DOI: https://doi.org/10.5114/ait.2022.122614

The effect of caring for critically ill patients with COVID-19 acute respiratory distress syndrome in undesignated intensive care unit wards on mortality and length of hospital stay

Rashid Nadeem[1], Mona Oyar Husseini[1], Induja Rajendran[1], Atif Latif[1], Mayada Mahmoud[1], Manoj Mathews[1], Yusra Omar Alshaikh SayedAhmed[1], Ekta Sharma[1], Maged Talaat Salama Khalil[1], Aju Rafeeq[2]

[1]Dubai Hospital, Dubai, United Arab Emirates
[2]National Field Hospital, Dubai, United Arab Emirates

Abstract

Background: COVID-19 has caused 4 million deaths as of 24 August 2021. A significant number of patients were admitted to undesignated ICU areas before transfer to a designated ICU owing to the unavailability of ICU beds. We aim to compare the mortality and length of stay of patients in these 2 areas.

Methods: We retrospectively studied all critically ill patients with COVID-19 pneumonia who were admitted to Dubai hospital between 1 January 2020 and 30 June 2020. Patients who transferred to wards other than designated ICU constitute cases, while those who were admitted directly to designated ICUs constitute controls. The demographics, clinical parameters, and treatment profile of these patients were recorded and compared. Mortality and length of stay were calculated.

Results: The sample includes 239 subjects (admitted to an undesignated ICU ward [n = 107] and directly admitted to a designated ICU ward [n = 132]). Patients admitted to an undesignated ICU had extra transfers between wards and had more days on MV (median [IQR] 18 (19) vs. 11 (14); P = 0.001), greater length of stay in the ICU (median [IQR]) 21.5 (19) vs. 15 (14); P = 0.001), and greater length of stay in hospital (median [IQR] 32 (28) vs. 21 (26); P = 0.001). Multiple logistic regression analysis showed that patients treated at an undesignated ICU have better survival (odds of death for patients cared for at an undesignated ICU was 0.347 with CI 0.178–0.676; P = 0.002). Multiple linear regression analysis also showed that patients treated at an undesignated ICU had longer stay – 4.2 days, CI 1.3–7.13, P = 0.004).

Conclusions: Admission to an undesignated ICU impacts mortality and length of ICU and hospital stay.

Key words: mortality, ARDS, COVID-19, designated ICU, undesignated ICU.

Anaesthesiol Intensive Ther 2022; 54, 5: 378–386

Received: 09.12.2021, **accepted:** 17.08.2022

CORRESPONDING AUTHOR:

Rashid Nadeem, Dubai Hospital, Dubai, United Arab Emirates, e-mail: Nadeem.dr@gmail.com

The coronavirus disease 2019 (COVID-19) pandemic, caused by severe acute respiratory syndrome coronavirus (SARS-CoV-2), has led to high rates of morbidity and mortality worldwide [1]. At the start of the pandemic in Wuhan, China in 2020, hospitals were overwhelmed by the excessive number of critical patients requiring intensive care, which was greater than the available capacity of these hospitals. Therefore, a significant number of patients stayed in emergency areas or were transferred to general wards until intensive care unit (ICU) beds became available [2]. Some of these areas were serviced by registered nurses who were not trained to treat ICU patients. Isolation of patients required negative pressure rooms in wards that were specifically created to deal with the pandemic. Many hospitals established negative pressure rooms and ICU beds outside of designated ICU areas. As a result, many critical patients were transferred between wards when a negative pressure room or ICU bed became available. Whenever these mechanically ventilated patients are transferred, they require a change from ventilator to mobile ventilator, which may result in a shifting in the endotracheal tube position or loss of positive end expiratory pressure (PEEP). These transfers may require a temporary hold on dynamic

monitoring equipment (clamping arterial line) or infusion pumps of medications (sedatives). Schwebel *et al.* [3] documented that patients with intrahospital transport are 1.9 times more likely to develop a complication (atelectasis, ventilator-associated pneumonia, hypoglycaemia, or hyperglycaemia). Braman *et al.* [4] also documented increased complications from intrahospital transport in critically ill patients and concluded that these complications can be prevented. The impact of these transfers is largely unknown for COVID-19 patients with acute respiratory distress syndrome (ARDS); as such, the number of patient transfers was unprecedented. We aimed to record the occurrence of transfers and evaluate the impact of these transfers on the clinical outcome of mortality and length of stay in the ICU.

