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Original Research

A comparison of characteristics and outcomes of patients with community-acquired and hospital-acquired COVID-19 in the United Kingdom: An observational study



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ABSTRACT

Background and objectives: Reports comparing the characteristics of patients and their clinical outcomes between community-acquired (CA) and hospital-acquired (HA) COVID-19 have not yet been reported in the literature. We aimed to characterise and compare clinical, biochemical and haematological features, in addition to clinical outcomes, between these patients.

Methods: This multi-centre, retrospective, observational study enrolled 488 SARS-CoV-2 positive patients - 339 with CA infection and 149 with HA infection. All patients were admitted to a hospital within the University Hospitals of Morecambe Bay NHS Foundation Trust between March 7th and May 18th 2020.

Results: The CA cohort comprised of a significantly younger population, median age 75 years, versus 80 years in the HA cohort ($P = 0.0002$). Significantly less patients in the HA group experienced fever ($P = 0.03$) and breathlessness ($P < 0.0001$). Furthermore, significantly more patients had anaemia and hypoalbuminaemia in the HA group, compared to the CA group ($P < 0.0001$ for both). Hypertension and a lower median BMI were also significantly more pronounced in the HA cohort ($P = 0.03$ and $P = 0.0001$, respectively). The mortality rate was not significantly different between the two cohorts (34% in the CA group and 32% in the HA group, $P = 0.64$). However, the CA group required significantly greater ICU care (10% versus 3% in the HA group, $P = 0.009$).

Conclusion: Hospital-acquired and community-acquired COVID-19 display similar rates of mortality despite significant differences in baseline characteristics of the respective patient populations. Delineation of community- and hospital-acquired COVID-19 in future studies on COVID-19 may allow for more accurate interpretation of results.

1. Introduction

In December 2019, The Chinese health authorities warned the World Health Organization (WHO) of several cases of pneumonia of unknown

aetiology in patients that either worked or lived near a local seafood market in Hunan province [1]. In the UK, as of August 21, 2020, 322,280 cases of COVID-19 have been confirmed and the total number of reported deaths stands at 41, 403 [2].

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A large breadth of our understanding of COVID-19 comes from studies performed outside of the United Kingdom. These have proved to be a major source of information in directing medical practice as well as dictating national government policy. However it is important to note that key differences persist in both the demographics of the populations and the health systems between these studies and the UK. The ISARIC WHO CCP-UK report was pivotal in describing the manifestations of COVID-19 in the UK, particularly with regard to clinical presentations, however investigative data was not presented [3]. Numerous reports have been documented in the literature with regard to these, however, those describing a UK population are limited. Furthermore, there are reports of community- and hospital-acquired COVID-19, but no direct comparison between the two in the literature. We aimed to characterise the clinical, biochemical and haematological features of hospitalised patients with COVID-19 and compare these between two groups – community-acquired (CA) and hospital-acquired (HA) COVID-19.

2. Methods

This multi-centre, retrospective, observational study was performed at the University Hospitals of Morecambe Bay NHS Foundation Trust (UHMB) and included two of its teaching hospitals – the Royal Lancaster Infirmary and Furness General Hospital.

All patients in the trust which obtained a positive result for SARS-CoV-2 on a reverse transcription polymerase chain reaction (RT-PCR) test of naso/oro-pharyngeal swabs and were an inpatient at any point between March 7th 2020 and May 18th 2020 were included. Patients who tested positive on admission as well as at any point during an inpatient stay were included, this allowed the identification and stratification of community acquired and hospital acquired COVID-19. Hospital-acquired COVID-19 was defined as a positive result on a naso/oro-pharyngeal swab taken at least 48 h after admission.

Biochemical and haematological parameters were measured on the date of first contact with hospital services in the cases of community-acquired COVID-19 and on the date of a positive naso-/oro-pharyngeal PCR swab in the cases of hospital-acquired COVID-19. During the course of the study, RT-PCR processing time varied from 24 to 168 h as urgent processing facilities were established. All laboratory values for these patients are recorded on the date the swab was taken. Patients were re-tested if there was a high clinical suspicion of COVID-19 despite previous negative results.

Patient records were obtained via an electronic health record (Lorenzo; DXC Technology). Data parameters collected included demographic characteristics, clinical characteristics and clinical outcomes. Demographic characteristics included age, gender and ethnicity. Clinical characteristics included symptomatology, co-morbidities, Do Not Attempt Cardio-Pulmonary Resuscitation (DNAR) status, initial laboratory test results, radiological outcomes, RT-PCR testing outcomes and relevant medications. Clinical outcomes such as mortality and the need for intensive care unit (ICU) admission were also recorded and these comprised the primary and secondary outcomes, respectively. Follow-up data regarding length of stay and mortality was recorded up to June 17th, 2020, at which point 4 patients remained in-patients and their hospital admission course was not concluded.

This data was obtained as part of a service evaluation. The research and development department of the Trust assessed the study protocol and deemed an ethical review by the Health Research Authority to not be warranted. All conduct was in line with the 2013 Declaration of Helsinki.

