2, n (%)	
< 18.5	2 (3.9)
18.5 to 24.9	20 (39.2)
25 to 29.9	18 (35.3)
> 30	5 (9.8)
Unrecorded	6 (11.8)
Employment status, n (%)	
Key worker	1 (2)
Mean LOS from admission to diagnosis, days (range)	13.9 (3 to 44)
Prior COVID-19 infection, n	0
Vaccination, n	0

*There was a 100% telephone response rate.
ASA, American Society of Anaesthesiologists physical status classification system; LOS, length of stay.

were nosocomial infections with an average LOS from admission to diagnosis of 9.9 days (3 to 26). The mortality rate was 12.5% (n = 2).

Table V depicts clinical characteristics of 12 patients with COVID-19 infection who died. In all, 8/12 (66.7%) were nosocomial infections. These patients were over the age of 60 years, with six (50%) having surgery, and four (33.3%) with ICU admission. The mean HLOS was 19.8 days (2 to 71).

Discussion

This study compares series of patients' clinical characteristics and outcomes of nosocomial COVID-19 infection during their admission on major trauma and orthopaedic wards during the first and second wave. We chose this time frame for the second wave as it represents the time the new variant SARS-CoV-2 VUI 202012/01 (variant under investigation (VUI), year 2020, month 12, variant 01) was identified.

There were fewer admissions during the second wave (n = 522) over the same amount of days (80 days) compared to the first wave (n = 657). Trauma admissions were significantly higher ($p < 0.001$) in the first wave (53.4%) compared to 30.8% in the second wave. A contributing factor to fewer admissions could be due to the holiday season. Furthermore, the first wave reflects pre-COVID-19 and pre-lockdown admission, while public comprehension had led to improved public health compliance by the second wave.[12] Falls and RTAs remained the most common MOI in both waves. There was approximately three-times the COVID-19 patients in

Table IV. Characteristics of COVID-19 hip patients in the second wave.

Variable	Hip fractures (n = 16)
Mean age, yrs (range)	80.6 (55 to 98)
Sex, male: female	10:5
Mechanism of injury, n (%)	
Fall	13 (81.2)
Road traffic accident	1 (6.3)
Pain	2 (12.5)
Comorbidities, n (%)	
Hypertension	6 (37.5)
Cardiovascular disease	7 (43.8)
Kidney disease	5 (31.3)
Dementia	1 (6.3)
Type of surgery, n (%)	
Hemi	6 (37.5)
Dynamic hip screw	4 (25)
Intramedullary nail	5 (31.3)
Washout	1 (6.3)
Onset of infection, n (%)	
Community infection	3 (18.8)
Nosocomial infection	13 (81.2)
Mean LOS from admission to diagnosis of hospital associated infection, days (range)	9.9 (3 to 26)
Pre-morbid state, n (%)	
Independent	11 (68.8)
Supported housing	2 (12.5)
Home carer	3 (18.8)
ASA score, n (%)	
<3	8 (50)
>3	8 (50)
Ethnicity, n (%)	
White	8 (50)
Black	0 (0.0)
Asian	5 (31.3)
Mixed	0 (0.0)
Unrecorded	3 (18.8)
BMI, kg/m2 n (%)	
< 18.5	1 (6.3)
18.5 to 24.9	5 (31.3)
25 to 29.9	5 (31.3)
> 30	0 (0.0)
Unrecorded	5 (31.3)
Intensive care unit, n (%)	
Admission	3 (18.8)
Mean LOS, days (range)	3.5 (2 to 5)
Mortality, n (%)	2 (12.5)

ASA, American Society of Anaesthesiologists; DHS, dynamic hip screw; Hemi, hemiarthroplasty; IM nail, intramedullary nail; LOS, length of stay; MOI, mechanism of injury.

major trauma in the second wave compared to the first (14.4% vs 5.9%).

Traumatically injured patients requiring hospital admission are a unique cohort of relatively well and usually non-COVID-19 infected people. This represents the normal population forced to use hospital services at a time when public health messages encourage avoidance of hospitals. Surgery may be a risk factor for COVID-19 infection. The incidence of surgery across all patients in the second wave was significantly higher ($p < 0.001$) at 50.2% (n = 262) compared to 40% (n = 263) in the first wave.

There was approximately double the number of COVID-19 patients undergoing surgery in the second wave cohort, with 13 (33.3%) in the first wave cohort versus 46 (61.3%) in the second ($p = 0.005$). This finding may be influenced by findings by Lei et al,[13] who studied 34 operative patients in Wuhan, China, and suggests that surgery may have accelerated and exacerbated the disease progression due to patients developing symptoms shortly after surgery.