We evaluated the effect of the care of critically ill COVID-19 patients in undesignated ICU wards, with a particular focus on observing the occurrence of transfer of patients between wards before reaching designated ICU areas, on the clinical outcomes of mortality and length of stay in the ICU (LOSICU).

METHODS

We retrospectively collected the data from electronic medical records of all critically ill patients with COVID-19 pneumonia meeting ICU admission criteria, who were admitted to Dubai Hospital between 1 January 2020, and 30 June 2020. All patients who transferred to wards other than the medical intensive care unit (MICU) or surgical intensive care unit (SICU) constituted the cases, because they were cared for in undesignated ICU areas. All other patients who were transferred to the MICU or SICU directly from the emergency department (without going to any other ward) constituted controls. The decision about where the patient was admitted was based upon the availability of an ICU bed at the time of admission, because most patients had a waiting time in the emergency department before admission to the ICU bed. Two investigators recorded data on the number of transfers from transfer notes written by intensivists or anaesthesia registrars, because the hospital protocol required each ventilated patient to be escorted by teams supervised only by these assigned doctors. The demographics recorded were as follows: age; sex; body mass index (BMI); nationality; clinical parameters recorded; positive swab sample polymerase chain reaction (PCR) test result for SARS-CoV-2; number of swabs; number of days to negative PCR test result; number of days of symptoms; and presence of symptoms such as cough, fever, dyspnoea, gastric complaints on admission to ICU, and first set of vitals. Data on comorbidities included diabetes, hypertension, coronary artery disease, renal failure, and outpatient dialysis. Inpatient clinical data on admission to the ICU, including fever (temperature > 38.0°C), tachycardia (pulse > 100 per minute), hypotension (systolic BP less than 90 mmHg), hypoxia (SpO_2 < 92%), use of oxygen (L min^{-1}), mechanical ventilation, use of pressors, and inpatient dialysis. Laboratory parameters on the day of admission to the ICU included disease activity markers or inflammatory markers (C-reactive protein [CRP], ferritin, and procalcitonin levels [PCT]), haematological indices (white blood and platelet counts), chemistries (electrolyte levels), and culture results of sputum, blood, pleural or peritoneal fluid, or pneumonia panels because secondary bacterial infection impacts clinical outcomes. Data on therapeutic agents, including chloroquine and antivirals, were also recorded because they can be significant confounding factors. We calculated APACHE-2 scores within 24 hours of admission to the ICU, to assess the severity of illness. Because many patients later in the course worsened and required transfer to the designated ICU for extracorporeal membrane oxygenation (ECMO) provision, the initial APACHE-2 score may not be truly reflective of severity, which means that the designated ICU probably had a high severity of illness. Medical management was provided by the same team of physicians for both groups; therefore, the same treatment was provided in terms of medication (steroids, tocilizumab, anticoagulation) or timing for intubation or continuous renal replacement therapy (CRRT). Some undesignated ICU rooms lack the materials necessary for CRRT, so they had to be transferred to dialysis sections as needed, which resulted in a greater number of transfers. Similarly, an undesignated ICU room was not suitable for ECMO cannulation, so patients were transferred to the designated ICU if ECMO was prescribed. Therefore, more sick patients were probably transferred to the designated ICU at some point if a bed was available at that time. Similarly, bedside tracheostomies were performed in the operating theatre for patients from undesignated ICUs, while designated ICU patients may have bedside percutaneous tracheostomy in the ICU. As the number of licensed ICU nurses (LICUN) was insufficient to service the presented load of patients, all ICU ward nurses were supervised by LICUN. Relatively more LICUNs were assigned to undesignated ICUs to offset the other factors (non-critical care nurses were less familiar with critical care procedures such as ventilator management, haemodialysis, and central line placements). The undesignated ICUs had some rooms that were smaller in size, and some rooms were cubicles that had 2 patients, while all designated ICU rooms were single beds. The designated ICU

rooms had fixed ventilators while the undesignated ICU rooms had similar but moveable ventilators.

Because the rooms in undesignated ICUs did not have the capability for in-room dialysis or interventional procedures (i.e. haemodialysis, bronchoscopy, and bedside tracheostomy), patients in undesignated ICUs had more transfers.

