

Advanced care planning during the COVID-19 pandemic: ceiling of care decisions and their implications for observational data

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Abstract

Background

Observational studies investigating risk factors in coronavirus disease 2019 (COVID-19) have not considered the confounding effects of advanced care planning, such that a valid picture of risk for elderly, frail and multi-morbid patients is unknown. We aimed to report ceiling of care and cardiopulmonary resuscitation (CPR) decisions and their association with demographic and clinical characteristics as well as outcomes during the COVID-19 pandemic.

Methods

Retrospective, observational study conducted between 5th March and 7th May 2020 of all hospitalised patients with COVID-19. Ceiling of care and CPR decisions were documented using the Recommended Summary Plan for Emergency Care and Treatment (ReSPECT) process. Unadjusted and multivariate regression analyses were used to determine factors associated with ceiling of care decisions and death during hospitalisation.

Results

A total of 485 patients were included, of whom 409 (84.3%) had a documented ceiling of care which was level one for 208 (50.9%), level two for 75 (18.3%) and level three for 126 (30.8%). CPR decisions were documented for 451 (93.0%) and 336 (74.5%) were not for resuscitation. Advanced age, frailty, White-European ethnicity, a diagnosis of any co-morbidity and receipt of cardiovascular medications were associated with ceiling of care decisions. In a multivariate model only advanced age (odds 0.89, 0.86-0.93 $p<0.001$), frailty (odds 0.48, 0.38-0.60, $p<0.001$) and the cumulative number of co-morbidities (odds 0.72, 0.52-1.0, $p=0.048$) were independently associated. Death during hospitalisation was independently associated with age, frailty and requirement for level two or three care.

Conclusion

Ceiling of care decisions were made for the majority of patients during the COVID-19 pandemic, broadly in line with known predictors of poor outcomes in COVID-19, but with a focus on co-morbidities suggesting ICU admission might not be a reliable end-point for observational studies where advanced care planning is routine.

Background

In December 2019, acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first identified as the causative agent for a cluster of pneumonia cases in Wuhan City, China.¹ A global pandemic was declared by the World Health Organisation (WHO) in March 2020, which continues to challenge healthcare systems globally. SARS-CoV-2 can result in a spectrum of illness, from asymptomatic infection to coronavirus disease 2019 (COVID-19), a severe viral pneumonia resulting in high rates of hospitalisation,

intensive care unit (ICU) admission and requirement for mechanical ventilation.^{2,3} There has been considerable interest in exploring risk factors for susceptibility to infection and severe disease in COVID-19, with proposed risk factors including age,⁴ cardiovascular co-morbidities (including diabetes mellitus),⁵ medications inhibiting the renin-angiotensin-aldosterone system,⁶ obesity⁷ and ethnicity.⁸ Observational data have resulted in contradictory findings, possibly owing to heterogeneous definitions of what constitutes severe disease, with hospitalisation, ICU admission,^{3,9,10} mechanical ventilation¹¹ or death^{12,13} explored as primary end-points.

The low rate of testing in many countries means that studies have often been limited to hospitalised patients which have not considered the confounding effects of advanced care planning, such that a valid picture of risk factors for severe disease in elderly, frail and multi-morbid populations is unknown. Without accounting for the confounding effects of these decisions, admission to ICU or receipt of mechanical ventilation might be associated with *better* prognosis when compared with conservative management for patients in whom these treatments were considered inappropriate or futile.¹⁴

The aim of this analysis was therefore firstly, to report pre-emptive ceiling of care and cardiopulmonary resuscitation (CPR) decisions in patients admitted with SARS-CoV-2 infection in a large University teaching hospital trust in the UK during the COVID-19 pandemic. Secondly, we aimed to describe the demographic and clinical characteristics associated with ceiling of care decisions, along with reporting their clinical outcomes.

Methods

Patients

We performed a retrospective, observational study to explore factors associated with outcomes in COVID-19 at the Leeds Teaching Hospitals NHS Trust (LTHT), one of the largest University teaching hospitals in Europe, comprising of two large and four smaller facilities providing over 1800 inpatient beds, serving a secondary care population of more than 750,000 people. All patients aged ³18 years with laboratory confirmed SARS-CoV-2 infection hospitalised at LTHT between 5th March and 7th May 2020 were included. Approval was given following institutional governance review and, in view of the retrospective nature, individual patient consent was waived as appropriate data protection safeguards were in place. In keeping with WHO guidance, laboratory confirmation for SARS-CoV-2 was defined as a positive result of real-time reverse transcriptase-polymerase chain reaction assay of nasal or pharyngeal swabs, or lower respiratory tract aspirates.¹⁵ Patients who tested positive, but admitted for other reasons or were infected with SARS-CoV-2 during hospitalisation were excluded, as were those who were assessed but not hospitalised.

Data sources and definitions

Clinical data and outcomes were obtained from the Leeds Patient Pathway Manager Plus electronic care record, which updates mortality events daily directly from the UK Office of National Statistics database. Ceiling of care and CPR decisions were standardised and documented electronically using the Recommended Summary Plan for Emergency Care and Treatment (ReSPECT) process (Resuscitation Council UK).¹⁶ Demographic data include age, sex and ethnicity. Ethnicity was self-reported and classified according to the 2011 Census for England, Northern Ireland and Wales as White-European, South-Asian, East-Asian, Black-African, mixed race and other ethnicities, and for the purpose of analysis was dichotomised as White-European or Black, Asian and minority ethnic (BAME). Clinical data include major co-morbidities, frailty and the prescription of medical therapy. Major co-morbidities were any of: hypertension, diabetes mellitus, chronic kidney disease (CKD) stage III-V, atrial fibrillation, chronic obstructive pulmonary disease (COPD), ischaemic heart disease (IHD), heart failure with reduced ejection fraction (HFrEF), history of stroke or transient ischaemic attack (TIA) and active malignancy. Frailty was classified by the Canadian Study of Health and Aging Clinical Frailty Scale (CFS)¹⁷ according to national recommendations¹⁸. Pre-admission medical therapy was obtained by regular prescription information from electronic primary care records. At the time of hospitalisation, we recorded clinical markers of disease severity including laboratory investigations, chest radiography and the earliest assessment of physiology.

