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■ **GENERAL ORTHOPAEDICS**

40 days and 40 nights: Clinical characteristics of major trauma and orthopaedic injury comparing the incubation and lockdown phases of COVID-19 infection

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Aims

The first death in the UK caused by COVID-19 occurred on 5 March 2020. We aim to describe the clinical characteristics and outcomes of major trauma and orthopaedic patients admitted in the early COVID-19 era.

Methods

A prospective trauma registry was reviewed at a Level 1 Major Trauma Centre. We divided patients into Group A, 40 days prior to 5 March 2020, and into Group B, 40 days after.

Results

A total of 657 consecutive trauma and orthopaedic patients were identified with a mean age of 55 years (8 to 98; standard deviation (SD) 22.52) and 393 (59.8%) were males. In all, 344 (approximately 50%) of admissions were major trauma. Group A had 421 patients, decreasing to 236 patients in Group B (36%). Mechanism of injury (MOI) was commonly a fall in 351 (52.4%) patients, but road traffic accidents (RTAs) increased from 56 (13.3%) in group A to 51 (21.6%) in group B (p = 0.030). ICU admissions decreased from 26 (6.2%) in group A to 5 (2.1%) in group B. Overall, 39 patients tested positive for COVID-19 with mean age of 73 years (28 to 98; SD 17.99) and 22 (56.4%) males. Common symptoms were dyspnoea, dry cough, and pyrexia. Of these patients, 27 (69.2%) were nosocomial infections and two (5.1%) of these patients required intensive care unit (ICU) admission with 8/39 mortality (20.5%). Of the patients who died, 50% were older and had underlying comorbidities (hypertension and cardiovascular disease, dementia, arthritis).

Conclusion

Trauma admissions decreased in the lockdown phase with an increased incidence of RTAs. Nosocomial infection was common in 27 (69.2%) of those with COVID-19. Symptoms and comorbidities were consistent with previous reports with noted inclusion of dementia and arthritis. The mortality rate of trauma and COVID-19 was 20.5%, mainly in octogenarians, and COVID-19 surgical mortality was 15.4%.

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Introduction

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On 30 January 2020, the World Health Organization (WHO) declared the coronavirus disease 2019 (COVID-19) as an outbreak of Public Health Emergency and International Concern.[1] On 5 March 2020, over 100 cases were identified and the first official death in the UK occurred.[2] On 11 March 2020, the Director General of the WHO characterized COVID-19 as a global pandemic caused by the viral pathogen Severe Acute Respiratory Syndrome Coronavirus 2 (SAR-CoV-2).[1]

Due to the highly infectious nature of the virus, some hospitals and healthcare systems have been overwhelmed.[3] The UK government implemented social lockdown

with measures including social distancing and self-isolation. The rapidly changing situation caused hospitals to continually update their healthcare management policies, including surgical management and ward based treatment. Elective surgery was suspended, with emergency and time-critical surgery, including trauma surgery, continuing.[4] The British Orthopaedic Association (BOA) published guidelines suggesting changes in approach to standard management practices so as to minimize patient exposure to the virus and reduce overall impact on resources.[5]

Currently there is a paucity of data on the clinical characteristics and outcomes of the traumatically injured patient with COVID-19 infection. This is of importance in order to understand risk factors, comorbidities, multiplicity of infection (MOI), the anatomy at risk, and the surgical sub-specialties required. Redistribution of resources had an unanticipated impact on the healthcare system and the importance of understanding the clinical characteristics of traumatically injured COVID-19 patients could help to protect patients and staff. The challenge of the pandemic is the need to balance resources while considering the individual, the population, the economy, and the supply of personal protective equipment (PPE) to prevent the possibility of overwhelming healthcare systems.

The aim of this paper is to analyze and present the clinical characteristics of trauma patients presenting to a Level 1 major trauma centre during the early stages of the COVID-19 pandemic in the UK.

Methods

This single-centre, observational study was designed and reported according to STROBE guidance.[6] A retrospective analysis of a prospectively collected trauma database was performed at our Level 1 trauma hospital in south west London providing specialist care for 3.5 million people. All clinical notes of major trauma and orthopaedic patients from 26 January 2020 to 14 April 2020 were reviewed. The first confirmed case of COVID-19 in the UK was on 28 February 2020. It is known that many asymptomatic patients had travelled from infected regions into the UK prior to this. We refer to this period as the incubation phase. When SARS-CoV-2 severe pneumonia started to cause mortality on 5 March 2020, the virus was spreading exponentially, requiring governments around the world to begin imposing lockdown strategies. UK official lockdown commenced on 23 March 2020. Even prior to official quarantine, many companies and professional bodies were commencing their own lockdown. This time period is referred to as the lockdown phase. Cases were divided into two groups: Group A (incubation phase), 40 days before the first UK recorded death, and Group B (lockdown phase), 40 days after. No patient was directly involved in this study.