LOSICU includes the total number of days in ICU regardless of designated or undesignated ICU or a combination of the 2. For example, if a patient stayed 5 days in an undesignated ICU and was then transferred to the designated ICU and stayed there for 10 days, the total LOSICU for this patient was 15 days.

The study was approved by the Dubai Scientific Research Ethics Committee (DSREC), Dubai Health authority on 10 June 2021 (approval number DSREC-05/2021_18). Written informed consent was waived because of the retrospective nature of the analysis.

Statistical analysis

Sample characteristics were compared between the group of patients who went to non-ICU wards before reaching the MICU or SICU for administrative reasons (lack of available beds in the MICU or SICU) and the group that was admitted directly to the designated ICU (MICU or SICU). Chi-square tests were performed for categorical variables, and the Mann-Whitney *U* test was performed for continuous variables because the data were found to be non-normally distributed.

Initially, univariate logistic regression analysis determined that the variables were significant predictors of mortality. Multiple logistic regression analysis was performed by including only those variables found to be significant predictors in univariate analysis. Similarly, univariate linear regression was performed to determine significant variables as predictors of LOSICU admission. Multiple linear regression was used by including only those variables found to be significant in univariate regression analysis to assess predictors of LOSICU. A *P*-value of 0.05 was considered significant. All analyses were performed with SPSS version 27 (IBM Corp., Armonk, N.Y., USA).

RESULTS

The characteristics of the total sample ($N = 239$) and the 2 groups (undesignated ICU ward/extra transfers [cases], $n = 107$; and direct transfer to designated ICU bed [controls], $n = 132$) are shown in Table 1 for categorical variables and in Table 2 for continuous variables. The sample included 208 (87%) males and 31 (12.2%) females. The mean age of the sample was 49 years. Mechanical ventilation was required in 203 (85.2%) patients (107 in designated vs. 98 in undesignated, $P = 0.08$). Vasopressors were required in 188 (79%) subjects (100 in designated vs. 88 in undesignated ICUs, $P = 0.266$). One-third of patients (30.3%) developed renal injury requiring CRRT (38 in designated vs. 34 in undesignated, $P = 0.644$). The prevalence of documented secondary bacterial infection was 106 (44.3%), which was similar between the 2 groups (59 in designated vs. 47 in undesignated, $P = 0.905$). Steroids were prescribed in 188 (79.3%) patients (99 in designated and 89 in undesignated ICU patients, $P = 0.18$). All patients who received ECMO were in designated ICU beds because it cannot be provided at an undesignated ICU bed.

Details of how many extra transfers were made are reported in Table 3. The crude mortality was better for patients in the undesignated ICUs: 45 (37.8%) vs. designated ICUs 74 (62.2%), $P = 0.02$. Patients with care at an undesignated ICU and with extra transfers spent more days on mechanical ventilation [median (IQR) 18 (19) vs. 11 (14), $P = 0.001$], LOSICU [21.5 (19) vs. 15 (14), $P = 0.001$], more days alive in the first 30 days after admission [24.5 (13) vs. 11 (17), $P = 0.001$], LOSH [32 (28) vs. 21 (26), $P = 0.001$], and had a lower prevalence of secondary bacterial infection [47 (43.9%) vs. 59 (44.6%), $P = 0.905$]. They also had a higher occurrence of being sedated [102 (95.2%) vs. 109 (83.2%), $P = 0.003$] and being paralyzed [98 (91.6%0 vs. 104 (79.4%), $P = 0.009$] than patients in the designated ICU. Univariate logistic regression showed the interaction of each clinically significant variable with mortality (Table 4A). After inclusion of only significant variables in univariate analysis, a model for multiple logistic regression was developed, which showed that patients with care at an undesignated ICU bed had better survival, with an odds of death of 0.347 (CI of 0.178–0.676), $P = 0.002$. The use of steroids also predicted better survival, with an odds of death of 0.166 (CI of 0.058–0.474), $P = 0.001$. Patients who had tracheostomy also had better survival – odds of death 0.08 (CI of 0.026–0.247), $P \leq 0.001$. Those receiving CRRT had worse survival, with an odds of death of 4.5 (CI of 2.047–10.236), $P \leq 0.001$ (Table 4B).

