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Original Research Article

Insights into the Epidemiology of the First Wave of COVID-19 ICU Admissions in South Wales – the Interplay between Ethnicity and Deprivation

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Abstract: On the 9th March 2020, the first patient with COVID-19 was admitted to ICU in the Royal Gwent Hospital, Newport, Wales. We prospectively recorded the rate of ICU admissions of 52 patients with COVID-19 over 60 days, focusing on the epidemiology of ethnicity and deprivation.

Patients were 65% (34 of 52) male and had a median (IQR) age of 55 (48-62) years. Prevalent comorbidities included obesity (52%); diabetes (33%), and asthma (23%). COVID-19 hospital and ICU inpatient numbers peaked on days 23 and 39, respectively – a lag of 16 days. The ICU mortality rate was 33% (17 of 52).

Black, Asian and Minority Ethnics (BAME) population represented 35% of ICU COVID-19 admissions (18 of 52) and 35% of deaths (6 of 17). Within the BAME group, 72% (13 of 18) were found to reside in geographical areas representing the 20% most deprived in Wales, versus 27% of Caucasians (9 of 33).

Less than 5% of the population within the hospital catchment area are of BAME descent, yet they represent a disproportionately high proportion of patients with ICU admission and mortality suffering from COVID-19. The interplay between ethnicity and deprivation, which is complex, may be a factor in our findings. This in turn could be related to an increased prevalence of co-morbidities; higher community exposure; or genetic polymorphisms.

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1. **Introduction:** SARS-CoV-2 infection, originating from Wuhan, China is the underlying cause of COVID-19 disease [1]. The pandemic reached Italy in February and caused significant strain on the Lombardy critical care units [2]. The first known patient with SARS-CoV-2 infection was discovered in Wales on the 2nd March 2020. The first COVID-19 patient admitted to an ICU in Wales was admitted to the Royal Gwent Hospital (RGH) in Newport on the 9th March. Heeding the warning from Italy, the RGH moved early to cancel elective activity and prepare for the surge of admissions [3].

The RGH in Aneurin Bevan University Health Board (ABUHB) is the major specialist centre, which provides acute secondary services to a population of approximately 400,000 people. RGH is situated in Newport, Gwent and its catchment area has the highest number of deprived lower super output areas (LSOA) compared to any other Welsh hospital according to the 2011 Census data from the Office of National Statistics (ONS).

We have previously reported that social deprivation is an independent risk factor of long-term outcome following critical care discharge [4]. Social deprivation is often linked to reduced access to healthcare and this has been a particular problem amongst the Black, Asian and Minority Ethnic (BAME) group. During the first wave of the COVID-19 pandemic, data emerged which indicated that BAME people are at higher risk of ICU admission and death with COVID-19 [5]. In this case-series analysis we report the epidemiology of the first wave of COVID-19 patients in South-East Wales admitted into ICU, and describe the connection between ethnicity and social deprivation using data from the first 60 days of the COVID-19 pandemic in the RGH.

2. Methods:

2.1 Conceptualisation and Approval

Our prospective service evaluation on the ICU was developed before the first patient with COVID-19 was admitted. We collected anonymised data, including postcode in order to place the patients in their respective LSOA. The ABUHB Risk Review Committee approved the project and waived the need for written informed consent.

2.2 Setting

RGH is a medium-size district general hospital with 800 inpatient beds in Newport, South Wales. The critical care unit is normally a 16-bedded combined ICU and HDU located in two areas on the same floor, admitting both invasively ventilated patients and patients needing other organ support. During the COVID-19 surge, the critical care capacity has been upscaled to a 40 bedded ICU spanning three separate areas with relaxed nurse-to-patient ratios. All patients with suspected or confirmed COVID-19 disease were enrolled in a multicentre clinical trial as appropriate. We have not used any novel disease modifying agents or therapies outside these clinical trials.

2.3 Data Sources

Data on COVID-19 patients admitted to the ICU was collected prospectively from 9th March 2020 (day 1) to the 7th May 2020 (day 60). COVID-19 was defined as confirmed (respiratory failure and radiological changes with SARS-CoV-2 RNA detected on PCR testing), or suspected (respiratory failure and radiological changes consistent with COVID-19 but without a confirmed PCR test result). We recorded patient age; sex; BMI; ethnicity; postcode; need for any assistance with daily activities; APACHE II score; time from hospital admission to ICU, and ICU mortality. Background data on ethnicity within RGH catchment area was obtained from the ONS.