Assessment of outcomes

Outcomes data include treatments administered during hospitalisation, maximum level of care received, and death prior to discharge. Administered treatments were oxygen therapy, continuous positive pressure ventilation (CPAP), mechanical ventilation, circulatory support (vasopressors or inotropes) or new requirement for renal replacement therapy. Level one care was hospitalisation without need for organ support (but including oxygen therapy) and delivered in a ward setting; level two care was single organ support (usually CPAP), but excluding mechanical ventilation, and delivered in either in a ward, high-dependency unit or ICU setting; level three care was multi-organ support or mechanical ventilation and delivered on the ICU.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics version 26 (IBM Corporation, Armonk, NY). After testing for normality of distribution, continuous variables are expressed as mean \pm standard deviation or median (interquartile range), as appropriate. Discrete variables are presented as number (percentage), and ordinal data as median (interquartile range). Groups were compared using Student's t-test or one-way analysis of variance for normally distributed continuous data, by Mann-Whitney U test or Kruskal-Wallis H-test for non-normally distributed continuous data and by Pearson χ^2 tests for categorical data. Age-sex adjusted and multivariate analyses were performed using binary logistic regression analysis. All tests were two-sided and statistical significance was defined as $p < 0.05$.

Results

Patients

Between 5th March 7th May 2020, a total of 599 patients tested positive for SARS-CoV-2 in LTHT and of these, 65 were admitted for reasons other than COVID-19, 38 were not hospitalised, five were aged <18 years and six tests were subsequently amended as negative following quality control. The final dataset therefore consisted of 485 patients, with a mean age of 71.2 ± 16.9 years of whom 259 (53.4%) were male. A total of 109 (22.5%), 130 (26.8%), 105 (21.6%) and 141 (29.1%) had zero, one, two and three or more major co-morbidities, respectively. The most common co-morbidity was hypertension, which was present in 222 (45.8%) patients, whilst 147 (30.3%) had diabetes mellitus (Table 1). Self-reported ethnicity was available for 475 patients (97.9%), of whom 402 (84.6%) classified themselves as White-European, 31 (6.5) as South-Asian, 19 (4.0%) as Black-African, two (0.4%) as East-Asian and 21 (4.4%) as either mixed or other ethnicities.

Ceiling of care and cardiopulmonary resuscitation decisions

Following consultation with patients and their next-of-kin, pre-emptive ceiling of care decisions were documented for 409 (84.3%) patients hospitalised with SARS-CoV-2 infection. Of patients in whom these decisions were made, 208 (50.9%), 75 (18.3%) and 126 (30.8%) patients were deemed suitable for a maximum of level one, two or three care, respectively. Bar charts showing ceiling of care decisions divided by patient demographics are displayed in Figure 1. CPR decisions were made for 451 (93.0%) patients, of whom 336 (74.5%) were deemed not for CPR in event of cardiac arrest, whereas 115 (25.5%) were.

Demographics and clinical characteristics

Patients considered suitable for escalation of treatment were younger, less frail and had fewer major co-morbidities. In unadjusted analysis, age was strongly associated with treatment escalation decisions, most evident in patients over 85 years of age (odds ratio (OR) 0.004, 95% confidence interval (CI) 0.001-0.017, $p < 0.001$). Other variables associated with ceiling of care decisions were higher CFS, lower BMI, a diagnosis of any major co-morbidity, the prescription of cardiovascular medications and White-European ethnicity (Figure 2).

Compared to White-European patients, BAME patients were on average younger (58.0 ± 15.4 vs 73.7 ± 16.0 years, $p < 0.001$), had fewer major co-morbidities (1 (0,2) vs 2 (1,3), $p = 0.037$) and were less frail (CFS 2 (2,4) vs 5 (3,7), $p < 0.001$). When adjusted for age and sex White-European ethnicity was not associated with ceiling of care decisions, nor were there associations between ceiling of care decisions and lower BMI or the prescription of most cardiovascular medications. Associations between a ceiling of care decision of less than level three and frailty, a diagnosis of diabetes mellitus, COPD, CKD, history of stroke or TIA and prescription of loop diuretic or statin remained when adjusted for age and sex. In multivariate regression analysis, predictors of ceiling of care decisions were advanced age (OR 1.1 per year, 95% CI 1.1-1.2, $p < 0.001$) and higher CFS (OR 2.1, 95% CI 1.7-2.7, $p < 0.001$) (Table 2). No other clinical or demographic variables were independently associated with the decision to limit the maximal care level

provided. No individual co-morbidities featured as part of a multivariable analysis although there was a significant association between the cumulative number of major co-morbidities and ceiling of care decisions (OR 1.4 per co-morbidity, 95% CI 1.0-1.9, $p=0.048$) (Table 3).

Clinical markers of disease severity

Patients deemed inappropriate for level three care had on average fewer markers of severe SARS-CoV-2 infection at the time of presentation compared to those who were (Table 4). Laboratory markers of systemic inflammation such as C-reactive protein and serum ferritin were more often abnormal in patients deemed eligible for escalation to level three care, as were assessments of physiology such as respiratory rate, heart rate and tympanic temperature. Chest radiography data were available for 471 (97.1%) patients at the time of hospitalisation of which 217 (44.7%) were reported as consistent with, 151 (31.1%) were indeterminate for and 103 (21.2%) inconsistent with COVID-19. Patients who were considered appropriate for level three care were more likely to have chest radiography consistent with COVID-19 compared to those who were not ($p<0.001$), suggesting a higher severity of disease in these patients.

Treatments administered during hospitalisation

During hospitalisation, a total of 383 (79.0%) patients required oxygen therapy, 88 (18.1%) received CPAP, 38 (7.8%) received mechanical ventilation, renal replacement therapy was used in 11 (2.3%) and 28 (5.8%) patients required inotropes or vasopressors. CPAP was delivered in a ward setting for 6 (6.8%), on the high-dependency unit for 13 (14.8%) and on ICU for 69 (78.4%). All patients who required mechanical ventilation were cared for in an ICU setting. Overall, 92 (19.0%) of patients were admitted to ICU, 61 (81.3%) of whom were deemed suitable for level three care, whilst 14 (18.7%) were suitable for, and received, level two care.