Inclusion criteria for major trauma was activation of the major trauma call or patients with orthopaedic injuries requiring admission. Diagnosis of COVID-19 was by the hospital's standard swabbing process of the nose and throat and on-site laboratory RNA confirmation. Clinical records were analyzed for diagnostics, pathology results, treatments and outcomes. COVID-19 cases were designated as Group C and non-COVID-19 cases as Group D.

Statistical analysis

Following verification of distributional assumptions of normality, groups were compared in continuous variables using the independent-samples t-test. When equality of variances could not be assumed between groups, Satterwaite's approximation to the degrees of freedom was made. When distributional assumptions could not be made, groups were compared in continuous variables using the Mann-Whitney U test (test statistic denoted by U). Groups were compared in categorical variables using the chi-squared test, and when invalid by using Fisher's exact 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, Armonk, New York, USA).

Results

Overall, 657 consecutive trauma patients were included in this study. A total of 421 (64.1%) patients were admitted within the first 40 days (Group A: early incubation phase) versus 36 (35.9%) patients in the following 40 days (Group B: early lockdown phase). There was a progressive decline in the number of patients per week in both groups (Figure 1).

Table I shows the baseline characteristics of patients admitted under major trauma and orthopaedics (T & O) during the onset of the COVID-19 pandemic. Injury and demographics are shown. Both groups had a higher percentage of male patients, with falls and RTA's being the most common mechanism of injury. Group B showed higher incidence of pelvis, chest and thorax, and spine injuries (p < 0.050). ICU admissions were fewer in the lockdown phase: Group A (26; 6.2%) compared to group B (2.1%); p = 0.020.

A total of 39 patients tested positive for COVID-19 by RNA swab tests with ten patients in Group A and 29 in Group B. It is noted that there was 0% community acquired COVID-19 in Group A and 12 patients (5.1%) in Group B. Overall, there were 2.4% nosocomial infections in Group A and 7.2% in Group B. Within the COVID-19 group, 69.2% (n = 27) were nosocomial infections.

Table II depicts the baseline characteristics of patients with COVID-19 infection (Group C) admitted under T & O in comparison to all non-COVID-19 (Group D) patients. The mean age in Group C was 73.2 years (28
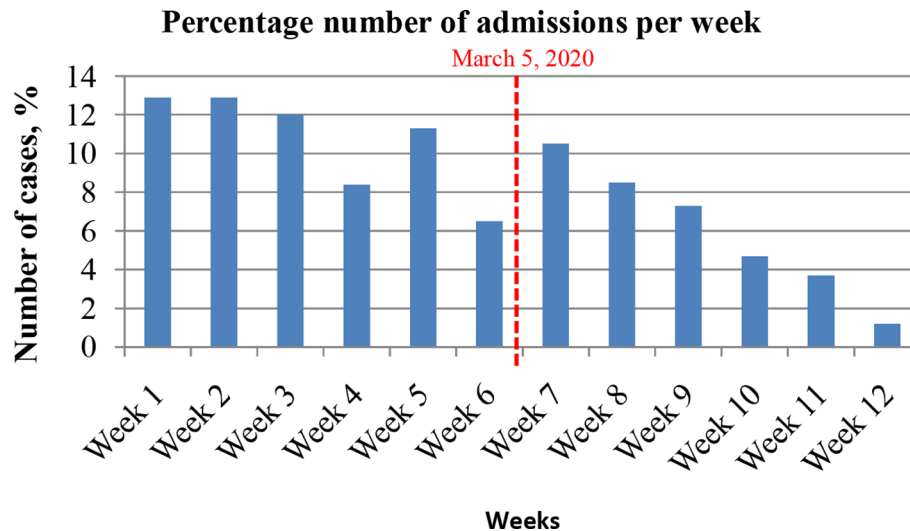
Percentage number of admissions per week

Fig. 1

Number of cases admitted under major trauma and orthopaedics (T&O) during the COVID-19 pandemic. Group A (weeks 1 to 6) 40 days before 5 March 2020 vs Group B (weeks 7 to 12) 40 days after 5 March 2020.

to 98; SD 17.99) versus 54.1 years (8 to 98; SD 22.3) in Group D. Group C shows that 32 (82.1%) patients were > 60 years versus 263 (42.6%) in Group D. There was no difference in ratio of sex between groups. Group C (COVID-19) had significantly higher percentage of comorbidities than Group D (non-COVID-19 patients): hypertension in 18 (46.2%), CVD in 14 (35.9%), arthritis in nine (23.1%), dementia in seven (17.9%), and malignancy in six (15.4%). Diabetes ($p = 0.072$; Fisher's Exact test) and renal disease ($p = 0.001$; Fisher's Exact test) were not significantly different. Surgical intervention occurred less in Group C with 33.3% compared to 40.5% in Group D. Surgical mortality was higher in Group C (15.4%) compared to group D (2.8%).