To put the ICU admissions into context and to aid in national comparisons, we utilised the daily situation report data from the Welsh Government Acute Secondary Care COVID-19 Group, available from the 23rd March 2020 (day 16) onwards. This administrative data summarised the daily patient admissions and discharges, including the COVID-19 related deaths reported in each Welsh hospital. Deprivation was defined by the Welsh Index of Multiple Deprivation (WIMD) quintiles from the ONS. Patients' postcodes were plotted in their corresponding LSOAs using the interactive online WIMD map tool at https://wimd.gov.wales/.

Data is summarised as absolute numbers or percentages and median and interquartile range as appropriate.

3. Results

3.1 Overview

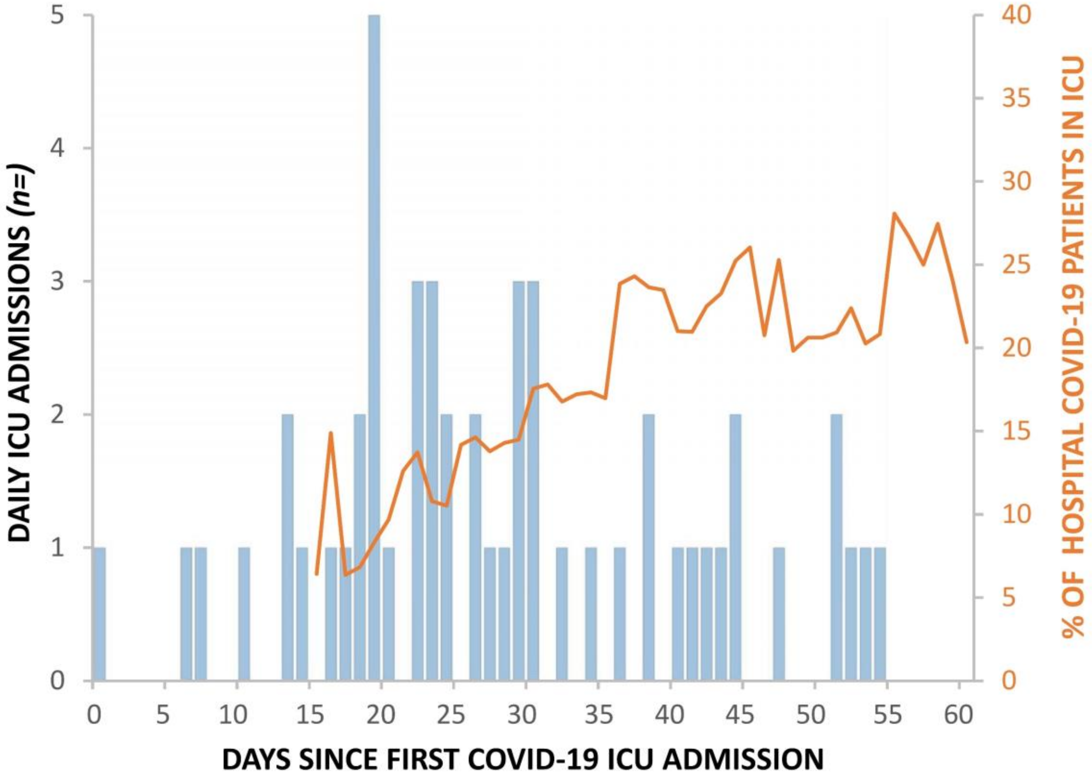
Between 9th March 2020 (day 1) and 7th May (day 60), 52 patients (46 confirmed and 6 suspected) with COVID-19 disease were admitted to the ICU. All patients were mechanically ventilated on admission. Table 1 describes the demographics of the 52 patients admitted to the ICU. One out of 52 patients needed assistance with daily activities of living before admission. Figure 1 shows the daily ICU admission figures from 9th March and their relation to the total number of patients in the hospital with COVID-19 disease from 23rd March onwards (day 15).

Table 1. Demographics of COVID-19 ICU patients. Values are median (IQR) or number (proportion).