Clinical outcomes

The mean length of hospital admission for patients who had been discharged was 12.7 ± 10.5 days and was 25 ± 11.2 days those who remained in hospital. Following a mean follow-up of 12.6 ± 11.2 days, a total of 307 (63.3%) patients had been discharged, 159 (32.8%) had died and 19 (3.9%) remained in hospital. Despite on average having more markers of disease severity, patients deemed to be suitable for level three care were more likely to be discharged and less likely to have died during hospitalisation ($p<0.001$) (Figure 3). Of the 20 (16%) patients eligible for level three care who died during the study period, all were admitted to ICU and received mechanical ventilation prior to death. Overall, including patients in whom ceiling of care decisions were not documented, 38 (7.8%) received mechanical ventilation during the study period and of these seven (18.4%) had been discharged, nine (23.7%) remained in hospital and 22 (57.9%) had died.

Death during admission was associated with advanced age, White-European ethnicity, higher CFS, a diagnosis of HFrEF, atrial fibrillation, CKD or COPD and the prescription of anticoagulant (Table 5). When

adjusted for age and sex, associations between death during admission and higher CFS remained (OR 1.2, 95% CI 1.1-1.4, $p=0.001$), but not the associations with White-European ethnicity, any major co-morbidity or medication. In a multivariate model including age, CFS and maximum level of care receiving during admission, receipt of level two (OR 2.6, 95% CI 1.1-11.6, $p=0.033$) or level three care (OR 8.1, 95% CI 3.7-17.8, $p<0.001$) were associated with an increased risk of death during hospitalisation.

Discussion

In this study, we present data regarding pre-emptive advanced care planning in patients admitted with SARS-CoV-2 infection during the COVID-19 pandemic according to national recommendations.¹⁸ These decisions were made for the majority of hospitalised patients, who were often elderly, frail and multi-morbid. Advanced age, higher CFS and the accrued number of co-morbidities were independently associated with a decision to limit the ceiling of care below full intensive care treatment (level three). In contrast, only age and frailty were associated with death during hospitalisation, suggesting studies using ICU admission as a primary endpoint and/or measure of disease severity might be confounded by these decisions, which are infrequently available in care records.

Addressing goals of care during the COVID-19 pandemic

Early reports from Wuhan^{10,19,20} and Lombardy² highlighted the risks to patients due to demand for ICU care surpassing surge capacity.^{21,22} Considerable focus on preparedness has therefore included timely and patient-centred pre-emptive discussions, addressing advanced care planning in the setting of a potentially fatal illness which disproportionately affects the elderly and those with underlying health conditions. The priorities of such decisions were to avoid intensive and distressing treatments in patients who would not want to receive them and to manage patients appropriately according to the likelihood of benefit from intensive treatment.²³

Advanced care planning can be challenging for patients and healthcare professionals. It is essential that such discussions occur at an appropriate time and framed within the individual patient's beliefs and wishes.²⁴ At LTHT, establishing and documenting goals of care were assisted by the availability of the ReSPECT process.¹⁶ This simple electronic documentation is standardised across care settings, and is recognised regionally by hospitals, primary care practices and ambulance services and facilitates timely shared decision-making amongst patients, their next-of-kin and surrogate decision makers. Ceiling of care and CPR resuscitation decisions were documented in a high proportion of patients (84.3% and 93.0%) admitted with SARS-CoV-2 infection. Hence, LTHT is well-placed to report on the clinical application of this approach.

The COVID-19 pandemic continues to challenge healthcare systems globally, and has raised important ethical issues, particularly the need to prioritise access to limited resources to those with the greatest chance of survival and anticipated shorter recovery.^{21,23} The majority of our patients were considered inappropriate for escalation of care to an ICU setting, or for CPR. Although this could imply that decisions

were influenced by a drive to protect resources, ICU and ward bed occupancy at LTHT was below surge capacity throughout the study period and a local database monitored and disseminated this information to treating teams daily. Hence, we do not believe that these decisions were influenced by the capacity to provide care. On the contrary, these decisions were more likely to have been made by treating teams following discussions with patients regarding their preferences. The high rate of not-for-resuscitation and ceiling of care decisions therefore probably reflects the demographics and clinical characteristics of our patients who were often elderly, frail and multi-morbid. Furthermore, in a multivariate model adjusted for age and CFS, receipt of level two or three care were associated with an increased risk of death, reflecting baseline differences in disease severity in patients who were considered appropriate for intensive treatments. It is feasible, however, that a more challenging environment including the requirement for appropriate personal protective equipment prior to CPR, risks of transmission to healthcare professionals²⁵ and the limited effectiveness of cardiopulmonary resuscitation in the setting of COVID-19²⁶ may have influenced these decisions.

Demographic and clinical characteristics and their association with ceiling of care decisions

In response to the appreciation that a high proportion of patients admitted with SARS-CoV-2 infection were elderly and frail, and therefore potentially unlikely to benefit from intensive treatments, even in the absence of COVID-19 infection, in March 2020 the National Institute for Health and Care Excellence (NICE) produced guidance that included the CFS as an adjunct to assist in discussions with patients and carers around advanced care planning and suitability for ICU care in the event of deterioration.¹⁸ The CSF is a nine point scale, originally designed in an epidemiological setting, which provides healthcare professionals with a simple screening tool for measuring frailty. The CSF has been validated in frail patients receiving ICU care, in which it reliably predicts outcomes^{27,28} In our patients, frailty was a strong predictor of ceiling of care decisions, which is likely to reflect both the known poor prognosis in frail patients receiving ICU and also the aforementioned national recommendations. As would be expected, advanced age was strongly associated with these decisions, with patients aged over 85 years being far more likely to be deemed eligible for level three care compared to those under 65 (OR 0.004, 95% CI 0.001-0.017, $p < 0.001$).

BAME patients were more likely than White-European patients to be considered appropriate for level three care (OR 5.7, 95% CI 3.1-10.4, $p < 0.001$), however they were on average younger, had fewer co-morbidities and were less frail. In age-sex adjusted analysis, ethnicity was not associated with ceiling of care. These observations are relevant to observational data from the UK and elsewhere with White-European patients being on average older.