Table III shows the type of orthopaedic procedures and surgical specialties that were involved with patients with COVID-19 compared to non-COVID-19 patients. Two patients (5.1%) required ICU admission and both recovered. In total, 13 patients (33.3%) with COVID-19 infection underwent orthopaedic surgery with five (12.9%) requiring hip surgery. Neurosurgery was required in 12 (30.8%) and cardiothoracic surgery in five (12.8%) patients with COVID-19 infection. Patients with COVID-19 infection had a significantly higher mortality 20.5% (n = 8) versus 3.7% (n = 23) in non-COVID-19 patients ($p < 0.010$).

Table IV shows signs, symptoms and laboratory findings of COVID–19 patients. The most common symptoms were dyspnoea (56.4%), fever (20.5%) and dry cough (15.4%). Antibiotic treatment, oxygen support and laboratory findings between survivors and non-survivors are shown.

Table V depicts clinical characteristics of eight patients with COVID-19 infection who died. 87.5% (7 out of 8) were nosocomial infections. These patients were elderly with a mean age of 84.4 years ($p = 0.047$) with 25% receiving surgery and no ICU admissions. Discussion

This is, to our knowledge, the first study describing the baseline clinical characteristics and outcomes of major trauma and orthopaedic injured patients with COVID-19 infection. We chose the pivotal timepoint of 5 March 2020 as it represented the day of the first UK death from COVID-19 infection. The first known positive test in the UK was 31 January 2020[7] and Group A represents the early incubation period in this region. After the first death, measures were undertaken, though not stringent, until the official UK lockdown commenced on 23 March 2020[8]. There was a decrease of 56% in trauma admissions between these two times.

Falls remained the most common MOI, however the percentage of RTAs was significantly higher ($p = 0.036$). Anecdotal evidence suggested that empty roads were associated with higher speeding and there has been a call to lower speed limits to 20mph in urban areas.[9]

A contributing factor to decreased tertiary admissions lay in the recommendations from national guidelines to limit referrals to major trauma centres. Novel telemedicine or video conferencing allowed expert specialist opinions to deliver care locally and prevent transfer where appropriate.[10]

Surgery itself did not seem to be a risk factor for SARS-CoV-2 pneumonia. The incidence of surgery was 40% (n = 263) across 657 patients, with one-third of COVID-19 patients and one-quarter of COVID-19 deaths undergoing surgery. In contrast to this, a study of 34 operative patients in Wuhan during the incubation period of COVID-19 suggests that surgery may have accelerated and exacerbated the disease progression due to patients developing symptoms shortly after surgery.[11]

There was a significantly higher ICU admission rate in Group A (6.2%) versus Group B (2.1%). These figures may reflect bed pressures. We had our peak of inpatient

Table I. Baseline characteristics of patients admitted under Orthopaedics during the onset of the COVID-19 pandemic.

	Group A (n = 421)	Group B (n = 236)	Total (n = 657)	p-value
Mean age, yrs (range)	55.6 (16 to 98)	54.6 (8 to 98)	55.3 (8 to 98)	0.598
Age, n (%)				
< 60 yrs	223 (53.0)	139 (58.9)	362 (55.1)	0.165
> 60 yrs	198 (47.0)	97 (41.1)	295 (44.9)	0.165
Sex, n (%)				
Female	169 (40.1)	95 (40.3)	264 (40.2)	0.978
Male	252 (59.9)	141 (59.7)	393 (59.8)	0.978
Admission type, n (%)				
Major trauma	217 (51.5)	127 (53.8)	344 (52.4)	0.576
Orthopaedic	204 (48.5)	109 (46.2)	313 (47.6)	0.576
MOI				0.036
Fall	230 (54.6)	121 (51.3)	351 (53.4)	
RTA	56 (13.3)	51 (21.6)	107 (16.3)	
Pain	38 (9.0)	16 (6.8)	54 (8.2)	
Assault	31 (7.4)	14 (5.9)	45 (6.8)	
Self-harm	18 (4.3)	6 (2.5)	24 (3.7)	
Wound infection	11 (2.6)	6 (2.5)	17 (2.6)	
Accidental	5 (1.2)	9 (3.8)	14 (2.1)	
Sport	8 (1.9)	3 (1.3)	11 (1.7)	
Twisting	3 (0.7)	3 (1.3)	6 (0.9)	
Malignancy	1 (0.2)	2 (0.8)	3 (0.5)	
Unknown	20 (4.8)	5 (2.1)	25 (3.8)	
Injury anatomy				
LL	120 (28.5)	53 (22.5)	173 (26.3)	0.091
UL	97 (23.0)	65 (27.5)	162 (24.7)	0.199
Thorax and abdomen	78 (18.5)	60 (25.4)	138 (21.0)	0.037
Pelvic	65 (15.4)	53 (22.5)	118 (18.0)	0.025
Head and neck	63 (15.0)	49 (20.8)	112 (17.0)	0.058
Spinal	45 (10.7)	43 (18.2)	88 (13.4)	0.007
Intervention				
Conservative	250 (59.4)	144 (61.0)	394 (60.0)	0.682
Surgical	171 (40.6)	92 (39.0)	263 (40.0)	0.682
Surgical speciality				
Orthopaedic	158 (37.5)	75 (31.8)	233 (35.5)	0.139
Plastics	7 (1.7)	8 (3.4)	15 (2.3)	0.155
Neurosurgery	1 (0.2)	4 (1.7)	5 (0.8)	0.059[†]
General surgery	3 (0.7)	2 (0.8)	5 (0.8)	1.000[†]
Maxillofacial	1 (0.2)	2 (0.8)	3 (0.5)	0.294[†]
Cardiothoracic	1 (0.2)	0 (0.0)	1 (0.2)	1.000[†]
ENT	0 (0.0)	1 (0.4)	1 (0.2)	0.359[†]
ICU admissions	26 (6.2)	5 (2.1)	31 (4.7)	0.020
Mortality	15 (3.6)	16 (6.8)	31 (4.7)	0.083
COVID-19 positive	10 (2.4)	29 (12.3)	39 (5.9)	< 0.001
Community infection	0 (0.0)	12 (5.1)	12 (1.8)	0.017[†]
Nosocomial infection	10 (2.4)	17 (7.2)	27 (4.1)	0.017[†]