	Patients (n = 52)
Age; years	55 (48-62)
Gender	
Female	18 (34.6%)
Male	34 (65.4%)
APACHE II score on admission	12 (10-15)
Hospital admission to ICU time; days	1.32 (0.36-3.66)
Ethnicity	
White	34 (65.4%)
Mixed	0 (0.0%)
Asian	12 (23.1%)
Black	3 (5.8%)
Other	3 (5.8%)
Wales Index of Multiple Deprivation	
Quintile 1 – least	6 (11.5%)
Quintile 2	7 (13.5%)
Quintile 3	11 (21.2%)
Quintile 4	5 (9.6%)
Quintile 5 – most	22 (42.3%)
Common comorbidities	
Essential hypertension	18 (34.6%)
Diabetes (type 1 and 2)	17 (32.7%)
Asthma (all severities)	12 (23.1)
Ischaemic heart disease	4 (7.7%)
Chronic kidney disease	2 (3.8%)
BMI	

18.5-<25	6 (11.5%)
25-<30	17 (32.7%)
30-<40	24 (46.2%)
40+	3 (5.8%)
Unknown	2 (3.8%)

Figure 1. Daily ICU COVID-19 admissions (blue bars) alongside corresponding percentage of total hospital COVID-19 inpatients in ICU (orange line)



3.2 Surge Capacity

The RGH critical care unit went into surge capacity on the 28th March, 20 days after the first admission with COVID-19 and remained in surge capacity for 40 days (Figure 2). Ward inpatient numbers peaked on the 31st March (day 23) while ICU numbers peaked, after a 16 day lag, on the 16th April (day 39), when calculated using a seven-day moving mean across the 60 day study. Figure 3 demonstrates how the first patient was discharged alive on the 25th March, 17 days following the first admission with COVID-19, while the first death occurred on the 31st March (day 23).

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Figure 2. Change in daily inpatient numbers in RGH: COVID-19 ward numbers (black line), COVID-19 ICU numbers (blue line), and total ICU numbers (yellow line). Pre-pandemic surge capacity threshold for invasively ventilated ICU patients (red dashed line); upscaled pandemic threshold for invasively ventilated patients (green dashed line).

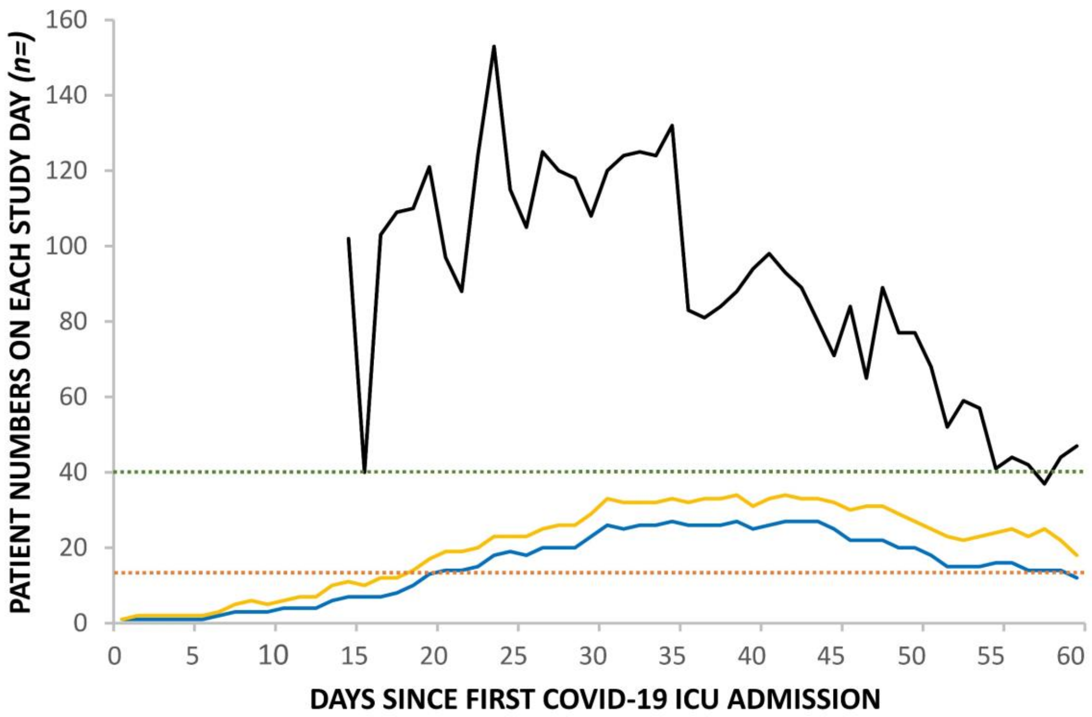
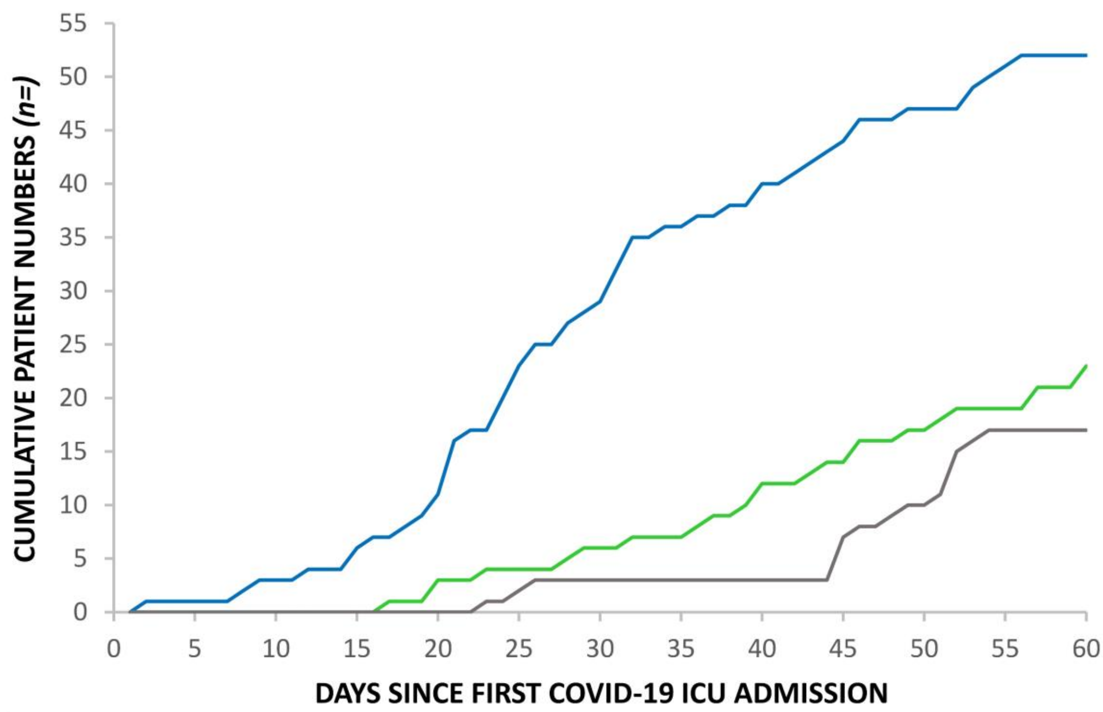