Regardless of COVID-19 infection, there were almost double the ICU admissions in the second wave (n = 56; 10.7%) versus the first wave (n = 31; 4.7%)($p < 0.001$). Both waves had a similar male to female ratio of COVID-19 infection in contrast to other studies that have reported males being at higher risk.[14,15]

The new variant of COVID-19 is reported to be more infectious and virulent,[16] and is highlighted by several of our results. First, there were three-fold more COVID-19 infections, and second, there was significant increase in COVID-19 patients admitted to ICU in the second wave (n = 16; 20.5%) compared to the first wave (n = 2; 5.1%) ($p = 0.024$).

Similar comorbidities, including hypertension, CV disease, kidney disease, diabetes, and arthritis, were seen in both waves, with patients in the first wave having a significantly higher number than the second wave: CV disease (n = 14 (35.9%) vs n = 13 (16.7%) ($p = 0.027$); dementia (n = 7 (17.9%) vs n = 4 (5.1%) ($p = 0.030$); and arthritis (n = 9 (23.1%) vs n = 3 (3.8%) ($p < 0.001$).

In support of the more virulent strain, patients with COVID-19 infection were significantly younger ($p < 0.001$) in the second wave (mean 60.1 years; 6 to 98) compared to 73.2 years (28 to 98) in the first wave. We demonstrated that no children were discovered with COVID-19 in the first wave, but there were infections of children in the second wave, with one (1.3%) aged nine years or younger, and one (1.3%) aged between ten and 19 years. Reports now show that the COVID-19 does occur in children, but infections are milder or asymptomatic, with a better prognosis than adults.[17]

We did not show a high prevalence of increased BMI in our patients. Among the nosocomial COVID-19 patients in the second wave, only six (11.8%) had a BMI greater than 30 kg/m^2. We also did not show a high prevalence of ethnic minority infections, where only 44.9% of the London, UK, population is white British.[18] Interestingly, 25.5% of our COVID-19 cohort (n = 13) were of the BAME population. Our results are noteworthy because they differ from other reports that have shown that BAME ethnicity and higher BMI were independently associated with the greater odds of COVID-19.[15,19]

Table V. Clinical characteristics of 12 patients who died with COVID-19 infection.

Variable	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
DOA	08/12/2020	04/12/2020	07/01/2021	10/12/2020	14/12/2020	01/12/2020
Age, yrs	66	83	67	71	66	65
Sex, male/female	Male	Female	Male	Male	Female	Female
Comorbidities						
Hypertension	Y	Y	Y	N	N	Y
Cardiovascular disease	N	Y	Y	Y	N	N
Diabetes	N	N	N	N	N	Y
Kidney disease	N	N	Y	N	N	N
Dementia	N	N	N	N	N	N
Arthritis	N	N	N	N	N	N
Admission type						
Trauma	N	N	N	Y	Y	Y
Orthopaedics	Y	Y	Y	N	N	N
Reason for admission	Fall	Fall	Fall	Fall	Road traffic accident	Fall
Injury						
Head and neck	Y	N	N	Y	Y	N
Thorax	Y	N	N	N	Y	N
Spine	N	N	N	N	Y	N
Pelvic	N	Y	Y	N	Y	N
Upper limn	N	N	N	N	N	Y
Lower limb	N	N	N	N	N	N
Intervention						
Surgery	N	Y	Y	N	Y	N
Date of surgery	N/A	05/12/2020	08/01/2021	N/A	15/12/2020	N/A
Conservative	Y	N	N	Y	N	Y
BMI, kg/m²	12.46	20.9	22.15	22.6	27.34	47.18
Ethnicity	White	White	Asian	Unrecorded	White	Asian
Pre-morbid state	Independent	Independent	Home carers	Family support	Independent	Home carers
Date of positive COVID-19 test	17/12/2020	11/12/2020	10/01/2021	23/12/2020	15/12/2020	11/01/2021
Nosocomial	Y	Y	Y	Y	N	Y
ICU	Y	N	Y	N	Y	N
ICU LOS	2	N/A	5	N/A	2	N/A
Date of death	18/12/2020	19/12/2020	21/01/2021	24/12/2020	16/12/2020	09/02/2021
HLOS	10	15	14	14	2	71