*The test statistics are for the null hypothesis significance test for the comparison of Group A with Group B. ‡ Fisher's Exact test conducted due to invalid Chi-Squared test. Group A, incubation phase; Group B, lockdown phase. Statistically significant.
MOI, mechanism of injury; RTA, road traffic accident; LL, lower limb; UL, upper limb; ENT, ear, nose and throat; ICU, intensive care unit; NA, not applicable; CVD, cardiovascular disease; COPD, chronic obstructive pulmonary disease

admissions (310 COVID-19 inpatients) on 2 April and our hospital peaked with 83 ICU patients on 19 April (Figure 2).

Stringent treatment escalation plans may also have persuaded families and patients to avoid ICU admission which caused nursing staff to issue warnings against blanket DNACPR notices.[12]

COVID-19 in our cohort had a similar preponderance for sex which correlates to a study in China on 135 patients,[13] whereas other reports have quoted males at

Table II. Baseline characteristics of patients with COVID-19 infection admitted under Orthopaedics.

	Total (n = 657)	Group C: COVID-19 (n = 39)	Group D: non-COVID-19 (n = 618)	p-value
Age, yrs				
Mean (SD; range)	55.3 (22.53; 8 to 98)	73.2 (17.99; 28 to 98)	54.1 (22.3)	<0.001$*
Median	57.0 (95% CI 13.0 to 25.2)	73.2	55.0	< 0.001
< 60 years, n (%)	362 (55.1)	7 (17.9)	355 (57.4)	< 0.001
> 60 years, n (%)	295 (44.9)	32 (82.1)	263 (42.6)	< 0.001
Sex n (%)				
Female	264 (40.2)	17 (43.6)	247 (40.0)	0.737
Male	393 (59.8)	22 (56.4)	371 (60.0)	0.737
Comorbidity, n (%)				
Hypertension	153 (23.3)	18 (46.2)	135 (21.8)	0.001
CVD	90 (13.7)	14 (35.9)	76 (12.3)	< 0.001
Arthritis	70 (10.7)	9 (23.1)	61 (9.9)	0.027‡
Diabetes	75 (11.4)	8 (20.5)	67 (10.8)	0.072‡
Dementia	52 (7.9)	7 (17.9)	45 (7.3)	0.027‡
Malignancy	43 (6.5)	6 (15.4)	37 (6.0)	0.035‡
COPD	29 (4.4)	4 (10.3)	25 (4.0)	0.086‡
Kidney disease	121 (18.4)	4 (10.3)	117 (18.9)	0.206
Asthma	99 (15.1)	2 (5.1)	97 (15.7)	0.102
Intervention, n (%)				
Surgical	263 (40.0)	13 (33.3)	250 (40.5)	0.405
Conservative	394 (60.0)	26 (66.7)	368 (59.5)	0.405
Surgical Mortality	9 (3.4)	2 (15.4)	7 (2.8)	0.089‡

*The test statistics are for the null hypothesis significance test for thecomparison of the COVID patients with non-COVID patients. $Satterwaite's approximation to the degrees of freedom used; ‡Fisher's Exact test conducted due to invalid Chi-Squared test; Statisitically significant.
CVD, cardiovascular disease; COPD, chronic obstructive pulmonary disease

Table III. Types of surgery and specialties involved.