Figure 3. Cumulative admissions, discharges and deaths to RGH ICU: COVID-19 ICU admissions (blue line), COVID-19 ICU discharges (green line) and COVID-19 ICU deaths (grey line).



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3.3 Ethnicity, Admissions and Mortality

We contrasted the admission and death rates of ICU of patients in the Caucasian and BAME subgroups to their local representation in the 2011 census of the RGH catchment area background population (Table 2). Asians/British Asians had the highest ICU admission rate (116.4 per 100,000) and ICU death rate (48.5 per 100,000) of any ethnic group, compared to Caucasians at 8.6 per 100,000 ICU admissions and 2.8 per 100,000 ICU deaths.

Table 2. COVID-19 ICU admissions and mortality by ethnicity – Causasian subgroup and BAME (Black, Asian, Ethnic minority) subgroup. Values are numbers (proportion).

	RGH Catchment Area – Background Population (n = 415,617)	**RGH ICU – Covid-19 Patients**	
		Admissions (n = 52)	**Mortality (n = 17)**
Caucasian	396,101 (95.3%)	34 (65.4%)	11 (64.7%)
BAME:	19,516 (4.7%)	18 (34.6%)	6 (35.3%)
Mixed	4,529 (1.1%)	0 (0.0%)	0 (0.0%)
Asian/Asian British	10,309 (2.5%)	12 (23.1%)	5 (29.4%)
Black/Black British	2,964 (0.7%)	3 (5.8%)	1 (5.9%)
Other	1,732 (0.4%)	3 (5.8%)	0 (0.0%)

3.4 Ethnicity and Deprivation

In terms of deprivation, 9 out of 33 patients (27%) in the Caucasian group compared to 13 of 18 patients (72%) in the BAME group, lived in areas in the bottom quintile of the WIMD (most deprived). The Asian/British Asian subgroup had the highest proportion, 11 of 13 (85%), within the bottom quintile. The absolute number of deaths was highest in the bottom quintile for both Caucasian and BAME patients. More patients died in the BAME group within the bottom quintile: 4 of 6 deaths versus 3 of 11 deaths in the Caucasian group. Figure 4 shows the interplay between socioeconomic deprivation, ethnicity and outcome.