Descriptive statistics included means with standard deviations (SD) and medians with inter-quartile ranges (IQR). Normality of distribution was determined using Shapiro-Wilk Normality tests. T-tests and Mann-Whitney U tests were implemented as appropriate depending on whether analysis was performed of parametric or non-parametric data. Categorical variables were analysed using Fisher's Exact tests or Chi Squared tests as appropriate. All statistical analyses were performed

using R 3-6-1 (R Foundation for Statistical Computing, Vienna, Austria).

3. Results

This study involved 488 patients with COVID-19, divided into two cohorts: 339 with CA infection and 149 with HA infection.

3.1. Demographic characteristics

The demographic characteristics of the study population were studied under the following categories: age, gender and ethnicity, and are illustrated in Table 1.

The median age of the CA cohort was 75, and the median age of the HA cohort was 80 ($P = 0.0002$, Mann Whitney U Test). The ages with the largest proportion of patients in each group was greater than 80 years old (See Fig. 1).

Both cohorts showed a slight majority of male patients, with 192 (57%) male and 147 (43%) female patients in the CA group and 78 (52%) male and 71 (48%) female patients in the HA group. This difference, however, was not statistically significant ($P = 0.44$, Chi Squared Test).

It was observed that the CA cohort had 277 (82%) White patients, 6 (2%) Asian patients, 3 (1%) Black patients and 53 (16%) patients of unknown ethnicity. The HA cohort consisted of 136 (91%) White patients and 13 (9%) patients of unknown ethnicity - there were no Asian or Black patients in this group. Statistical analysis highlighted that the ethnicity differences we observed in this study group were not significant ($P = 0.14$, Fisher's Exact Test).

3.2. Symptoms

The most prevalent symptoms in our study group were cough, expectoration, fever $>37.5^{\circ}$ Centigrade and breathlessness. Statistically significant differences between the cohorts were present for all of these, as highlighted in Table 2. Enteral symptoms represented the second most common sub-group of symptoms with a statistically significant difference noted in the prevalence of vomiting between the cohorts, but not diarrhoea. Upper respiratory and neurological symptoms did not represent a sizeable proportion of the presenting symptomatology and

Table 1
Demographic characteristics.

	Combined Groups (n = 488)	Community Acquired (n = 339)	Hospital Acquired (n = 149)	P-Value
Age, years				
Median	77	75	80	0.0002 ^c
IQR	20-25	24	12	
Range	13–98	17–98	13–96	
<18	2 (0%)	1 (0%)	1 (1%)	0.0005 ^b
18-39	24 (5%)	23 (7%)	1 (1%)	
40-49	22 (5%)	18 (5%)	4 (3%)	
50-59	54 (11%)	47 (14%)	7 (5%)	
60-69	53 (11%)	38 (11%)	15 (10%)	
70-79	127 (26%)	82 (24%)	45 (30%)	
≥80	206 (42%)	130 (38%)	76 (51%)	
Gender, n (%)				
Male	270 (55%)	192 (57%)	78 (52%)	0.44 ^a
Female	218 (45%)	147 (43%)	71 (48%)	
Ethnicity, n (%)				
White	413 (85%)	277 (82%)	136 (91%)	0.14 ^b
Black	3 (1%)	3 (1%)	0 (0%)	
Asian	6 (1%)	6 (2%)	0 (0%)	
Unknown	66 (14%)	53 (16%)	13 (9%)	

IQR = Inter-Quartile Range.

Percentages are rounded to the nearest percentage.

^a Chi Squared Test |

^b Fisher's Exact Test |

^c Mann Whitney U Test.

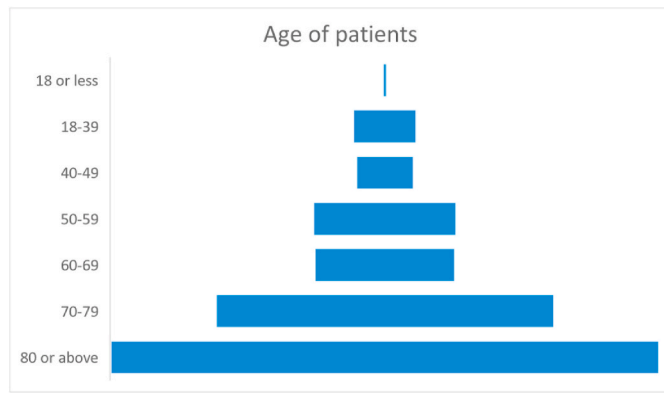


Fig. 1. Funnel chart demonstrating the distribution of ages across the combined groups.

no significant differences were noted between the cohorts in this regard (See Fig. 2).

3.3. Co-morbidities

When studying the pre-existing co-morbidities of the patients in our study group, interesting observations were noted.

Under metabolic disease, no significant differences were observed in prevalence of either type 1 or type 2 diabetes mellitus between the cohorts. However, studying the body mass index (BMI) of our patients revealed a significant difference. The median BMI of the entire study group was 25.25, with the median of the CA cohort being 26.5 and the median of the HA cohort being 23.4 ($P = 0.0001$, Mann Whitney U Test). It must be noted when interpreting these results that BMI values were not available for 52 patients in the CA group and 8 patients in the HA group.

The only co-morbidity under the category of cardiovascular disease that showed a significant difference between the two cohorts was hypertension. From all patients, 215 (44%) had hypertension- 138 (41%) in the CA cohort and 77 (52%) in the HA cohort. This difference was found to be significant ($P = 0.03$, Chi Squared Test).