	Patient 7	Patient 8	Patient 9	Patient 10	Patient 11	Patient 12
DOA	31/12/2020	01/01/2021	07/01/2021	15/01/2021	22/12/2020	12/02/2021
Age, yrs	86	74	70	98	86	74
Sex, male/female	Female	Male	Female	Female	Female	Female
Comorbidities						
Hypertension	Y	N	N	Y	Y	Y
Cardiovascular diseasse	N	N	N	N	Y	N
Diabetes	N	Y	N	N	N	N
Kidney disease	Y	Y	Y	N	N	N
Dementia	N	N	N	Y	N	N
Arthritis	Y	N	N	N	N	N
Admission type						
Trauma	N	Y	N	N	N	Y
Orthopaedics	Y	N	Y	Y	Y	N
Reason for admission	Fall	Fall	Fall	Fall	Fall	Fall
Injury						
Head and neck	N	Y	N	N	N	Y
Thorax	N	N	N	N	N	N
Spine	N	Y	N	N	N	Y
Pelvic	N	N	N	Y	N	N

Continued

Table V. Continued

	Patient 7	Patient 8	Patient 9	Patient 10	Patient 11	Patient 12
Upper limb	N	N	N	N	N	N
Lower limb	Y	N	Y	N	Y	N
Intervention						
Surgery	N	Y	N	Y	Y	N
Date of surgery	N/A	01/01/2021	N/A	15/01/2021	03/01/2021	N/A
Conservative	Y	Y	Y	N	N	Y
BMI, kg/m^2	26.84	25.41	25.97	18.01	26.84	Unrecorded
Ethnicity	Asian	White	Asian	White	Asian	White
Pre-morbid state	Family support	Independent	Independent	Supported housing	Independent	Independent
Date of positive COVID-19 test	13/01/2021	13/12/2020	06/02/21	15/01/2021	13/01/2021	12/02/21
Nosocomial	Y	N	Y	N	Y	N
ICU	N	N	N	N	N	Y
ICU LOS	N/A	N/A	N/A	N/A	N/A	10
Date of death	19/01/2021	15/01/2021	08/02/2021	21/01/21	19/01/2021	22/02/2021
HLOS	20	15	32	6	28	10

DOA, date of admission; HLOS, hospital length of stay; ICU, intensive care unit; LOS, length of stay; N/A, not applicable.

Interestingly, the overall inpatient mortality was similar between both waves, but the mortality rate of patients with COVID-19 was higher in the first wave (n = 8; 20.5%), compared to the second wave (n = 12; 16%). Our surgical mortality in patients with COVID-19 was lower in the second wave with (n = 6; 13%) compared to first wave (n = 2; 15.4%). Doglietto et al[20] evaluated the early surgical outcomes on patients with coronavirus who underwent surgery. Overall, 30-day mortality was shown to be significantly higher for those with COVID-19 compared with patients without COVID-19 and is supported by other studies.[21,22] The reasons for the lower mortality may be multifactorial, but with the explosion in research and treatment one might consider that our knowledge to treat COVID-19 by the second wave had improved.

We also looked at 16 patients (3.1%) who sustained a hip fracture and were COVID-19 positive. Overall, 13 (81.3%) were probably hospital-acquired infections. The 30-day mortality rate was 12.5% (n = 2), which differs from reports that have shown a higher increased risk of mortality of coronavirus infections in hip fracture patients.[23,24] Overall, ten patients (62.5%) were male, which is in support to a nationwide study done by Hall et al[25] on hip fractures. The study shows that the diagnosis of COVID-19 made between seven and 30 days of admission to hospital was independently associated with male sex.

Patients who died in the second wave were older (mean 75.5 years; 66 to 98), with common comorbidities in the second wave compared to the first wave, such as hypertension (35.9% vs 46.2%), CV disease (16.7% vs 35.9%), and kidney disease (16.7% vs 10.3%), with hypertension and CV disease reported as the most common comorbidities.[26,27] Comparing this to first wave, thiswas hypertension (46.2%), CV disease (35.9%), and arthritis (23.1%). Long hospital stay (mean 19.8 days; 2 to 71) also increased the risk of mortality.

Overall, 75 of patients (14.4%) in our second wave study tested positive for COVID-19 infection versus 39 of patients (5.9%) in the first wave. Of these 75 patients in our second wave cohort, 51 (68%) had hospital acquired coronavirus infection (overall cohort nosocomial rate 9.8%), which is similar to the estimated rate obtained during the first wave (n = 27; 69.2%).[5] We previously made the correct assumption that asymptomatic admissions were COVID-19 negative, but we also did not have the resources to test all admissions.