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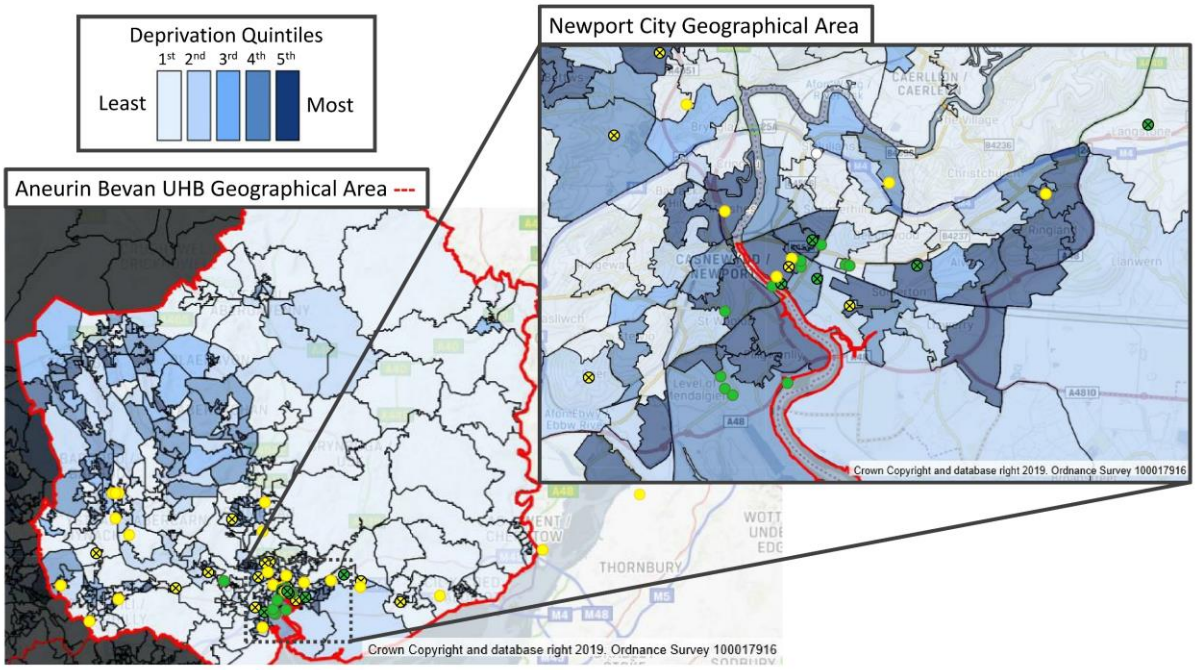
Figure 4. Ethnicity, deprivation and COVID-19 ICU admissions from the RGH ICU catchment area**:** postcodes of COVID-19 ICU individual patients, plotted on a map of "Welsh Index of Multiple Deprivation" (WIMD) quintiles, indicating ethnicity and ICU outcome. Caucasian (yellow circles); BAME (green circles); survivor (open circles); deceased (crossed circles).



4. Discussion

During the first wave of the COVID-19 pandemic, we found that patients from the BAME group are at significantly higher risk of ICU admission and death from COVID-19. Although the hospital's catchment area covers an overwhelmingly white ethnic population, over a third of the admissions to the critical care unit were from the BAME group. Notably, we observed a significant interplay between deprivation and ethnicity.

The lag behind the peak of hospital admissions and the peak of ICU admissions provides an important buffer and could be used in future modelling of ICU capacity for anticipated further waves of COVID-19 outbreaks. We have further observed a sharp decline in hospital admissions, but a much slower return to normal number of patients cared on the ICU after the stricter lockdown measures were implemented in Wales. This is in part explained by our long ICU length of stay for both survivors and non-survivors.

As our patient population was relatively young, with fewer comorbidities and frailty than the Welsh average, we have opted for keeping active treatment as long as feasible in a bid to improve outcomes [3,6]. Wales have significantly lower number of critical care beds compared to England or the rest of Western Europe, a shortage which has been known for over 20 years [3,7]. Despite increasing ICU surge capacity to 9.0/100,000 population from a baseline of 4.2/100,000, and thereby reaching the pre-surge level in Lombardy, initial estimations of excess death from COVID-19 predicted that the Welsh ICU capacity could be a limiting factor in the response [2,8].