For the outcome of length of stay, we conducted 2 analyses: LOSICU and days the patient was alive in the first 30 days after admission to the ICU. First, univariate simple regression was performed to assess the relationship of variables to LOSICU (Table 5A). Only those variables that were found to be significant predictors of LOSICU were included in the final model of multiple linear regression, which showed that care at an undesignated ICU was associated with a longer LOSICU of 4.206 days (CI of 1.290–7.122), $P = 0.005$ (Table 5B). Other factors predictive of longer stay were occurrence of secondary bacterial infection,

TABLE 1. Sample characteristics (categorical variables)

Clinical features	All patients ($N = 239$), *n* (%)	Designated ICU ($n = 132$; 54.5%), *n* (%)	Undesignated ICU ($n = 107$; 44.5%), *n* (%)	*P*-value*
Male	208 (87.8)	117 (90.0)	91 (85.0)	0.247
Fever	216 (91.1)	118 (90.8)	98 (91.6)	0.825
Cough	190 (80.5)	105 (80.8)	85 (80.2)	0.911
Dyspnoea	190 (80.5)	103 (79.8)	87 (81.3)	0.778
Gastric symptoms	28 (11.8)	19 (14.5)	9 (8.4)	0.147
Diabetes	102 (43.0)	52 (40.0)	50 (46.7)	0.298
Hypertension	59 (25.0)	31 (23.8)	28 (26.4)	0.650
CAD	16 (6.8)	9 (6.9)	7 (6.6)	0.935
Renal disease	29 (12.2)	18 (13.7)	11 (10.3)	0.417
Outpatient dialysis	16 (6.7)	6 (4.6)	10 (9.3)	0.144
Immunodeficiency	9 (3.8)	5 (3.8)	4 (3.7)	0.966
Clinical variables				
Inpatient fever	205 (86.5)	107 (82.3)	98 (91.6)	0.037
Tachycardia	187 (78.6)	100 (76.3)	87 (81.3)	0.352
Hypotension	119 (50.0)	62 (47.3)	57 (53.3)	0.362
Hypoxia	206 (86.6)	108 (82.4)	98 (91.6)	0.040
MV	203 (85.3)	107 (81.7)	96 (89.7)	0.081
Vasopressors	188 (79.0)	100 (76.3)	88 (82.2)	0.266
CRRT	72 (30.3)	38 (29.0)	34 (31.8)	0.644
Bacterial infection	106 (44.3)	59 (44.6)	47 (43.9)	0.905
Treatment				
Steroids	188 (79.3)	99 (76.2)	89 (83.2)	0.184
Tocilizumab	38 (16.0)	21 (16.2)	17 (15.9)	0.956
Sedatives	211 (88.7)	109 (83.2)	102 (95.3)	0.003
Narcotics	181 (76.7)	96 (73.8)	85 (80.2)	0.252
Paralytics	202 (84.9)	104 (79.4)	98 (91.6)	0.009
GI bleeding prophylaxis	228 (96.6)	125 (95.4)	103 (98.1)	0.259

*χ^2 to compare categorical variables.
CAD – coronary artery disease, MV – mechanical ventilation, CRRT – continuous renal replacement therapy, GI – gastrointestinal

tracheostomy, and provision of ECMO. Although these factors were more prevalent in designated ICUs, they did not have any significant collinearity among them (VIF < 4) (Table 5B). A similar analysis for days alive in the first 30 days after admission was performed, with similar results (Table 5C).

DISCUSSION

The COVID-19 pandemic exhausted health care systems worldwide. Hence, an obvious concern was whether care provided under these unprecedented conditions affected the quality of care and clinical outcomes.