ICU admission *per se* is not a reliable marker of severe disease when advanced care planning is routine

Studies investigating risk factors in COVID-19 have often classified ICU admission as a marker of severe disease, either in recognition of poor outcomes in these patients or where mortality data were not yet available. For example, a population based study in the UK found that the receipt of an angiotensin-

converting enzyme inhibitor (ACEi) or angiotensin-II-receptor blocker (ARB) were associated with a reduced risk (except in Black-African patients).⁹ However, these observations have not been confirmed in studies restricted to patients already on ICU in which death was the primary end-point.^{29,30} In our patients, prescription of ACEi (but not ARB) was associated with reduced likelihood of being considered appropriate for level three care, but was not associated with an increased risk of death during hospitalisation. These observations may be a result of biases introduced by pre-emptive ceiling of care decisions where those with co-morbidities are not considered for ICU care, and the relative risk of severe disease appears less where this definition is applied. In our patients, admission to ICU was guided by these pre-emptive decisions in addition to severity of disease, however, the setting of care was not consistent for all patients. For example, some patients who were deemed inappropriate for mechanical ventilation received CPAP in an ICU setting, whilst others received these treatments in a ward or high-dependency unit.

A further paradox revealed by our data is that whilst patients deemed appropriate for level three care were more unwell at presentation, as evidenced by more abnormal laboratory values, chest radiography and physiological assessment, when compared to patients suitable for level one or two care, outcomes were favourable with the vast majority surviving until discharge. In our analysis, all those patients deemed appropriate for level three care who then died, did so following escalation of their care to an ICU setting and mechanical ventilation. Overall 14 (18.7%) of patients deemed eligible for level two and 61 (48.8%) of those deemed eligible for level three care were admitted to an ICU setting allowing for delivery of key treatments for COVID-19 of CPAP and mechanical ventilation. Including patients in whom ceiling of care decisions were not made, 38 (7.8%) patients received mechanical ventilation. This rate was low compared to earlier reports from Wuhan and Lombardy, but similar to contemporary reports from the UK.⁷ Despite an average age of 57.8 ± 13.2 years, more than half of these patients had died at follow-up, with fewer than one in five having a successful discharge and, at the time of reporting, almost a quarter still in hospital. It might therefore be reasonable to regard mechanical ventilation as a marker of severe disease in patients who remain in hospital at the time of censorship, due to the poor prognosis in this group.

Strengths and limitations

This is an analysis of a carefully characterised cohort of consecutively admitted patients with SARS-2-CoV infection in whom standardised documentation of ceiling of care decisions was routine and completed in the majority of cases. The principle limitations are inherent to the retrospective design and single centre setting, and our findings should be interpreted in light of this. Recommendations to assist treating teams making ceiling of care decisions were available;¹⁸ however these have not been validated in COVID-19, nor are there randomised data supporting their use and it is important to recognise that there is a risk of undertreatment with this approach. These decisions were not standardised, rather they were made following discussion between patients, their next-of-kin and surrogate decision makers regarding their goals of care. The availability of ICU beds,³¹ demographic and cultural differences between

countries may limit the generalisability of our findings. Finally, the follow-up time is relatively short and outcomes data were therefore not available for patients who remained in hospital.

Conclusions

To our knowledge, this study is the first to report ceiling of care and CPR decisions during the COVID-19 pandemic and their association with demographic and clinical characteristics. Decisions were made broadly in line with known predictors of poor outcomes in COVID-19, but with a focus on co-morbidities suggesting ICU admission might not a reliable endpoint for observational datasets aiming to explore risk factors of severe disease, with those at the greatest risk of death being the least likely to receive intensive treatments.

Declarations

Ethical approval

Approval was given following institutional governance review and, in view of the retrospective nature, individual patient consent was waived as appropriate data protection safeguards were in place.

Consent for publication

Not applicable.

Availability of data and materials

The data are available from the corresponding author upon reasonable request.

Competing interests

There are no competing interests for any of the authors.

Funding

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Authors contributions

SS and KKW conceived the study.

SS, MD, TAS, AC, SK, AOK, MP, PAP, NW and RB collected the data.

SS, SDR and RC undertook statistical analysis.

SS, MM and KKW produced the first version of the manuscript.

JG, RC and MTK provided critical revision of the manuscript.

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Abbreviations

SARS-CoV-2 – acute respiratory syndrome coronavirus 2

WHO – World Health Organisation

COVID-19 – coronavirus disease 2019

ICU – intensive care unit

CPR – cardiopulmonary resuscitation

LTHT – Leeds Teaching Hospitals NHS Trust

ReSPECT – Recommended Summary Plan for Emergency Care and Treatment BAME – Black-Asian-Minority-Ethnic

CKD – chronic kidney disease

COPD – chronic obstructive pulmonary disease

IHD – ischaemic heart disease

HFrEF – heart failure with reduced ejection fraction

TIA – transient ischaemic attack

CFS – Clinical Frailty Scale

CPAP – continuous positive airways pressure

OR – odds ratio

CI – confidence interval

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Tables

Table 1

Title: Baseline clinical characteristics of patients divided by ceiling of care decisions.