Respiratory disease encompassed chronic obstructive pulmonary disease (COPD) and Asthma. There were no significant differences between the CA and HA cohorts for either of these respiratory conditions.

The prevalence of renal, hepatic and neurological disease was assessed among our patients. As per Table 2, there was also no significant difference found for any of these conditions between the two cohorts.

The percentage of patients with a DNAR order in place was also assessed- 184 (54%) patients in the CA cohort and 108 (72%) patients in the HA cohort. The difference between the two cohorts was found to be statistically significant ($P = 0.0002$, Chi Squared Test).

3.4. Medications

In Table 3, the number of patients taking relevant medications is highlighted. No significant differences were observed between the two cohorts regarding these medications.

3.5. Investigative results

Table 4 relates to the results of various investigations performed on our study participants.

It was observed that 408 (84%) of all patients had no negative RT-PCR test prior to diagnosis. The results from each cohort show that 310 (91%) of the CA cohort had no negative RT-PCR test before being diagnosed, compared to 98 (66%) of the HA cohort. This difference between the cohorts was statistically significant ($P < 0.0001$, Fisher's

Table 2
Clinical characteristics.

	Combined Groups (n = 488)	Community Acquired (n = 339)	Hospital Acquired (n = 149)	P-Value
Symptoms, n (%)				
Cough	298 (61%)	228 (67%)	70 (47%)	<0.0001 ^a
Expectoration	98 (20%)	78 (23%)	20 (13%)	0.02 ^a
Headache	25 (5%)	22 (6%)	3 (2%)	0.07 ^a
Nausea	36 (7%)	30 (9%)	6 (4%)	0.09 ^a
Sore Throat	23 (5%)	18 (5%)	5 (3%)	0.48 ^a
Rhinorrhoea	3 (1%)	3 (1%)	0 (0%)	0.56 ^b
Diarrhoea	66 (14%)	51 (15%)	15 (10%)	0.18 ^a
Vomiting	47 (10%)	43 (13%)	4 (3%)	0.001 ^a
Fever > 37.5 °C	279 (57%)	205 (60%)	74 (50%)	0.03 ^a
Breathlessness	304 (62%)	234 (69%)	70 (47%)	<0.0001 ^a
Anxiety	18 (4%)	12 (4%)	6 (4%)	1.0 ^a
Anosmia	7 (1%)	7 (2%)	0 (0%)	0.11 ^b
Ageusia	4 (1%)	4 (1%)	0 (0%)	0.32 ^b
Diaphoresis	11 (2%)	8 (2%)	3 (2%)	1 ^b
Co-morbidities, n (%)				
Metabolic Disease				
Diabetes Mellitus				
Type 1	8 (2%)	7 (2%)	1 (1%)	0.44 ^b
Type 2	116 (24%)	80 (24%)	36 (24%)	0.98 ^a
Body Mass Index ^d				
Median	25.25	26.5	23.4	0.0001 ^c
IQR	8.625	8.75	7.8	
<18.5	32 (7%)	14 (5%)	18 (13%)	0.003 ^a
18.5–24.9	176 (41%)	111 (39%)	65 (46%)	
25–29.9	110 (26%)	79 (28%)	31 (22%)	
≥30	110 (26%)	83 (29%)	27 (19%)	
Cardiovascular Disease				
Hypertension	215 (44%)	138 (41%)	77 (52%)	0.03 ^a
Coronary Artery Disease	78 (16%)	48 (14%)	30 (20%)	0.13 ^a
Disease				
Heart Failure	60 (12%)	36 (11%)	24 (16%)	0.12 ^a
Arrhythmias				
Atrial Fibrillation	78 (16%)	55 (16%)	23 (15%)	0.93 ^a
Heart Block	4 (1%)	2 (1%)	2 (1%)	0.59 ^b
Respiratory Disease				
Chronic Obstructive Pulmonary Disease	63 (13%)	42 (12%)	21 (14%)	0.71 ^a
Asthma	81 (17%)	61 (18%)	20 (13%)	0.26 ^a
Renal Disease				
Chronic Kidney Disease	90 (18%)	58 (17%)	32 (21%)	0.31 ^a
Hepatic Disease				
Cirrhosis	10 (2%)	8 (2%)	2 (1%)	0.73 ^b
Neurological Disease				
Stroke	37 (8%)	20 (6%)	17 (11%)	0.68 ^a
Dementia	27 (6%)	17 (5%)	10 (7%)	0.59 ^a
Parkinson's Disease	10 (2%)	4 (1%)	6 (4%)	0.75 ^b
Epilepsy	9 (2%)	6 (2%)	3 (2%)	1 ^b
Other	7 (1%)	4 (1%)	3 (2%)	0.44 ^b
DNAR Order, n (%)	292 (60%)	184 (54%)	108 (72%)	0.0002^a
Age, years				
Median	81	82	80.5	0.47 ^c
IQR	11	10	11	

IQR = Inter-Quartile Range; DNAR = Do Not Attempt Cardio-Pulmonary Resuscitation.

Percentages are rounded to the nearest percentage.

^a Chi Squared Test |

^b Fisher's Exact Test |

^c Mann Whitney U Test.

^d Body mass index values were not available for 52 patients in the community-acquired group and 8 patients in the hospital-acquired group.