We addressed this issue and found that care in an undesignated ICU was associated with better survival and longer stays in the ICU. This was not expected. We believe this may have resulted from any combination of the following factors: sicker patients who required complex therapies such as ECMO and CRRT were preferably treated at designated ICUs because the provision of these therapies was only possible in designated ICUs. Data on ARDS from COVID-19 treated with ECMO therapy showed higher mortality compared to non-COVID-19 ARDS treated with ECMO therapy [5]. Similarly, patients with COVID-19 ARDS who developed acute kidney injury had higher mortality [6]. The primary indication for choosing CRRT over intermittent haemodialysis (HD) is haemodynamic instability; therefore, patients treated in undesignated ICU areas are more likely to be haemodynamically stable than those with haemodynamic instability (who are more likely to be treated with CRRT in designated ICU areas) [7]. In contrast to our findings, Yung *et al.* [8]

TABLE 2. Sample characteristics – continuous variables

Clinical features	All patients ($N = 239$)		Designated ICU ($n = 132$; 54.5%)		Undesignated ICU ($n = 107$; 44.5%)		*P*-value
	Median	IQR	Median	IQR	Median	IQR	
Age (years)	49.0	13	46.5	13	51.5	13	0.460
BMI (kg m^{-2})	27.6	6.17	27.3	5.2	28.1	6.36	0.127
Days to seroconversion	16	17	11	16	16	16	0.235
Ferritin (µg L^{-1})	1334	1424	1453	1515	1138	1291	0.189
D-Dimer (mmol L^{-1})	0.01	0.02	0.01	0.03	0.01	0.02	0.123
Procalcitonin (µg L^{-1})	0.33	0.59	0.40	1.03	0.23	0.46	0.001
CRP (mg L^{-1})	131.0	121.0	142.5	108.7	122.2	141.4	0.096
Creatinine (µmol L^{-1})	68.6	26.6	68.6	34.3	68.6	24.4	0.182
CPK (µkat L^{-1})	3.86	10.20	5.92	11.02	4.00	8.66	0.407
ABG pH	7.39	0.13	7.36	0.13	7.39	0.16	0.021
PCO_2 (mmHg) (kPa)	37.7 (5.02)	15.4 (2.05)	36.6 (4.87)	13.9 (1.85)	37.8 (5.03)	18.8 (2.50)	0.540
PO_2 (mmHg) (kPa)	64.0 (8.53)	35.1 (4.67)	63.2 (8.42)	31.8 (4.23)	69.1 (9.21)	38.0 (5.06)	0.318
Lactate (mmol L^{-1})	1.7	1.1	1.7	0.9	1.7	1.2	0.312
Bicarbonate (mmol L^{-1})	22.2	5.3	22.2	4.3	22.7	6.0	0.025
Magnesium (mmol L^{-1})	0.84	0.15	0.84	0.21	0.85	0.13	0.815
Platelets (10^9 L^{-1})	201	111	189	114	205	106	0.820
Days on MV	16	19	11	14	18	19	0.001
LOSICU (days)	19	22	15	14	21.5	19	0.001
Days alive in first 30 days	19	22	11	17	24.5	13	< 0.001
Days alive outside ICU in first 30 days	0	4	25	17.5	13	16	< 0.001
LOSH (days)	29	29	21	26	32	28	0.001
APACHE – 2 scores	15	7	17	9	15	7	0.093

CPK – creatine phosphokinase, ABG – arterial blood gas, MV – mechanical ventilation, LOSICU – length of ICU stay, LOSH – length of hospital stay

TABLE 3. Numbers of administrative transfers

	Total ($N = 235$), *n* (%)	Alive ($n = 116$), *n* (%)	Died ($n = 119$), *n* (%)	*P*-value
No extra transfer	129 (54.9)	55 (47.4)	74 (62.2)	0.023
Extra transfers	106 (45.1)	61 (52.6)	45 (37.8)	
Number of transfers				
1	61 (26.0)	30 (25.9)	31 (26.1)	
2	27 (11.5)	17 (14.7)	10 (8.4)	
3	15 (6.4)	12 (10.3)	3 (2.5)	
4	3 (1.3)	2 (1.7)	1 (0.8)	

found a beneficial effect of CRRT on mortality in COVID-19 patients with renal failure. Their sample size was very small – only 36 patients were included. We believe that their trial was underpowered and that they may have overestimated the survival. Ng *et al.* [9] retrospectively examined patients with end-stage kidney disease and concluded that they had a higher rate of in-hospital death than those without end-stage kidney disease (31.7% vs. 25.4%; OR 1.38; 95% CI: 1.12–1.70). To date, there has been no large prospective trial addressing the effect of CRRT on mortality among critically ill COVID-19 patients. Secondary bacterial or fungal infections are more likely to be from a resistant organism (carbapenem resistance or methicillin resistance) in designated ICU areas in comparison to undesignated ICU areas, owing to the difference in composition of microbial inhabitance in designated and undesignated ICU areas. For example, *Stenotrophomonas* are rarely isolated from respiratory secretions in

TABLE 4.