	All patients (n = 409)	Level 1 (n = 208)	Level 2 (n = 75)	Level 3 (n = 126)	p-value
Demographics					
Age (years)	73.1 ± 15.3	81.9 ± 9.4	75.4 ± 9.9	57.6 ± 12.8	< 0.001
Male sex [n(%)]	211 (54)	103 (49.5)	43 (57.3)	75 (59.5)	0.17
BMI (kg/m ²)	26.3 (22.1–30.8)	23.2 (20.5–27.1)	27.6 (22.0–31.8)	29.4 (25.8–34.0)	< 0.001
BAME [n(%)]	56 (13.7)	12 (5.8)	8 (10.7)	36 (28.6)	< 0.001
Clinical Frailty Scale	5 (3–6)	6 (5–7)	4 (3–5)	2 (2–3)	< 0.001
Co-morbidities					
HFrEF [n(%)]	51 (12.5)	34 (16.3)	13 (17.3)	4 (3.2)	0.001
IHD [n(%)]	62 (15.2)	39 (18.8)	15 (20.0)	8 (6.3)	0.004
Hypertension [n(%)]	191 (46.7)	99 (47.6)	44 (58.7)	48 (38.1)	0.017
AF [n(%)]	87 (21.3)	60 (28.8)	17 (22.7)	10 (7.9)	< 0.001
Diabetes mellitus [n(%)]	125 (30.6)	67 (32.2)	32 (42.7)	26 (20.6)	0.004
Stroke/TIA [n(%)]	48 (11.7)	34 (16.3)	10 (13.3)	4 (3.2)	0.001
CKD [n(%)]	103 (25.2)	69 (33.2)	29 (38.7)	5 (4.0)	< 0.001
COPD [n(%)]	64 (15.6)	41 (19.7)	16 (21.3)	7 (5.6)	0.001
Malignancy [n(%)]	33 (8.1)	22 (10.6)	7 (9.3)	4 (3.2)	0.050
Medications					
ACEi [n(%)]	74 (18.1)	30 (14.4)	23 (30.7)	21 (16.7)	0.007
ARB [n(%)]	32 (7.8)	10 (4.8)	8 (10.7)	14 (11.1)	0.069
BB [n(%)]	99 (24.2)	61 (29.3)	22 (29.3)	16 (12.7)	0.001
CCB [n(%)]	68 (16.6)	27 (13.0)	20 (26.7)	21 (16.7)	0.024
Loop diuretic [n(%)]	64 (15.6)	50 (24.0)	12 (16.0)	2 (1.6)	< 0.001

BMI; body mass index, BAME; Black Asian and minority ethnic, BMI; body mass index, HFrEF; heart failure with reduced ejection fraction, IHD; ischaemic heart disease, AF; atrial fibrillation, CKD; chronic kidney disease, COPD; chronic obstructive pulmonary disease, ACEi; angiotensin converting enzyme inhibitor, ARB; angiotensin II receptor blocker, BB; beta-adrenoceptor antagonist, CCB; calcium channel blocker, MRA; mineralocorticoid receptor antagonist.

	All patients (n = 409)	Level 1 (n = 208)	Level 2 (n = 75)	Level 3 (n = 126)	p-value
MRA [n(%)]	16 (3·9)	11 (5·3)	3 (4·0)	2 (1·6)	0·24
Statin [n(%)]	171 (41·8)	85 (40·4)	49 (65·3)	38 (30·2)	< 0·001
Antiplatelet [n(%)]	105 (25·7)	57 (27·4)	23 (30·7)	25 (19·8)	0·17
Anticoagulant [n(%)]	57 (13·9)	42 (20·2)	11 (14·7)	4 (3·2)	< 0·001
Metformin [n(%)]	50 (12·2)	23 (11·1)	14 (18·7)	13 (10·3)	0·17
Sulphonylurea [n(%)]	20 (4·9)	5 (2·4)	8 (10·7)	7 (5·6)	0·016
Corticosteroid [n(%)]	21 (5·1)	12 (5·8)	3 (4·0)	6 (4·8)	0·82
Immunosuppression [n(%)]	21 (5·1)	9 (4·3)	5 (6·7)	7 (5·6)	0·71

BMI; body mass index, BAME; Black Asian and minority ethnic, BMI; body mass index, HFrEF; heart failure with reduced ejection fraction, IHD; ischaemic heart disease, AF; atrial fibrillation, CKD; chronic kidney disease, COPD; chronic obstructive pulmonary disease, ACEi; angiotensin converting enzyme inhibitor, ARB; angiotensin II receptor blocker, BB; beta-adrenoceptor antagonist, CCB; calcium channel blocker, MRA; mineralocorticoid receptor antagonist.

Table 2

Title: Multivariate binary regression analysis of clinical characteristics and ceiling of care decisions (with individual co-morbidities).

	Odds ratio	95% CI	p-value
Age (per year)	0·89	0·86 – 0·92	< 0·001
Male sex	1·8	0·81 – 4·0	0·15
CFS (per nodal point)	0·47	0·37 – 0·60	< 0·001
Diabetes	0·49	0·20 – 1·2	0·11
COPD	0·60	0·19 – 1·9	0·38
CKD	0·31	0·093 – 1·1	0·062
Stroke/TIA	1·1	0·25 – 5·1	0·88
Loop diuretic	0·27	0·031 – 2·3	0·23
Statin	0·68	0·30 – 1·5	0·35

CI; confidence interval, CFS; Clinical Frailty Scale, COPD; chronic obstructive pulmonary disease, CKD; chronic kidney disease, TIA; transient ischaemic attack.

Table 3

Title: Multivariate binary regression analysis of clinical characteristics and ceiling of care decisions (with cumulative number of co-morbidities).

	Odds ratio	95% CI	<i>p</i>-value
Age (per year)	0·89	0·86 – 0·93	< 0·001
Male sex	1·75	0·79 – 3·8	0·17
CFS (per nodal point)	0·48	0·38 – 0·60	< 0·001
Co-morbidities (per co-morbidity)	0·72	0·52 – 1·0	0·048
Loop diuretic	0·23	0·026 – 2·1	0·19
Statin	0·65	0·30 – 1·4	0·28

CI; confidence interval, CFS; Clinical Frailty Scale.

Table 4
Title: Markers of severity of disease divided by ceiling of care decisions.