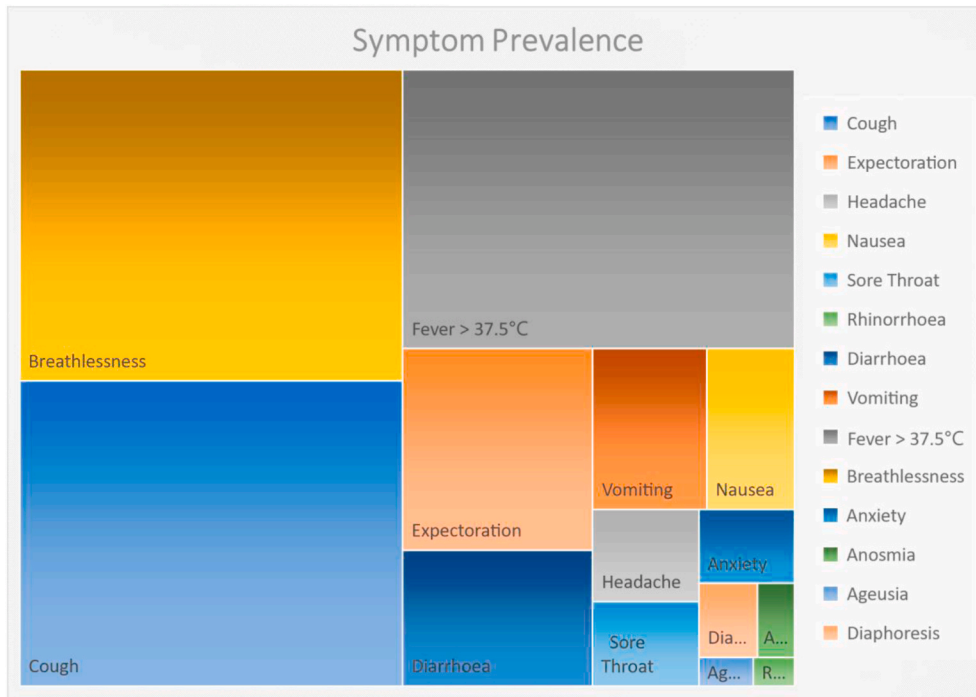


Fig. 2. Tree plot illustrating the distribution of symptoms among both cohorts.

Table 3
Relevant medication use.

	Combined Groups (n = 488)	Community Acquired (n = 339)	Hospital Acquired (n = 149)	P- Value
Immunosuppressive Medication, n (%)				
Corticosteroids	23 (5%)	17 (5%)	6 (4%)	0.81 ^a
Biologics	8 (2%)	7 (2%)	1 (1%)	0.45 ^b
DMARDS	10 (2%)	7 (2%)	3 (2%)	1 ^b
Others	4 (1%)	4 (1%)	0 (0%)	0.32 ^b
Angiotensin-Converting Enzyme Inhibitor, n (%)	91 (19%)	59 (17%)	32 (21%)	0.35 ^a
Angiotensin II Receptor Blocker, n (%)	24 (5%)	16 (5%)	8 (5%)	0.94 ^a

DMARD = Disease-modifying antirheumatic drugs. Percentages are rounded to the nearest percentage.

^a Chi Squared Test | ^b Fisher's Exact Test.

Exact Test).

Haematological investigation results showed highlighted numerous differences between the cohorts. It must be noted that whilst we report many blood tests here, not every test was performed on every patient.

Haemoglobin levels were assessed in 480 patients (336 CA patients and 144 HA patients). Median haemoglobin values for all patients was 128. When divided into cohorts, the median haemoglobin value was 134 for the CA cohort and 117.5 for the HA cohort ($p < 0.0001$, Mann Whitney *U* Test).

White Blood Cell (WBC) levels were assessed in 480 patients (336 CA patients and 144 HA patients). The median WBC was 7.2 for all patients overall, and 7.2 for the CA cohort and 6.7 for the HA cohort ($P = 0.02$, Mann Whitney *U* Test). Another statistically significant result observed on analysis of this parameter was in the number of patients with a level < 4.0 . In all patients, 49 (10%) were found to have WBCs below 4.0–27 (8%) in the CA and 22 (15%) in the HA cohort ($P = 0.03$, Chi Squared Test).

C-reactive protein (CRP) levels were measured in a total of 469 patients- 329 in the CA cohort and 140 in the HA cohort. The median CRP value was 87.2 mg/L in all patients, and 92 in the CA cohort compared to 66.5 in the HA cohort ($P = 0.003$, Mann Whitney *U* Test).

Pro-calcitonin levels were assessed in 172 of all patients, 154 in the CA cohort and 18 in the HA cohort. From all patients who had their levels assessed, 56 (33%) had a pro-calcitonin level $> 0.5\text{ng/ml}$ -this included 44 (29%) of the CA cohort and 12 (67%) of the HA cohort ($P = 0.003$, Chi Squared Test).