A. Univariate logistic regression analysis of clinically relevant predictors of mortality

Variable	β	Odds ratio	95% CI for odds ratio		*P*-value
			Lower	Upper	
Age (years)	0.026	1.026	1.002	1.051	0.035
Gender	0.276	1.318	0.603	2.879	0.489
BMI	0.003	1.003	0.978	1.028	0.827
Diabetes	–0.235	0.791	0.471	1.328	0.375
Hypertension	0.150	1.161	0.641	2.106	0.622
Coronary disease	1.154	3.17	0.991	10.135	0.052
Outpatient HD	0.52	1.682	0.591	4.788	0.330
Hypotension	0.741	2.097	1.247	3.529	0.005
Hypoxaemia	0.619	1.858	0.863	4.000	0.113
MV	0.368	1.444	0.700	2.981	0.320
Vasopressors	0.827	2.286	1.187	4.402	0.013
CRRT	1.187	3.278	1.805	5.953	< 0.001
Bacterial infection	0.187	1.206	0.721	2.018	0.476
Steroids	–0.663	0.515	0.269	0.986	0.045
Tracheostomy	–1.592	0.204	0.080	0.519	< 0.001
ECMO	0.328	1.387	0.428	4.503	0.586
Sedatives	1.426	4.163	1.614	10.737	0.003
Paralytics	0.427	1.533	0.747	3.144	0.244
APACHE – 2 score	0.049	1.051	1.010	1.093	0.014
Undesignated ICU	–0.601	0.548	0.326	0.922	0.023

HD – haemodialysis, MV – mechanical ventilation, ECMO – extracorporeal membrane oxygenation

B. Multiple logistic regression analysis (predictors of mortality)

Variable	β	Odds ratio*	95% CI for odds ratio		*P*-value
			Lower	Upper	
Undesignated ICU	–1.059	0.347	0.178	0.676	0.002
Age (years)	0.029	1.030	0.996	1.065	0.084
Hypotension	0.559	1.749	0.902	3.392	0.098
Vasopressors	0.505	1.657	0.550	4.992	0.369
CRRT	1.521	4.577	2.047	10.236	< 0.001
Steroid	–1.798	0.166	0.058	0.474	0.001
Tracheostomy	–2.522	0.080	0.026	0.247	< 0.001
Sedative usage	1.570	4.809	0.838	27.609	0.078
APACHE – 2 score	0.001	1.001	0.949	1.055	0.977

*For all categorical variables, odds are for presence versus absence of the variable.
CRRT – continuous renal replacement therapy

patients occupying undesignated ICU areas or general medical wards. *Stenotrophomonas* are more common in designated ICU areas, and they can be acquired through the shared use of ICU equipment between ICU patients. A study documented the use of bronchoscopy and calorimetry in the transmission of this organism among ICU patients [10].

Braman *et al.* [4] documented complications from intrahospital transport in 1987. At that time, technology to assist intrahospital transport was not as advanced as it is today. Szem *et al.* [11] observed that mortality was elevated in high-risk patients involving transfer, but intrahospital transfers were not the direct reason for the high mortality. The positive outcomes in our study may be the result of better organization of undesignated ICU beds, use of newer and more advanced portable monitors and ventilators, and improved preparation by escorting

TABLE 5.