	All patients (n = 409)	Level 1 (n = 208)	Level 2 (n = 75)	Level 3 (n = 126)	p-value
Laboratory findings					
Hb	129.2 ± 20.7	126.6 ± 21.8	125.0 ± 21.6	135.9 ± 16.5	< 0.001
WCC	7.0 (5.4–9.4)	7.2 (5.4–10.0)	6.5 (5.0–9.1)	7.1 (5.6–9.5)	0.23
ANC	5.4 (4.0–8.0)	5.7 (4.0–8.9)	5.1 (3.9–7.8)	5.6 (4.2–8.3)	0.38
Lymphocyte count	0.8 (0.5–1.1)	0.7 (0.5–1.1)	0.7 (0.5–1.0)	0.8 (0.6–1.1)	0.12
Na ²⁺	138 (136–141)	140 (136–145)	137 (135.8–140)	137 (135–139)	< 0.001
K ⁺	4.0 (3.7–4.4)	4.0 (3.7–4.5)	4.2 (3.7–4.5)	3.9 (3.7–4.2)	0.034
Creatinine	81 (63–117)	95 (68–143)	86.5 (65.8–129.5)	74 (60.3–89.8)	< 0.001
CRP	90 (45–169)	77.5 (34.8–159.8)	106 (72.3–187.3)	110 (68–192)	0.001
Ddimer	467 (258.5–1035.3)	496 (266–1978)	671 (387–1042)	373 (223–924)	0.068
hsTNI	20.5 (8.1–60)	40.0 (17.2–94.3)	25.5 (9.9–70.5)	8.5 (4.6–22.2)	< 0.001
Ferritin	460 (220–982)	365 (143.8–671.5)	510 (261.3–946)	674 (338.5–1458)	< 0.001
Procalcitonin	0.15 (0.08–0.38)	0.17 (0.08–0.52)	0.14 (0.08–0.32)	0.15 (0.09–0.40)	0.60
Clinical observations					
RR (min ⁻¹)	22 (18–28)	20 (18–28)	22.5 (20–28)	24 (20–29)	0.026
O ₂ saturations (%)	94.5 (89–96)	95 (90–97)	94 (88–96)	94 (89–96)	0.065
Heart rate (min ⁻¹)	90 (76–103)	89 (73–102.8)	89 (79–101.3)	96 (86–108.5)	0.001
SBP (mmHg)	129.2 ± 23.5	130.4 ± 25.5	131.2 ± 24.4	126.2 ± 18.8	0.21

Hb; haemoglobin, WCC, white cell count, ANC; absolute neutrophil count, Na²⁺; sodium, K⁺; potassium, CRP; C-reactive protein, hsTNI; high-sensitivity troponin-I, RR; respiratory rate, O₂; oxygen, SBP; systolic blood pressure.

	All patients (n = 409)	Level 1 (n = 208)	Level 2 (n = 75)	Level 3 (n = 126)	p-value
Temperature (°C)	37.7 ± 1.1	37.4 ± 1.1	37.7 ± 1.1	38.0 ± 1.0	< 0.001
Chest radiography					
COVID-19 [n(%)]	190 (47.4)	61 (29.6)	40 (55.6)	89 (72.4)	< 0.001
Indeterminate [n(%)]	125 (31.2)	79 (38.2)	22 (30.6)	24 (19.5)	
Non-COVID-19 [n(%)]	86 (21.4)	66 (32.0)	10 (13.9)	10 (8.1)	
Hb; haemoglobin, WCC, white cell count, ANC; absolute neutrophil count, Na ²⁺ ; sodium, K ⁺ ; potassium, CRP; C-reactive protein, hsTNI; high-sensitivity troponin-I, RR; respiratory rate, O ₂ ; oxygen, SBP; systolic blood pressure.					

Table 5

Title: Baseline clinical characteristics of patients divided by those who were alive or had died during the study period.

	All patients (n = 485)	Alive (n = 326)	Dead (n = 159)	p-value
Demographics				
Age (years)	71.6 ± 16.3	68.4 ± 17.4	78.1 ± 11.5	< 0.001
Male sex [n(%)]	259 (53.4)	168 (51.5)	91 (57.3)	0.24
BMI (kg/m ²)	26.3 (22.1–30.8)	26.7 (22.2–31.4)	25.5 (21.9–29.9)	0.13
BAME [n(%)]	73 (15.4)	59 (18.6)	14 (8.9)	0.006
Clinical Frailty Scale	5 (3–6)	3 (2–6)	6 (3–7)	< 0.001
Co-morbidities				
HFrEF [n(%)]	59 (12.2)	31 (9.5)	28 (17.6)	0.010
IHD [n(%)]	69 (14.2)	46 (14.1)	23 (14.5)	0.92
Hypertension [n(%)]	222 (45.8)	155 (47.5)	67 (42.1)	0.26
AF [n(%)]	97 (20.0)	52 (16.0)	45 (28.3)	0.001
Diabetes mellitus [n(%)]	147 (30.3)	90 (27.6)	57 (35.8)	0.064
Stroke/TIA [n(%)]	53 (10.9)	32 (9.8)	21 (13.2)	0.26
CKD [n(%)]	119 (24.5)	71 (21.8)	48 (30.2)	0.043
COPD [n(%)]	69 (14.2)	37 (11.3)	32 (20.1)	0.009
Malignancy [n(%)]	37 (7.6)	23 (7.1)	14 (8.8)	0.50
Medications				
ACEi [n(%)]	84 (17.3)	57 (17.5)	27 (17.0)	0.89
ARB [n(%)]	41 (8.5)	31 (9.5)	10 (6.3)	0.23
BB [n(%)]	113 (23.3)	75 (23.0)	38 (23.9)	0.83
CCB [n(%)]	80 (16.5)	57 (17.5)	23 (14.5)	0.40
Loop diuretic [n(%)]	74 (15.3)	47 (14.4)	27 (17.0)	0.46

BMI; body mass index, BAME; Black Asian and minority ethnic, BMI; body mass index, HFrEF; heart failure with reduced ejection fraction, IHD; ischaemic heart disease, AF; atrial fibrillation, CKD; chronic kidney disease, COPD; chronic obstructive pulmonary disease, ACEi; angiotensin converting enzyme inhibitor, ARB; angiotensin II receptor blocker, BB; beta-adrenoceptor antagonist, CCB; calcium channel blocker, MRA; mineralocorticoid receptor antagonist.