Surgery	Total (n = 657)	Group C: COVID-19 (n = 39)	Group D: non-COVID-19 (n = 618)	p-value
Orthopaedic procedures, n (%)				
ORIF	99 (15.1)	4 (10.3)	95 (15.4)	0.493
Hemi	20 (3.0)	4 (10.3)	16 (2.6)	0.026‡
DHS	15 (2.3)	1 (2.6)	14 (2.3)	0.605‡
Intramedullary nail	31 (4.7)	2 (5.1)	29 (4.7)	0.705‡
Exploration	17 (2.6)	0 (0.0)	17 (2.8)	0.616‡
Debridement & washout	31 (4.7)	2 (5.1)	29 (4.7)	0.705‡
MUA	2 (0.3)	0 (0.0)	2 (0.3)	1.000‡
Ex-fix	5 (0.8)	0 (0.0)	5 (0.8)	1.000‡
Tendon repair	9 (1.4)	0 (0.0)	9 (1.5)	1.000‡
Arthroscopy	4 (0.6)	0 (0.0)	4 (0.6)	1.000‡
Total	233 (35.4)	13 (33.3)	220 (35.6)	1.000‡
Specialities involved, n (%)				
Plastics	24 (3.7)	0 (0.0)	24 (3.9)	0.389‡
Cardiothoracic	55 (8.4)	5 (12.8)	50 (8.1)	0.363‡
Neurosurgery/spine	129 (19.6)	12 (30.8)	117 (18.9)	0.094‡
General surgery	41 (6.2)	2 (5.1)	39 (6.3)	1.000‡
Maxillofacial	19 (2.9)	2 (5.1)	17 (2.8)	0.313‡
ENT	4 (0.6)	0 (0.0)	4 (0.6)	1.000‡
ICU admissions	31 (4.7)	2 (5.1)	29 (4.7)	0.693‡
Mortality	31 (4.7)	8 (20.5)	23 (3.7)	< 0.000‡

*The test statistics are for the null hypothesis significance test for thecomparison of the COVID patients with non-COVID patients. ‡Fisher's Exact test conducted due to invalid Chi-Squared test. Statistically significant.
ORIF, open reduction internal fixation; DHS, dynamic hip screw; MUA, manipulation under anaesthesia; ENT, ear, nose, throat; ICU, intensive care unit.

higher risk.[14] The comorbidities in COVID-19 patients compared to noninfected patients were hypertension, cardiovascular disease, dementia, cancer, and arthritis. Arthritis has not previously been reported. Unlike other reports diabetes was not prevalent. While body mass index and ethnicity are noted to be factors influencing

Table IV. Signs, symptoms and laboratory findings of COVID -19-positive patients.