The mechanisms of viral spread between patients who contracted the virus while an inpatient is yet to be established. Transmission of COVID-19 infection in healthcare settings has a significant implication for patients and healthcare workers, which may add to the burden on resources. Zheng et al[28] reported an increase in COVID-19 rates in healthcare workers, and showed that clinical staff had a higher rate of laboratory confirmed COVID-19 than non-clinical staff, with doctors having the highest rate of infection but took the fewest sickness days. Another possible mechanism of contamination could be through the movement of patients within the hospital. Of note, only one trauma patient admitted with COVID-19 was a healthcare worker.

We agree with literature that shows airborne spread is a significant factor other than just fomite spread by surface contact.[29] Good ventilation became more apparent as a useful combat technique against spread, and was soon adopted by public healthcare warnings advising open windows to improve. There may also be a role for UV light and UV air filters in public domains.[30] During the COVID-19 pandemic, preventive measures were implemented at our centre to reduce the risk of contamination in hospital. Measures included mandatory wearing of masks, increased use of alcoholic prep solutions and hand washing, and staff training. Hospital visitors were also restricted and checked on entry for hand washing and mask use, something which was not implemented until September 2020. Mandatory screening of all patients on admission, whether or not they have symptoms, was also implemented by the NHS England and NHS Improvement on 24 June 2020.[7] Patients travelling for tests and throughout the hospital were also given masks (e.g. when travelling to surgery by bed). Patient bed state was assigned based on patient status on admission. Elective patients were placed on 'super green' wards (14 days shielded and COVID-19 negative). Other admissions were placed on green wards (three days shielded and COVID-19 negative); amber wards (low/high risk pending COVID-19 results); yellow wards (non-shielding COVID-19 negative); and blue wards (COVID-19 positive). We also used local independent hospitals, which maintained super green or green status for ambulatory trauma, reducing footfall, virtual outpatient clinics, and a cessation of the majority of elective surgery was well implemented.[5]

The limitations of this study include the lack of COVID-19 testing on admission in our first wave cohort. Analysis of characteristics during the second wave after the advent of the new UK variant were conducted on the basis and knowledge of its rapidly spreading existence. However, we cannot confirm which variants were detected in our cohort. The 80 days in both cohorts looked at slightly different parts of the curves, but represents relevant snapshots of time during the pandemic. The time frames chosen were based on publically announced major singular events; the first UK death and the first announcement of a new UK variant.

There was a steady admission in the second wave cohort with a significant ($p < 0.001$) Overall, 20% less admissions compared to the first wave cohort. There was a three-fold increase in COVID-19-infected patients in the second wave.

In support that the new UK variant was more infectious, we see from our cohort during the second wave that surgery on COVID-19 patients was significantly higher ($p = 0.005$), with 61.3% compared to 33.3% in the first wave. ICU admissions of patients with COVID-19 infection also showed a significant increase ($p = 0.024$) from 5.1% in the first wave to 20.5% in second wave. Furthermore, those who were infected were significantly younger.

Overall mortality was similar between first wave (4.7%) and the second wave (6.1%). However, the risk of death with COVID-19 infections was high, with 16% mortality in the second wave compared to 20.5% in the first wave. Concomitant COVID-19 and the necessity of major trauma surgery showed 13% mortality in the second wave compared with 15.4% in the first wave. It is clear that COVID-19 infection is a significant risk factor for mortality in trauma patients regardless of whether they have surgery.

In contrast to the literature, we showed a high percentage of nosocomial infection, normal BMI, and limited BAME infections. There was a similar proportion of hospital-acquired COVID-19 infection in the first wave (69.2%) compared to the second wave (68%), with equal preponderance of males to females ratio in both groups. COVID-19 patients in the second wave were younger, with a mean age of 60 years (6 to 98) compared to the first wave (mean age 73 years; 28 to 98), supporting the greater virulence of the new variant SARS-CoV-2 VUI 202012/01. High BMI (9.8% BMI > 30 kg/m^2) and BAME (25%) were not significant risk factors.

During the second wave, the overall COVID-19 infection rate was 14.4% (9.8% nosocomial). If the patient had COVID-19, 68% were hospital-acquired, and 15.7% of these patients died. It will be of future importance to mitigate hospital-acquired infection, and will be of significant interest to evaluate how COVID-19 vaccines change these patient characteristics and nosocomial infection rates.

Take home message

- This study describes a large cohort of major trauma and orthopaedic patients in a UK setting and captures the clinical characteristics and nosocomial infection with COVID-19 in the first and second wave, supporting that the new UK variant was more infectious as we see from our cohort during the second wave.
- These findings will help guide future healthcare policies against COVID-19. It will be of future importance to mitigate hospital-acquired infection, and will be of significant interest to evaluate how COVID-19 vaccines change these patient characteristics and nosocomial infection rates.

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