	All patients (n = 485)	Alive (n = 326)	Dead (n = 159)	p-value
MRA [n(%)]	18 (3·7)	12 (3·7)	6 (3·8)	0·96
Statin [n(%)]	200 (41·2)	136 (41·7)	64 (40·3)	0·76
Antiplatelet [n(%)]	115 (23·7)	75 (23·0)	40 (25·2)	0·60
Anticoagulant [n(%)]	67 (13·8)	38 (11·7)	29 (18·2)	0·049
Metformin [n(%)]	61 (12·6)	39 (12·0)	22 (13·8)	0·56
Sulphonylurea [n(%)]	23 (4·7)	18 (5·7)	5 (3·2)	0·23
Corticosteroid [n(%)]	24 (4·9)	14 (4·3)	10 (6·4)	0·34
Immunosuppression [n(%)]	22 (4·5)	13 (4·0)	9 (5·7)	0·41
<p>BMI; body mass index, BAME; Black Asian and minority ethnic, BMI; body mass index, HFrEF; heart failure with reduced ejection fraction, IHD; ischaemic heart disease, AF; atrial fibrillation, CKD; chronic kidney disease, COPD; chronic obstructive pulmonary disease, ACEi; angiotensin converting enzyme inhibitor, ARB; angiotensin II receptor blocker, BB; beta-adrenoceptor antagonist, CCB; calcium channel blocker, MRA; mineralocorticoid receptor antagonist.</p>				

Figures

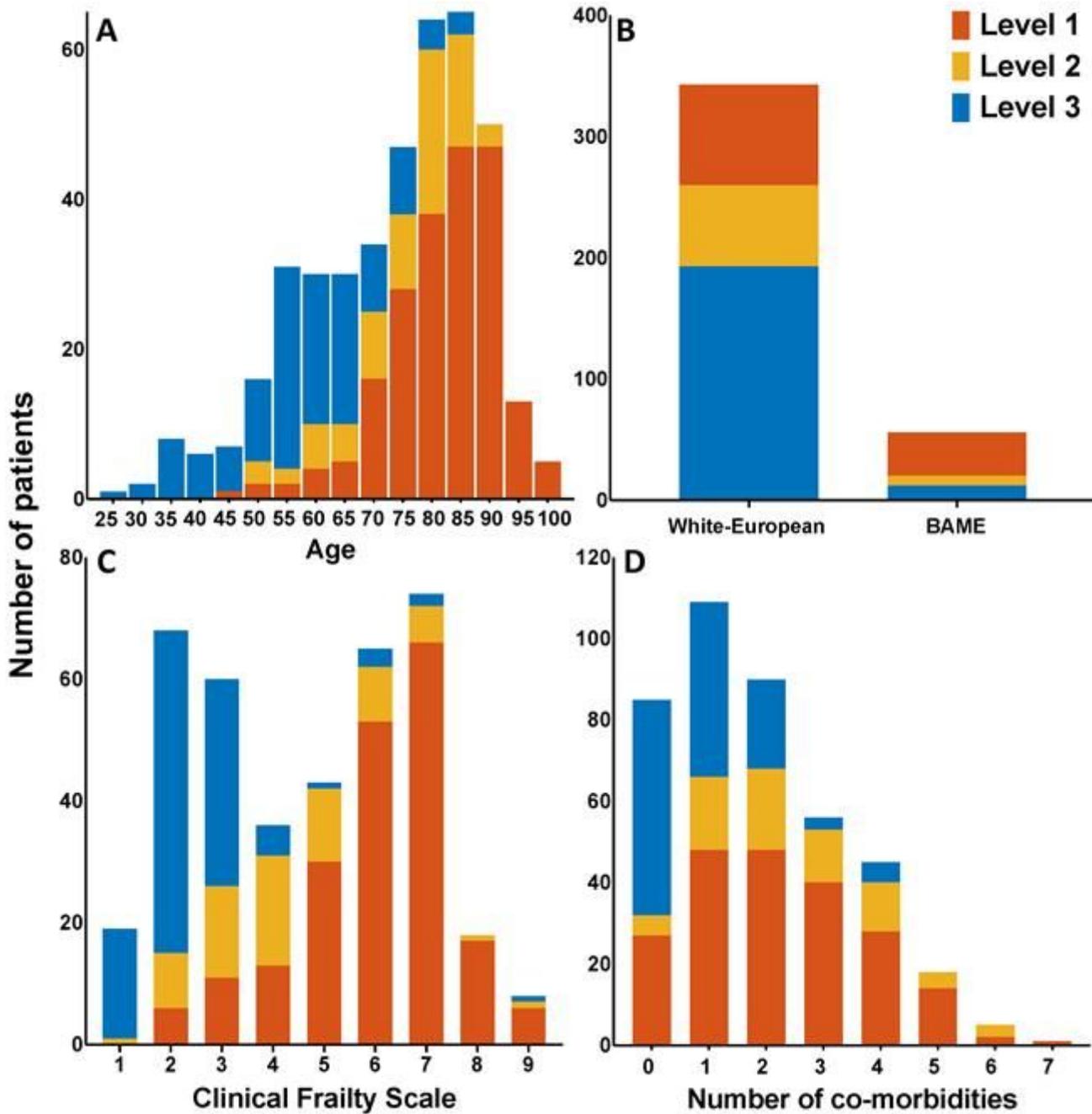


Figure 1

Title: Bar charts showing A age, B ethnicity, C Clinical Frailty Scale and D co-morbidities in patients deemed appropriate for level one, two or three care. Caption: Patients in the present study were often elderly, frail and were multi-morbid.