	Reference range	Total (n = 39)	Survival (n = 31)	Non-survival (8)	p-value
Median age, yrs (range)		80 (28 to 98)	76 (28 to 90)	89 (62 to 98)	0.047
Age, n (%)					
< 60 years	NA	7 (17.9)	7 (22.6)	0 (0)	0.308
> 60 years	NA	32 (82.1)	24 (77.4)	8 (100)	0.308
Signs and symptoms, n (%)					
Fever	NA	8 (20.5%)	7 (22.6%)	3 (37.5%)	0.399‡
Dry cough	NA	6 (15.4%)	8 (25.8%)	3 (57.5%)	0.663‡
Dyspnoea	NA	22 (56.4%)	16 (51.6%)	7 (87.5%)	0.109‡
Fatigue	NA	4 (10.3%)	11 (35.9%)	5 (62.5%)	0.235‡
Onset of infection, n (%)					
Community	NA	12 (30.8)	11 (35.5)	1 (12.5)	0.394‡
Nosocomial	NA	27 (69.2)	20 (64.5)	7 (87.5)	0.394‡
Median laboratory findings (range)					
White cell count × 10^9/l	3.6 to 11.0	7.5 (5.4 to 9.4)	7.1 (5.4 to 8.4)	8.6 (5.3 to 14.6)	0.401
Neutrophil count × 10^9/l	1.8 to 7.5	4.4 (3.6 to 6.5)	4.4 (3.5 to 6.4)	7.3 (3.8 to 12.6)	0.132
Lymphocyte count × 10^9/l	1.0 to 4.0	0.9 (0.7 to 1.0)	0.9 (0.7 to 1.1)	0.8 (0.6 to 0.9)	0.346
Monocyte count x 10^9/l	0.2 to 0.8	0.5 (0.4 to 0.7)	0.5 (0.4 to 0.7)	0.6 (0.3 to 1.1)	0.527
Platelet count × 10^9/l	140 to 400	230 (139 to 313)	220 (134 to 294)	314.5 (230.5 to 477.3)	0.052
Creatine, umol//l	60 to 110	75.0 (51 to 98)	72 (51 to 96)	109.5 (46.5 to 327.0)	0.249
C-reactive protein, mg/l	< 5	74.0 (37 to 135)	56 (32 to 119)	196 (129.0 to 326.5)	< 0.001
INR	0.8 to 1.2	1.1 (1.0 to 1.3)	1.1 (1.0 to 1.3)	1.3 (1.1 to 1.7)	0.044
Urea, mmol/L	2.5 to 7.8	5.9 (4.5 to 9.0)	5.8 (4.3 to 7.7)	14.75 (5.2 to 34.6)	0.048
Bilirubin, umol/L	< 21	8 (6 to 14)	8 (6 to 11)	11 (5.8 to 15)	0.462
Alanine transaminase, U/L	< 36	30 (21 to 45)	27 (19 to 38)	44 (33.8 to 56)	0.099
Alkaline phosphatase, IU/L	30 to 130	100 (76 to 178)	96 (74 to 154)	159 (91.3 to 257.3)	0.550
Albumin, g/L	35 to 50	25 (21.8 to 31.0)	25.5 (23 to 31.5)	20 (18.3 to 24)	0.132
Haemoglobin, g/L	115 to 180	108 (92 to 125)	108 (92 to 108)	101.5 (86.5 to 120)	0.021
Treatment, n (%)					
Antibiotics	N/A	13 (33.3)	9 (29)	4 (50)	0.402‡
Antiviral therapy	N/A	2 (5.1)	2 (6.5)	0	1.000‡
Steroids	N/A	2 (5.1)	2 (6.5)	0	1.000‡
Oxygen support, n (%)					
Nasal cannula	N/A	21 (53.8)	11 (35.5)	8 (100)	< 0.001‡
Noninvasive ventilator	N/A	10 (25.6)	5 (16.1)	5 (62.5)	< 0.001‡
Ventilator	N/A	3 (7.7)	2 (6.4)	1 (12.5)	< 0.001‡
HLOS	NA	22 (11 to 28)	24 (11 to 28)	17.5 (9.3 to 34.3)	0.670

*For laboratory findings and HLOS, the median plus interquartile range is presented. The test statistics are for the null hypothesis significance test for the comparison of the survival with the non-survival patients. ‡Fisher's Exact test conducted due to invalid Chi-Squared test. Statistically significant.
N/A, not applicable; HLOS, hospital length of stay; INR, international normalized ratio.

outcome in COVID-19, we were not able to include these due to incomplete data.[15]

Trauma patients with COVID-19 infection were significantly (p < 0.001) older (mean 73.2 years; 28 to 98) and had one or more underlying comorbidities. Jordan et al[16] reported that 25% of people are labelled high risk in the UK, including adults aged over 70 years in addition to people with underlying health conditions such as cardiovascular, respiratory disease, and cancer. Based on data in our study, no children were discovered with coronavirus and we show that during this time major trauma was uncommon in children. In support of these findings, reports from the Chinese Centre for Disease Control and Prevention showed that among 44,672 confirmed cases, most patients were 30 to 79 years, 1% were aged nine years or younger, 1% were aged ten to 19 years, and 3% were aged 80 years or older.[17]

The 39 patients in our study who developed COVID-19 had similar symptoms and presentation to those reported in other studies.[11,18]

Patients received antibiotics if indicative with the SAR-CoV-2 severe pneumonia. Supportive therapy was the main course of action including non-invasive ventilation (NIV) (25.6%; n = 10) and three patients ventilated (7.7%). There is currently no medication for the treatment of COVID-19 and the therapeutic strategies are only supportive.

There was increased C reactive protein in COVID-19 patients and in addition, the non-survival group had more deranged urea and Hb. White cell, neutrophil, and

Table V. Clinical characteristics of eight non-survival patients with COVID-19 infection.