Fortunately, the lockdown measures reduced the pressures on critical care capacity and allowed critical care units to manage their surge capacity, albeit with relaxed nurse-to-patient ratios. Despite initial concerns that critical care units may be overwhelmed with admissions, there were no ethical dilemmas of having to triage patients out of the ICU required [9]. Despite the operational difficulties, RGH mortality figures compare favourably with others reported in the international literature and in the UK [10-11].

At the beginning of the pandemic wave, critical care patients represented approximately 10-15% of the patients admitted to hospital, however after day 35, when the lockdown started to curb the number of hospital admissions, this had doubled. The reducing number of patients on the general wards enabled the redeployment of staff to the much higher work-intensity areas, including the ICU. This flexibility helped to maintain operational capabilities even when the RGH reached over 250% of conventional ICU occupancy levels [12].

The higher risk of death in the BAME group and in patients living in the most deprived areas of the country has been highlighted recently in the UK [4]. The weekly analysis of the data supplied to the Intensive Care National Audit and Research Centre (ICNARC) showed that Asian ethnic origin and living in an area at the bottom quintile of the deprivation index scale are both independently associated with mortality [13]. Our results are in agreement with the findings of these reports.

Furthermore, we postulate that BAME status and social deprivation may have a synergistic effect in our population. It has been known that in the UK, the BAME population are more likely to have comorbidities associated with higher susceptibility for severe COVID-19 disease such as diabetes and hypertension. They also are more likely to live in multi-generational households, and to be employed in lower band key-worker roles [13].

The risk of adverse health events, ICU admission and death are thought to be higher in people living in more deprived areas and this has been indicated in England and more recently in our study in Wales [3,14]. Interestingly international comparisons do not support this, notably in France multiple studies have shown no adverse association with low socioeconomic status and initial severity of illness on ICU admission or long-term outcome [15-16]. Currently, there is no definitive data on this subject in relation to COVID-19 disease.

Based on previously published data from England and evaluating mortality figures up to the end of April 2020, Razaq et al proposed a risk matrix to evaluate the risk of increased vulnerability due to SARS-CoV-2 exposure in the BAME group [13]. Interestingly, most of our patients admitted to the ICU were in the low risk group: aged between 30-69 and living in a multigenerational household.

Our data indicates that low socio-economic status in the BAME group disproportionately increases the risk of ICU admission and death from COVID-19. The exact mechanisms for this increased risk and vulnerability from COVID-19 are not clear. There has been speculation that this may be due to the higher prevalence of particular health conditions, such as cardiovascular disease or diabetes, or predisposing factors such as low vitamin D levels, among the BAME population. The findings of the OpenSAFELY collaborative, based on 17 million adult patients in England with more detailed primary care data, show that this is only a small part of the excess risk [17]. Increased susceptibility for SARS-CoV-2 infection in BAME people due to genetic polymorphism of the ACE-2 gene has also been postulated, however this will need to be confirmed in large multi-centre studies such as the one run by the ISARIC 4C Collaborators [18-19].

Our results suggest that poorer outcomes in BAME people in COVID-19 disease may be due to exposure risks in the community, which are over-represented in lower socio-economic groups. This may include higher household density with increased risk of transmission due to the lockdown, or disproportionate employment in lower band key worker roles, who either work in high exposure care environments or are unable to implement safe social distancing due to their roles.

There are significant limitations to our study: the sample size is limited and our findings might be unique to the significantly over-represented low socio-economic areas within the RGH catchment area. The small sample size also precludes more sophisticated analysis beyond simple descriptive statistics. There also might be selection bias, due to the admission policies of the ICU, however, criteria for admission into ICU have not been based on race or age. It is still possible that change in referral threshold from the other primary and secondary care providers have changed the case-mix of our population. However, comparison with the national ICNARC report suggests our

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case-mix is similar to elsewhere in the UK, when looking at patient factors other than socio-economic deprivation, and our findings could be extrapolated to other areas [11].

We could not compare ethnicity between hospitalised patients and those who were admitted to the critical care unit as this information has been generally poorly recorded in the hospital information system. To date there is no reliable information in the UK to corroborate our data presented here.

5. Conclusions

In conclusion we report that the first 52 patients with suspected and confirmed COVID-19 admitted to the Royal Gwent Hospital ICU has significantly stretched the critical care capacity, and it appears that the effect of the lockdown prevented the health service from being overwhelmed beyond the surge capacity created in preparation for the COVID-19 pandemic. We observed a disproportionately higher admission rate and mortality rate amongst the BAME group, and it appears this may be closely linked to socio-economic deprivation which is highly prevalent in the area. Improving access to healthcare, including increasing critical care bed numbers might prevent excess mortality in this population.

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