Liver function tests of patients were assessed in our study. Alanine aminotransferase (ALT) median levels were significantly higher in the CA cohort than the HA cohort ($P = 0.02$, Mann Whitney *U* Test). Conversely, alkaline phosphatase (ALP) median levels were significantly elevated in the HA cohort compared to the CA cohort ($P < 0.0001$, Mann Whitney *U* Test). Additionally, the number of patients with an ALP result above 130 was observed to be 68 (21%) in the CA cohort and 29 (35%) in the HA cohort ($P = 0.01$, Chi Squared Test). Median bilirubin results were found to be significantly higher in the CA cohort than in the HA cohort ($P = 0.02$, Mann Whitney *U* Test). The median albumin value was also found to be significantly elevated in the CA cohort compared to the HA cohort ($P < 0.0001$, Mann Whitney *U* Test).

D-dimer, ferritin, lactate dehydrogenase, derived fibrinogen, sodium, potassium, and adjusted calcium levels were all assessed among a varying portion of the total study participants. No significant differences were found in any of the values for these laboratory tests.

3.6. Clinical outcomes

Table 5 displays the clinical outcomes assessed in our study participants including ICU admission rates, the post-discharge follow-up period and the mortality rates.

From our total study cohort of 488 patients 38 (8%) patients required ICU care. This included 34 (10%) of the CA cohort and 4 (3%) of the HA cohort. This difference in the number of patients requiring ICU care between the cohorts was statistically significant ($P = 0.009$, Chi Squared Test).

Studying these patients who required ICU care further, the mean age was 62 years old for all patients-this mean age was 63 for the CA cohort

Table 4
Investigation results.

	Reference Ranges	Combined Groups	Community Acquired	Hospital Acquired	P-Value
Negative RT-PCR Tests Prior to Diagnosis, n (%)		(n=488)	(n=339)	(n=149)	
None		408 (84%)	310 (91%)	98 (66%)	<0.0001 ^d
One		69 (14%)	24 (7%)	45 (30%)	
Two		9 (2%)	4 (1%)	5 (3%)	
Three		2 (0%)	1 (0%)	1 (1%)	
Radiological (CT) Evidence of COVID-19, n (%)		(n=488)	(n=339)	(n=149)	0.91 ^a
		42	30	12	
Haemoglobin^c, g/L	115–165	(n=480)	(n=336)	(n=144)	
Median		128	134	117.5	<0.0001 ^b
IQR		31	27–25	26	
>165, n (%)		17 (4%)	16 (5%)	1 (1%)	0.03 ^d
<115, n (%)		129 (27%)	65 (19%)	64 (44%)	<0.0001 ^a
White Blood Cell Count, x10⁹/L	4.0–10.0	(n=480)	(n=336)	(n=144)	
Median		7.2	7.3	6.7	0.02 ^b
IQR		4.9	5.025	4.525	
>10.0, n (%)		122 (25%)	92 (27%)	30 (21%)	0.16 ^a
<4.0, n (%)		49 (10%)	27 (8%)	22 (15%)	0.03 ^a
Neutrophil Count, x10⁹/L	2.0–7.5	(n=480)	(n=336)	(n=144)	
Median		5.5	5.75	4.95	<0.0001 ^b
IQR		4.65	4.9	4.025	
>7.5, n (%)		159 (33%)	125 (37%)	34 (24%)	0.01 ^a
<2.0, n (%)		22 (5%)	11 (3%)	11 (8%)	0.06 ^a
Lymphocyte Count, x10⁹/L	1.0–3.0	(n=477)	(n=334)	(n=143)	
Median		0.7	0.7	0.7	0.56 ^b
IQR		0.6	0.5	0.8	
>3.0, n (%)		9 (2%)	8 (2%)	1 (1%)	0.29 ^d
<1.0, n (%)		324 (68%)	234 (70%)	90 (63%)	0.16 ^a
Eosinophil Count, x10⁹/L	0.02–0.50	(n=479)	(n=335)	(n=144)	
Median		0	0	0	<0.0001 ^b
IQR		0	0	0.1	
>0.50, n (%)		4 (1%)	1 (0%)	3 (2%)	0.08 ^d
<0.02, n (%)		375 (78%)	280 (84%)	95 (66%)	<0.0001 ^a
C-reactive Protein, mg/L	0–5.0	(n=469)	(n=329)	(n=140)	
Median		87.2	92	66.5	0.003 ^b
IQR		123.3	125	112	
>5, n (%)		449 (96%)	316 (96%)	133 (95%)	0.79 ^a
>50, n (%)		302 (64%)	226 (69%)	76 (54%)	0.004 ^a
>100, n (%)		203 (43%)	154 (47%)	49 (35%)	0.02 ^a
>200, n (%)		75 (16%)	57 (17%)	18 (13%)	0.28 ^a
Pro-calcitonin, ng/mL	0–0.50	(n=172)	(n=154)	(n=18)	
>0.50, n (%)		56 (33%)	44 (29%)	12 (67%)	0.003 ^a
Alanine Aminotransferase, IU/L	0–50	(n=413)	(n=329)	(n=84)	
Median		26	26	22	0.02 ^b
IQR		24	27	22	
>50, n (%)		84 (20%)	71 (22%)	13 (15%)	0.28 ^a
Alkaline Phosphatase, IU/L	30–130	(n=414)	(n=330)	(n=84)	
Median		91.5	87	113.5	<0.0001 ^b
IQR		57.75	49.75	79.25	
>130, n (%)		88 (21%)	68 (21%)	29 (35%)	0.01 ^a
<30, n (%)		1 (0%)	1 (0%)	0 (0%)	1 ^d
Bilirubin, μmol/L	0–21	(n=414)	(n=330)	(n=84)	
Median		11	12	10	0.02 ^b
IQR		7.75	7.75	7	
>21, n (%)		39 (9%)	33 (10%)	6 (7%)	0.55 ^a
Albumin, g/L	35–50	(n=413)	(n=329)	(n=84)	
Median		35	35	31	<0.0001 ^b
IQR		7	6	8	
>50, n (%)		1 (0%)	0 (0%)	1 (1%)	0.20 ^d
<35, n (%)		205 (50%)	145 (44%)	60 (71%)	<0.0001 ^a
CTPA-Confirmed PE, n (%)		(n=488)	(n=339)	(n=149)	0.29 ^d
		9 (2%)	8 (2%)	1 (1%)	
Doppler US-Confirmed DVT, n (%)		(n=488)	(n=339)	(n=149)	0.22 ^d
		3 (1%)	1 (0%)	2 (1%)	