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8	n (%)
DOA	19 March	27 February	9 March	29 February	10 March	26 January	25 March	7 March	N/A
Age, yrs	62	73	80	89	89	90	94	98	N/A
Sex, male/female	Male	Male	Male	Female	Female	Female	Male	Female	4:4
Comorbidities									
CVD	Yes	Yes	No	No	Yes	Yes	Yes	Yes	6
HTN	Yes	No	No	No	No	No	No	Yes	2
Diabetes	Yes	No	No	No	No	No	Yes	No	2
Kidney disease	Yes	No	Yes	No	No	Yes	No	No	3
COPD	No	Yes	No	No	No	No	No	No	1
Dementia	No	No	Yes	Yes	No	Yes	No	No	3
Admission type									
Trauma	No	No	Yes	Yes	Yes	No	Yes	No	4
Orthopaedics	Yes	Yes	No	No	No	Yes	No	Yes	4
MOI	Pain	Pain	Fall	Fall	Fall	Fall	Fall	Fall	N/A
Injury									
Head & neck	No	No	Yes	No	Yes	No	No	Yes	3
Thorax	No	No	No	Yes	Yes	No	No	No	2
Spinal	No	No	No	Yes	Yes	No	Yes	No	3
Pelvic	Yes	No	No	No	Yes	No	No	Yes	3
UL	No	No	No	Yes	No	Yes	No	No	2
LL	No	Yes	No	No	No	No	No	No	1
Intervention									
Surgery	No	No	No	No	Yes	No	No	Yes	2
Conservative	Yes	Yes	Yes	Yes	No	Yes	Yes	No	6
Surgical Intervention	N/A	N/A	N/A	N/A	Sacral fixation	N/A	N/A	Hemi	2
Date of surgery	N/A	N/A	N/A	N/A	11 March	N/A	N/A	8 March	N/A
COVID-19 onset									
Community	No	No	No	No	No	No	Yes	No	1
Nosocomial	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	7
First symptom	Fever	Dyspnoea	Dyspnoea	Fever	Dyspnoea	Cough	Cough	Dyspnoea	N/A
Date of swab test	21 March	27 March	25 March	15 March	25 March	11 March	26 March	15 March	N/A
Complication	ARDS	ARDS	ACS	ARDS	Resp failure	Resp failure	ARDS	Resp failure	N/A
Date of death	20 March	6 April	6 March	20 March	28 March	21 March	1 April	20 March	N/A
HLOS	8	39	17	20	18	55	7	13	N/A

CVD, cardiovascular disease; HTN, hypertension; MOI, mechanism of injury; UL, upper limb; LL, lower limb; HLOS, hospital length of stay; Hemi, hemiarthroplasty; Resp, respiratory; ACS, acute coronary syndrome; ARDS, acute respiratory distress syndrome

lymphocyte counts were normal. Biomarkers have been explored in the early stage of COVID-19 to determine the severity. Results showed CRP levels were significantly compared to the severity of illness and greater size of lung lesions. C reactive protein reflects disease severity in the early stages.[19] Our data shows a marked increase in later stages associated with severe SAR-CoV-2 pneumonia deaths.

The mortality rate increased between groups in the incubation phase and lockdown phase (3.6% (n = 15) and 6.8% (n = 16)), but this did not reveal statistical significance. However, the mortality of patients infected by COVID-19 was 20.5% compared to non-infected patients of 3.7% which was significantly higher. COVID-19 surgical mortality is as high as 27.3% with thoracic surgery.[20] Our surgical mortality in patients with COVID-19 was 15.4% (n = 2) in contrast to Bhangu et al[21] who reported on 1,128 patients in 24 countries with a mortality rate

of 23.8%, Of note, their mortality rate was composed of 75% emergency and 25% elective surgeries, whereas our data only represents emergencies. In contrast to our COVID-19 surgical mortality, the non-COVID-19 surgical mortality was only 2.8% (n = 7).

ICU admission rate during the lockdown phase was 2.1% (n = 5), which was significantly (p = 0.020) lower than patients during incubation phase (6.2%). Only 5.1% (n = 2) of COVID-19 patients were admitted to ICU. Critical care triage to allow the rationing of scarce ICU resources have been required in some countries.[22–24] We know from our hospital data that we were never overwhelmed by the pandemic. Ward inpatients peaked at over 300 and almost 90 ICU admissions, yet our capacity was 420 ventilated beds with a further 100 possible. Therefore, a rise in mortality but decrease in ICU admissions for our cohort of traumatically injured was not an ICU bed capacity/resource issue.