A. Univariate linear regression for factors determining length of stay in ICU

Variable	Unstandardised coefficients		Standardised coefficients	*P*-value	95.0% CI for β	
	β	Std. error	β		Lower bound	Upper bound
Age	–0.001	0.092	0.001	0.996	–0.182	0.181
Gender	5.064	3.090	0.109	0.103	–1.025	11.153
BMI	0.070	0.101	0.050	0.493	–0.130	0.270
Diabetes	0.536	2.043	0.018	0.793	–3.491	4.563
Hypotension	5.208	1.981	0.173	0.009	1.304	9.112
Ventilation	10.416	3.080	0.220	< 0.001	4.347	16.485
Vasopressors	11.023	2.534	0.278	< 0.001	6.029	16.017
CRRT	6.718	2.122	0.207	0.002	2.537	10.900
bacterial infection	17.223	1.671	0.568	< 0.001	13.931	20.515
Bacteraemia	15.149	1.779	0.495	< 0.001	11.643	18.654
Catheter infection	15.896	1.818	0.504	< 0.001	12.313	19.479
Steroids	11.718	2.498	0.299	< 0.001	6.796	16.639
tracheostomy	26.121	2.404	0.587	< 0.001	21.384	30.859
ECMO	21.348	4.262	0.317	< 0.001	12.950	29.746
Sedatives	16.446	3.556	0.295	< 0.001	9.439	23.453
Paralytics	15.715	2.924	0.337	<0.001	9.954	21.476
APACHE-2 score	–0.246	0.142	–0.118	0.086	–0.527	0.035
Undesignated ICU	7.337	1.959	0.242	< 0.001	3.476	11.198

CRRT – continuous renal replacement therapy, ECMO – extracorporeal membrane oxygenation

B. Multiple linear regression of variables determining length of stay in ICU

Variable predicting length of stay in ICU	Unstandardised coefficients	Significance	95% CI for β		Collinearity statistics	
	β		Lower bound	Upper bound	Tolerance	VIF
Hypotension	1.934	0.206	–1.071	4.940	0.834	1.198
Ventilation	–1.058	0.747	–7.511	5.395	0.776	1.289
Vasopressors	–1.202	0.616	–5.920	3.517	0.752	1.330
Dialysis	0.237	0.890	–3.124	3.598	0.747	1.338
Bacterial infection	6.256	0.005	1.930	10.583	0.407	2.456
Bacteraemia	0.737	0.779	–4.434	5.908	0.285	3.509
Catheter infection	3.610	0.139	–1.182	8.402	0.352	2.843
Steroids	4.183	0.045	0.093	8.273	0.847	1.181
Tracheostomy	18.971	< 0.001	14.769	23.173	0.868	1.152
ECMO	12.468	< 0.001	6.210	18.726	0.889	1.125
Sedatives	1.163	0.830	–9.539	11.866	0.590	1.695
paralytics	3.517	0.304	–3.217	10.252	0.624	1.604
APACHE – 2 score	–0.027	0.819	–0.261	0.207	0.670	1.492
Undesignated ICU	4.206	0.005	1.290	7.122	0.884	1.131

ECMO – extracorporeal membrane oxygenation

C. Multiple linear regressions of variables determining number of days alive in hospital

Variable predicting days alive in first 30 days after admission	Unstandardised coefficients	Significance	95% CI for β		Collinearity statistics	
	β		Lower bound	Upper bound	Tolerance	VIF
Hypotension	1.380	0.211	–0.787	3.548	0.830	1.205
Ventilation	–0.708	0.732	–4.783	3.367	0.792	1.262
Vasopressors	–2.679	0.110	–5.973	0.614	0.698	1.433
Dialysis	0.243	0.845	–2.195	2.680	0.738	1.355
Bacterial infection	6.406	< 0.001	3.289	9.523	0.402	2.486
Bacteraemia	0.885	0.644	–2.890	4.660	0.279	3.578
Line infection	–0.133	0.941	–3.648	3.383	0.343	2.912
Steroids	2.543	0.078	–0.283	5.368	0.843	1.186
Tracheostomy	6.643	< 0.001	3.518	9.768	0.867	1.154
ECMO	5.370	0.020	0.847	9.892	0.888	1.126
Paralytics	3.449	0.094	–0.587	7.485	0.730	1.370
APACHE – 2 score	–0.175	0.029	–0.332	–0.018	0.733	1.364
Undesignated ICU	7.073	< 0.001	4.986	9.161	0.893	1.120

ECMO – extracorporeal membrane oxygenation

staff (because the COVID-19 risk of exposure led to extraordinary precautions taken by staff, this may have positively affected the process).

Regarding the length of stay in the ICU, we also found that patients cared for at undesignated ICU beds had longer stays in the ICU. Other factors predictive of longer stay were tracheostomy, steroids, and ECMO, for obvious reasons. Secondary bacterial infection was associated with a shorter length of stay because they had higher mortality and may have died early in the course of illness. Similar results have been documented by others [12]. Schwebel *et al.* [3] documented that intrahospital transfers increase the LOSICU. However, their study was of non-COVID-19 patients. Ng *et al.* [9] documented that patients with end stage kidney disease (ESKD) have increased odds of having more than 7 days of LOSICU compared to those without ESKD.