CT = Computed Tomography; IU = International Units; CTPA = Computed Tomography Pulmonary Angiogram; PE = Pulmonary Embolism; US = Ultrasound; DVT = Deep Vein Thrombosis.

Percentages are rounded to the nearest percentage.

^a Chi Squared Test |

^b Mann Whitney *U* Test.

^c The haemoglobin reference range has been determined using the lower limit of normal for females and the higher limit of normal for males.

^d Fisher's Exact Test |

Table 5
Clinical outcomes.

	Combined Groups (n = 488)	Community Acquired (n = 339)	Hospital Acquired (n = 149)	P-Value
ICU Care, n (%)	38 (8%)	34 (10%)	4 (3%)	0.009^a
Age, years				
Mean	62	63	60	0.70 ^c
SD	13.58	13.87	12.15	
Length of ICU stay ^d , days	(n=34)	(n=30)	(n=4)	
Median	9.5	10	7	0.30 ^l
IQR	10-5	10-75	6-75	
Invasive Mechanical Ventilation, n (%)	34 (89%)	31 (91%)	3 (75%)	0.37 ^b
Invasive Mechanical Ventilation ^e , days	(n=33)	(n=30)	(n=3)	
Median	8	8	3	0.23 ^l
IQR	10	9	4	
Renal Replacement Therapy, n (%)	10 (26%)	9 (26%)	1 (25%)	1 ^b
Vasopressor Support, n (%)	25 (66%)	23 (68%)	2 (50%)	0.59 ^b
Died	15 (39%)	13 (38%)	2 (50%)	1 ^b
Died, n (%)	163 (33%)	116 (34%)	47 (32%)	0.64^a
Age, years				
Median	81	80.5	81	0.81 ^l
IQR	11	11	10.5	
As inpatient ^f	(n=161)	(n=114)	(n=47)	0.41 ^b
154 (96%)	110 (96%)	44 (94%)		
After discharge ^f	(n=161)	(n=114)	(n=47)	
7 (4%)	4 (4%)	3 (6%)		
Time from Admission to Onset of Infection, days	N/A	N/A	(n=149)	
Range	-	-	3-146	
Median	-	-	11	
IQR	-	-	17	
Post-Discharge Follow-Up^g, days	(n=328)	(n=225)	(n=103)	
Median	61	62	55	0.02 ^l
IQR	27	25	31.5	
Time to Death After Symptom Onset^h, days	(n=160)	(n=114)	(n=46)	
Median	7	7	8.5	0.19 ^l
IQR	9	9	9.25	
Length of Hospital Stay^{h,i}, days	(n=474)	(n=332)	(n=142)	
Median	10	7	28 [□]	<0.0001 ^l
IQR	17	9-75	38-75	
Time from Symptom Onset to Hospital Discharge^{h,k}, days	(n=461)	(n=322)	(n=139)	
Median	8	7	11	0.0002 ^l
IQR	12	11	21	

ICU = Intensive Care Unit; IQR = Inter-Quartile Range; SD = Standard Deviation.

Percentages are rounded to the nearest percentage.

^a Chi Squared Test |

^b Fisher's Exact Test |

^c Two Sample T Test.

^d This was inclusive of patients that died within the ICU, where the date of death was taken as the last day of ICU stay. Patients that remained admitted in ICU at the end of the study period were excluded. **2 patients remained inpatients in the ICU at the end of the study period in the CA group. Furthermore, 1 patient in CA group was transferred to a different hospital for more specialist input and is not included in the total. Furthermore, accurate data regarding ICU stay dates was not available for 1 patient in the CA group.**

^e 1 patient remained intubated at the end of the study period in the community acquired group and was excluded from this analysis.

^f Data was unavailable regarding location of death for 2 patients in the Community Acquired cohort.

^g For those patients that died post-discharge, the date of death is taken as the last day of follow-up.

^h Data not available for 1 patient regarding this in the HA cohort and 2 patients in the CA cohort.

ⁱ This was inclusive of patients that died within the hospital, where the date of death was taken as the last day of stay. Patients that remained inpatients at the end of the study period were excluded.