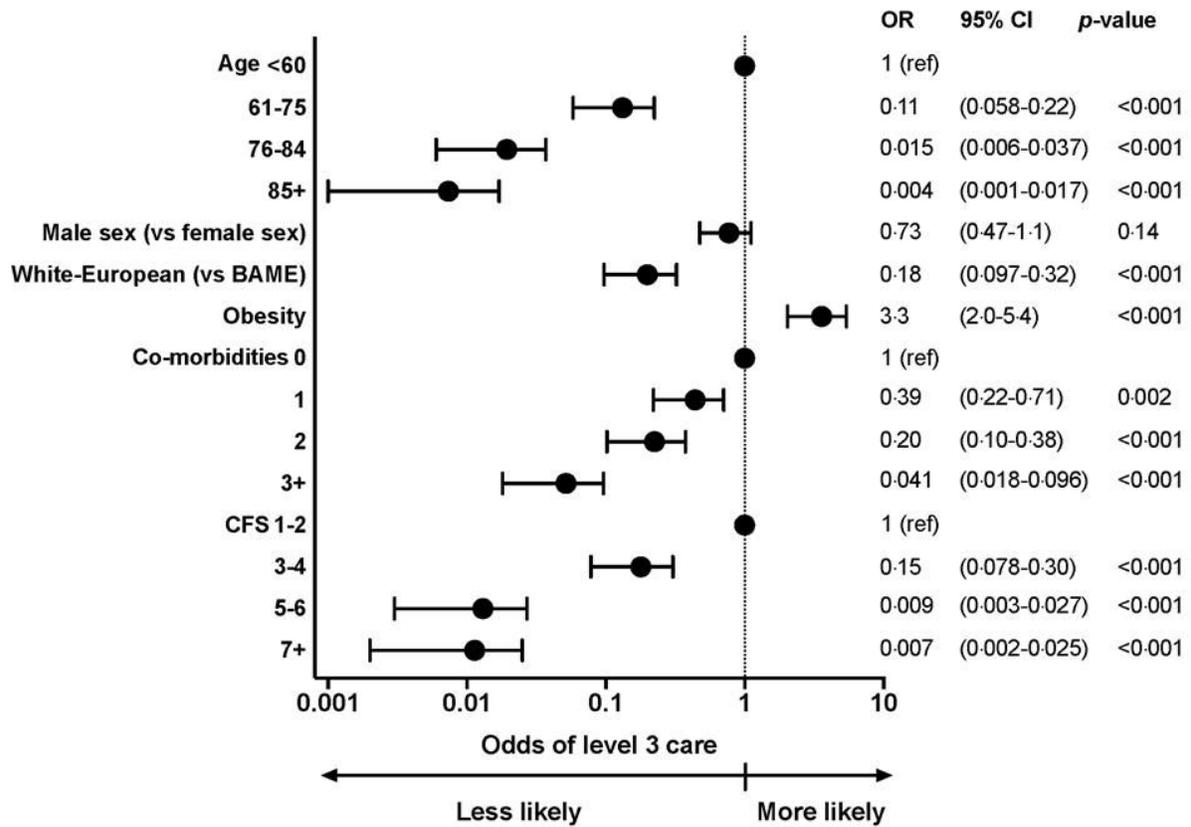


Figure 2

Title: Bar charts showing A age, B ethnicity, C Clinical Frailty Scale and D co-morbidities in patients deemed appropriate for level one, two or three care. Caption: Patients in the present study were often elderly, frail and were multi-morbid.

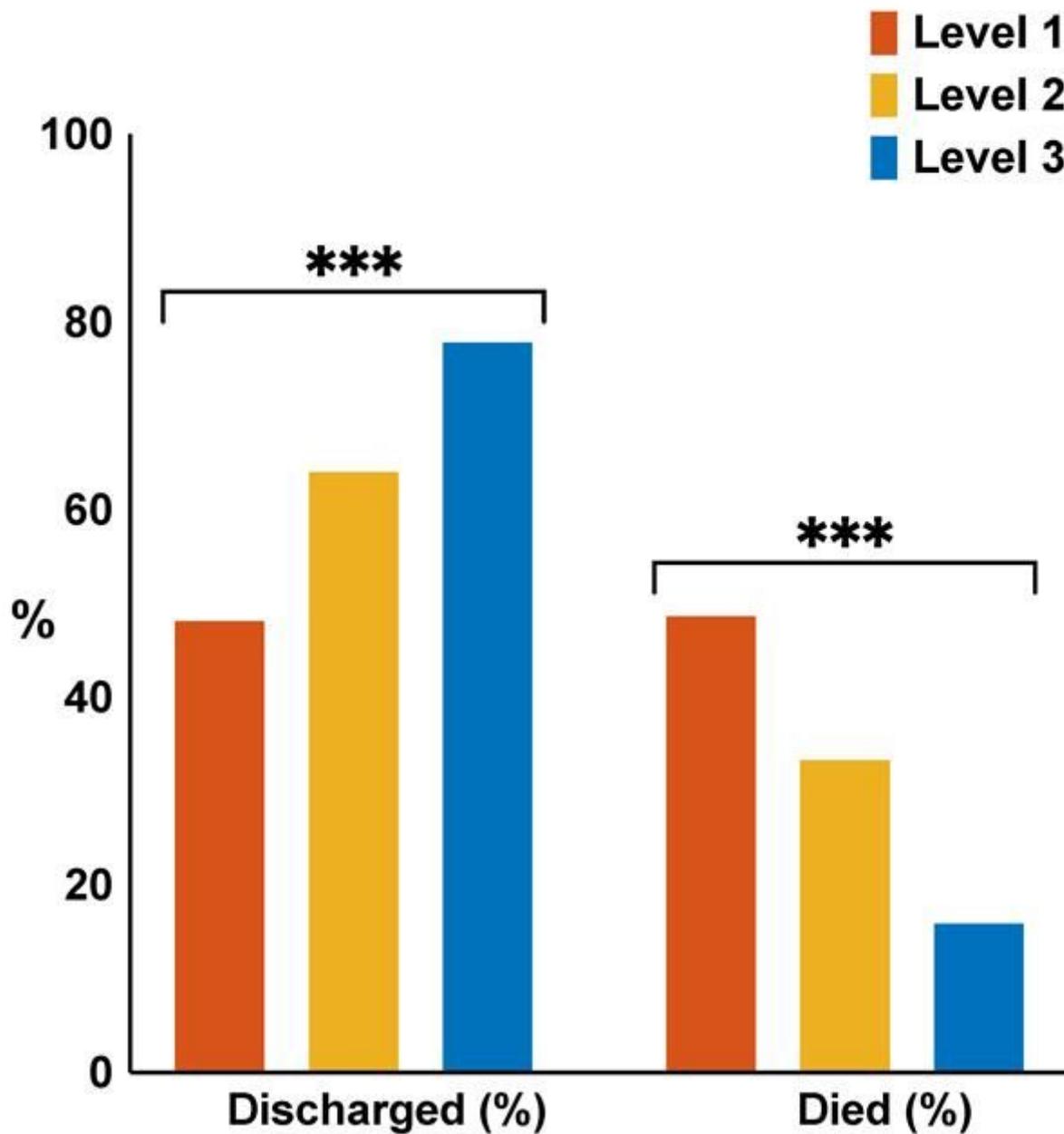


Figure 3

Title: Bar charts showing outcomes of patients appropriate for level one, two or three care. Caption: Patients appropriate for level three care were the most likely to be discharged and least likely to have died during admission. p-value <0.05*, <0.01**, <0.001***.