We identified the following limitations of our study: it was a single-centre, retrospective study with a small sample size, and the population was predominantly young males. Therefore, the findings of our study may not be applicable to other communities. We did not record the composition of complications (loss of PEEP, displacement of endotracheal or chest tube, etc.) that might have helped us to understand this process. This is the question we are presently studying in an ongoing study. We also did not record details of isolated pathogens that could affect the outcome. Similarly, details of the strategy of mechanical ventilation were not recorded. Finally, we did not record the nurse-to-patient ratio for either clinical setting. Nonetheless, this was the first step to document and reassure that extra transfers and care outside designated ICU areas do not adversely affect the clinical outcome.

CONCLUSIONS

Care of COVID-19 ARDS patients outside of designated ICU areas does not seem to affect clinical outcomes of mortality, length of stay in hospital, length of stay in ICU, or duration of mechanical ventilation.

ACKNOWLEDGEMENTS

1. Assistance with the article: none.
2. Financial support and sponsorship: none.
3. Conflicts of interest: none.
4. Presentation: none.

REFERENCES

1. Guan WJ, Ni ZY, Hu YU, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2020; 382: 1708-1720. doi: 10.1056/NEJMoa2002032.
2. Ma X, Vervoort D. Critical care capacity during the COVID-19 pandemic: Global availability of intensive care beds. J Crit Care 2020; 58: 96-97. doi: 10.1016/j.jcrc.2020.04.012.
3. Schwebel C, Clec'h C, Magne S; OUTCOMEREA Study Group. Safety of intrahospital transport in ventilated critically ill patients: a multicenter cohort study. Crit Care Med 2013; 41: 1919-1928. doi: 10.1097/CCM.0b013e31828a3bbd.
4. Braman S, Dunn S, Amico C, et al. Complications of intrahospital transport in critically ill patients. Ann Intern Med 1987; 107: 469-473. doi: 10.7326/0003-4819-107-4-469.
5. Henry B. COVID-19, ECMO, and lymphopenia: a word of caution. Lancet Respir Med 2020; 8: e24. doi: 10.1016/S2213-2600(20)30119-3.
6. Cheng Y, Luo R, Wang K, et al. Kidney disease is associated with in-hospital death of patients with COVID-19. Kidney Int 2020; 97: 829-838. doi: 10.1101/2020.02.18.20023242.

7. Vinsonneau C, Camus C, Combes A, et al. Continuous venovenous haemodiafiltration versus intermittent haemodialysis for acute renal failure in patients with multiple-organ dysfunction syndrome: a multicentre randomised trial. Lancet 2006; 368: 379-385. doi: 10.1016/S0140-6736(06)69111-3.
8. Yang Y, Shi J, Ge S, et al. Effect of continuous renal replacement therapy on all-cause mortality in COVID-19 patients undergoing invasive mechanical ventilation: a retrospective cohort study. medRxiv 2020. doi: https://doi.org/10.1101/2020.03.16.20036780.
9. Ng JH, Hirsch JS, Wanchoo R, et al.; Northwell COVID-19 Research Consortium and the Northwell Nephrology COVID-19 Research Consortium. Outcomes of patients with end-stage kidney disease hospitalized with COVID-19. Kidney Int 2020; 98: 1530-1539. doi: 10.1016/j.kint.2020.07.030.
10. Gideskog M, Welander J, Melhus Å. Cluster of S. maltophilia among patients with respiratory tract infections at an intensive care unit. Infect Prev Pract 2020; 2: 100097. doi: 10.1016/j.infpip.2020.100097.
11. Szem JW, Hydo LJ, Fischer E, et al. High-risk intrahospital transport of critically ill patients: Safety and outcome of the necessary "road trip". Crit Care Med 1995; 23: 1660-1666. doi: 10.1097/00003246-199510000-00009.
12. Shafran N, Shafran I, Ben-Zvi H, et al. Secondary bacterial infection in COVID-19 patients is a stronger predictor for death compared to influenza patients. Sci Rep 2021; 11: 12703. doi: 10.1038/s41598-021-92220-0.