^j For the hospital-acquired group, length of stay was inclusive of length of admission prior to being diagnosed with COVID-19. **2 patients in the community acquired group and 2 patients in the hospital acquired group were excluded as they remained inpatients on the final date of follow-up for the study period. Data regarding hospital stay for a further 5 patients in the community acquired group and 5 patients in the hospital acquired group was not available.**

^k 2 patients in the community acquired group and 2 patients in the hospital acquired group were excluded as they remained inpatients on the final date of follow-up for the study period. Data regarding hospital stay for a further 15 patients in the community acquired group (7 Patients were discharged and 3 patients died prior to a positive test result being reported, whereas data was missing for an additional 5 patients) and 8 patients in the hospital acquired group was not available (2 Patients were discharged and 1 patient died prior to a positive test result being reported, whereas data was missing for an additional 5 patients). 64 patients in the community acquired group had RT-PCR diagnosed COVID 19 prior to being admitted to the hospital.

^l Mann Whitney U Test

and 60 for the HA cohort. The median age of individuals admitted to ICU was 59 years (IQR 22.5), compared to 78 years (IQR 18) of those that were not admitted to the unit ($P < 0.0001$, Mann Whitney U test). The median length of stay in ICU was 9.5 days overall, 10 days for the CA cohort compared to 7 days for the HA cohort. The proportions of each group requiring invasive mechanical ventilation, renal replacement

therapy and vasopressor support, in addition to those who died, are reported in Table 5. There were no significant differences found between the cohorts for either of these parameters.

From all of the participants in this study, 163 (33%) had unfortunately died-this included 116 (34%) of the CA cohort and 47 (32%) of the HA cohort. The majority (96%) of these patients were affected by

this outcome during their inpatient stay in the hospital. There were no statistically significant differences found between the cohorts for this outcome.

The median post-discharge follow-up was 61 days for all 328 patients discharged alive before the end of the study period- 62 days for the CA cohort, and 55 days for the HA cohort ($P = 0.02$, Mann Whitney *U* Test).

The length of hospital stay was assessed as a clinical outcome for 474 patients in total- 332 in the CA cohort and 142 in the HA cohort. The median number of days for length of hospital stay was 10 overall- 7 days for the CA cohort compared to 28 days for the HA cohort ($P < 0.0001$, Mann Whitney *U* Test).

The time from symptom onset to hospital discharge was a clinical outcome assessed in this study for 461 patients (322 in the CA cohort and 139 in the HA cohort). It should also be noted that 64 patients in the CA cohort had RT-PCR diagnosed COVID 19 prior to being admitted to the hospital. The median value for symptom onset to hospital discharge was 8 days for all assessed patients- 7 days for those assessed in the CA cohort compared to 11 days for those assessed in the HA cohort ($P = 0.0002$, Mann Whitney *U* Test).

The time to death after symptom onset was a clinical outcome assessed in this study for 160 patients (114 in the CA cohort and 46 in the HA cohort). The median value was 7 days for all patients assessed for this outcome- 7 days for those assessed in the CA cohort versus 8.5 days for those assessed who were in the HA cohort. The difference observed between the cohorts for this outcome was not statistically significant.

4. Discussion

We report here a comparative analysis of the characteristics and outcomes of all patients admitted to two regional teaching hospitals during a two-month period, encompassing the peak of the COVID-19 outbreak in the United Kingdom. To our knowledge, no comparison has been documented in the literature of community-acquired and hospital-acquired COVID-19.

4.1. Patient population

The overall demographics in terms of gender are congruent with previous studies reported in China, the United States, and the UK, in that more men are represented in this sample of hospitalised patients [3–5]. Although no statistically significant differences in gender or ethnicity were noted, a disparity was evident in the age of the patients between the CA and HA cohorts. The overall age of this study's cohorts differs significantly from that reported elsewhere internationally [5]. The CA group represented a significantly younger cohort with a median age of 75 years, compared to a HA group median age of 80 years. Advancing age has been described as a negative prognostic factor in myriad studies [6–8]. The CA population age is more congruent with hospitalised UK populations that have been previously reported in the literature [3], whereas the HA population represents an older, more unorthodox demographic of COVID-19 patient not previously documented separately. In clinical practice however, this age disparity may have limited relevance.

4.2. Nature of the disease

The presence of fever and respiratory symptoms in the majority of patients is consistent with the classical findings of COVID-19. A significant discrepancy is however noted between the CA and the HA group where the HA cohort displayed less cough, vomiting, expectoration, fever and breathlessness. It is evident that all symptoms are less prevalent in the HA cohort, although not all reach the threshold for statistical significance. This could be indicative of the possibility of less symptomatic disease or a failure of adequate documentation of patient symptomatology. It is important to note that the CA cohort of individuals are included in this study as they were deemed to have a

degree of disease severity warranting the need for hospital admission. The HA cohort on the other hand, were not admitted based on the degree of severity of COVID-19, rather due to other medical reasons. The literature has already highlighted that up to 40% of patients have mild symptoms, it is thus reasonable to hypothesise that a proportion of patients in the HA cohort may have mild disease that may not warrant admission if evaluated via the same medical scrutiny as the CA group [9]. Furthermore, the HA cohort would have a greater propensity of undergoing screening due to the much greater access and higher indices of suspicion present in a hospital environment.