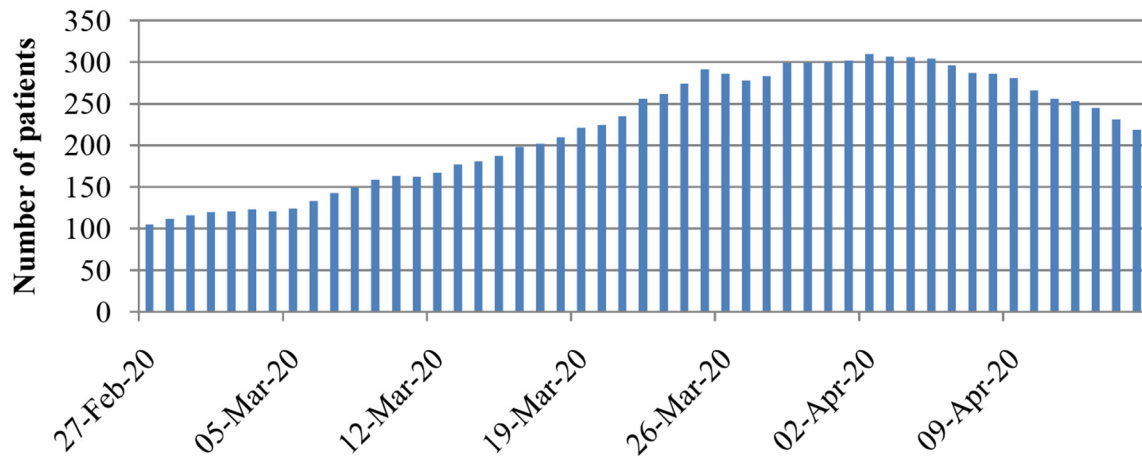## COVID-19 inpatient figures

Fig. 2

Total number of COVID-19 positive inpatient figures at our hospital during the period of 26 February to 14 April 2020.

Overall, 39 (5.9%) of patients in our study tested positive for COVID-19 infection. Of these 39 patients, 27 (69.2%) patients acquired their infection during their admission in hospital. Nosocomial infection was to be expected given the contagious infectivity.[25] Our figure is higher than the reported literature with a meta-analysis showing a COVID-19 nosocomial infection rate of 44%.[26] It is interesting to see a 70% nosocomial infection within the coronavirus cohort, but perhaps not surprising given their risk factors of age, comorbidities, as well as the immunosuppression associated with major trauma.

COVID-19 tests were not initially performed on asymptomatic admissions in our institution nor were healthcare providers routinely screened. Only five (12.8%) had definite positive swabs on admission and positive swabs occurred in an average of 12.3 days (mean 12.3; 0 to 45). In contrast, Wong et al[27] showed that with vigilant contact tracing nosocomial transmission may be controlled and was unlikely an airborne disease. COVID-19 virus is primarily transmitted between people through respiratory droplets (> 5 um) and contact routes.[28] Airborne transmission may occur if aerosol generating medical procedures (AGMP) transmit particles which may remain airborne longer. Rivett et al[29] showed only 3% of asymptomatic healthcare workers tested positive, suggesting our assumed asymptomatic patients on admission were true nosocomial infections. With multiple transmission routes, there are multiple factors to contribute to our high nosocomial infection rate. Recommendations of adequate indoor ventilation to remove virus laden respiratory droplets have been made.[30]

Our study reveals that eight trauma patients died with COVID-19 compared to 31 patients who survived. We show that patients who died were older (mean 84.4 years) and had multiple comorbidities (cardiovascular disease, hypertension, dementia, diabetes). In

one meta-analysis of seven studies it was reported that hypertension, respiratory system disease and cardiovascular disease were risk factors.[31] In another study, Lei et al[11] showed that hypertension and cardiovascular disease were the most common comorbidities of seven patients that died of COVID-19, in keeping with our study.

The limitations of this study include the small sample size of positive COVID-19 patients. However, this figure is in keeping with international figures, if not higher than from some of the highest incidence centres in the literature.[11] Numbers may have decreased at our centre secondary to national guidelines to reduce referrals to major trauma centres; however, suitable cases were always transferred.[10] National and local guidelines dictated that only symptomatic patients were tested on admission.[32] Lack of PPE in this country did not seem to be a major issue at our hospital although the frequently changing protocols may have contributed. Aerosol and contact transmission may play a role in the hospital environment but are difficult to measure. Statistical relevance must be carefully considered due to the small sample numbers but benefit from the large comparison cohort.

Major trauma will inevitably still occur in a pandemic where lockdown and social distancing have been imposed. While the numbers may decline, major trauma and orthopaedic injuries will account for regular admissions to hospital. This has implications for the spread of COVID-19. Our data shows that the total number of trauma patients with COVID-19 (5.9%; n = 39) was small, but rose from 2.4% (n = 10) in the incubation phase to 12.3% (n = 29) during the lockdown phase. It affects equal preponderance of males to females and the older age group (over 70 years). Their most common injuries were pelvic, chest and spine caused mainly by falls but also from an increased incidence of RTA. One-third were treated surgically. Our study confirms that symptoms

mainly included dyspnoea, dry cough, and pyrexia. Common comorbidities included hypertension, CVD, dementia, arthritis, and malignancy, but not diabetes. Trauma patients with COVID-19 have a high incidence of nosocomial infection (69.2%; n = 27) but also a high mortality rate (20.5%) in octogenarians. Our surgical COVID-19 mortality was 15.3%, moderately lower in comparison to other reports, but five-times greater than our non-COVID-19 surgical mortality, underlining the risk of COVID-19 infection with surgery.

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- Performed the statistical analysis.
- Designed the study, Analyzed and interpreted the data, Edited the manuscript.