More evidence indicative of this is present when the laboratory findings are analysed. The CA group presents a clinical picture of a more severe inflammatory response with a significantly greater elevation in inflammatory markers apparent in a significantly greater proportion of patients. The HA group, on the other hand, presents a picture resembling a heavy chronic disease burden as there is significant anaemia and hypoalbuminaemia. The presence of a lower overall BMI and more prevalent hypertension in this cohort further support this. These parameters are consistent with that of a chronically ill, undernourished and heavily co-morbid hospitalised population as highlighted in multiple studies [10–17]. In association with advanced age, this may indeed be an indicator of the much higher prevalence of DNAR orders for patients in the HA group. In the UK, DNAR orders are most often put in place for patients of increasing age, extensive co-morbidities, adverse prognostic factors, poor quality of life, as well as a low likelihood of successful cardio-pulmonary resuscitation [18].

4.3. Interpretation of clinical outcomes

Despite the aforementioned characteristics indicative of the HA population having poorer baselines with more features suggestive of a poorer prognosis and a much greater proportion of DNAR orders, the mortality rate remains statistically insignificant between the two groups (34% in the CA group and 32% in the HA group). The rates of mortality from COVID-19 vary considerably across the globe and are highly dependent on factors such as age and co-morbidities [19]. Additionally, the HA group also received minimal ICU therapy, 3% versus 10% of the CA group. This is in sharp contrast, both in isolation and in combination, to the ICU admission rates reported in Italy and the United States [4, 20–22]. The combined mortality rate for ICU patients also happens to be lower when compared to numerous studies from the United States [4, 20, 23]. This may, in part, be due to a robust method of selecting patients with the highest chance of benefit from ICU care as is evident by the much lower ICU admission rate in the less "fit" HA cohort as compared to the CA cohort, all the while the median age of the patients admitted to the ICU is significantly lower when compared to the overall for the entire study, with no statistically significant differences between the CA and HA cohorts in this regard. However, the prospect of the HA group suffering from a milder form of COVID-19 in association with early hospital detection should not be overlooked when interpreting this data.

4.4. Limitations

There are several limitations to this study that must be mentioned. Firstly, this study was a retrospective analysis of electronic patient records and thus not all laboratory tests were performed on all patients and robust representation of symptomatology was not guaranteed as errors could be present in both patient recall and clinical documentation. Secondly, despite the relatively similar prevalence of major cardiac, respiratory and renal conditions between the groups, a further investigation into the degree of severity of these conditions would have been beneficial in further classifying the co-morbid status of the cohorts, particularly with use of verified scoring systems. Thirdly, the study population was only inclusive of patients in the UHMB catchment area which represent a less ethnically diverse and more elderly population as

compared to the United Kingdom as a whole [24].

5. Conclusions

The fact that up to 31% of patients hospitalised with COVID-19 developed the disease as an inpatient is a thought-provoking phenomenon that must be used to inform further research. The similarities and differences highlighted in this study of CA and HA patients should be taken into consideration when reporting future studies of COVID-19. A more stratified approach to the description of results may present clearer associations with regard to clinical, biochemical and prognostic factors. In conclusion, hospital-acquired and community-acquired COVID-19 result in similar rates of mortality despite significant differences in baseline characteristics of the respective patient populations.

Conflict of interest declaration

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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CRediT authorship contribution statement

Haaris A. Shiwani: Data curation, Formal analysis, Writing - review & editing, conceived the idea, searched the literature, designed the study, collected the data, analysed the results, and wrote and reviewed the manuscript. **Muhammad Bilal:** Data curation, Formal analysis, Writing - review & editing, conceived the idea, searched the literature, designed the study, collected the data, analysed the results, and wrote and reviewed the manuscript. **Muhammad U. Shahzad:** Data curation, Formal analysis, Writing - review & editing, conceived the idea, searched the literature, designed the study, collected the data, analysed the results, and wrote and reviewed the manuscript. **Alson Rodrigues:** Data curation, Writing - review & editing, collected the data and reviewed the manuscript. **Jehad A. Suliman:** Data curation, Writing - review & editing, collected the data and reviewed the manuscript. **Muhammad Soban:** Data curation, Writing - review & editing, collected the data and reviewed the manuscript. **Shahzeb Mirza:** Data curation, Writing - review & editing, collected the data and reviewed the manuscript. **Nicoleta Lotca:** Data curation, Writing - review & editing, collected the data and reviewed the manuscript. **Mohammed R. Ruslan:** Data curation, Writing - review & editing, collected the data and reviewed the manuscript. **Danyal Memon:** Formal analysis, Writing - review & editing, searched the literature, analysed the results, and wrote and reviewed the manuscript. **Muhammad A. Arshad:** Formal analysis, Writing - review & editing, searched the literature, analysed the results, and wrote and reviewed the manuscript. **Kiran Fatima:** Formal analysis, Writing - review & editing, searched the literature, analysed the results, and wrote and reviewed the manuscript. **Asma Kamran:** Formal analysis, Writing - review & editing, searched the literature, analysed the results, and wrote and reviewed the manuscript. **Emmanuel E. Egom:** Formal analysis, Writing - review & editing, conceived the idea, designed the study, analysed the results and reviewed the manuscript. **Abdul Aziz:** Formal analysis, Writing - review & editing, conceived the idea, designed the study, analysed the results and reviewed the manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.rmed.2021.106314>.

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