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DETERMINANT FACTORS FOR A LONG STAY IN INTENSIVE CARE FOR COVID-19 PATIENTS

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ABSTRACT

Introduction: The COVID-19 pandemic has put unprecedented pressure on healthcare systems, with a rising demand for hospital and intensive care unit (ICU) services worldwide. As the pandemic intensifies, a key priority for many countries has become determining the healthcare resource needs, including beds, staff, and equipment. Forecasting future demand requires an estimation of the duration for which COVID-19 patients need different levels of hospital care, particularly in intensive care and ICUs. **Objective:** The objective of this work was to identify the determinant factors of a long stay (LOS) in intensive care for patients with severe COVID-19 pneumonia. **Methods:** This was a six-month case-control study conducted at the HMMV COVID-19 intensive care unit from August 2020 to February 2021. The study included patients hospitalized for COVID-19 pneumonia, with a diagnosis confirmed by a positive PCR test or based on clinical, biological, and radiological findings. Data were collected from the medical records of patients admitted to the ICU, including age, sex, BMI, and comorbidities such as diabetes, hypertension (HBP), cardiovascular diseases, asthma, COPD, hypothyroidism, and neoplastic pathologies. The degree of lung involvement from a CT scan and the use of mechanical ventilation (MV) were also recorded. The primary outcome was the length of stay in intensive care, defined as the time from admission to discharge (either by transfer, death, or survival). A patient was considered to have a "long stay" if they remained in the ICU for more than 5 days. **Results:** During the study period, 300 patients who tested positive for SARS-CoV-2 were admitted to the ICU. The average age of the patients was 67 ± 11 years, and 217 were male (72.3%). The majority of patients had medical comorbidities, with the most common being diabetes (35.7%), hypertension (31.8%), and obesity (29.7%). The length of stay ranged from 2 to 30 days, with a mean duration of 7.12 days and a median of 6 days. Using a multivariate logistic regression analysis, the adjusted odds ratios (ORa) showed a significant association between a long of stay (LoS) and the following factors:

- **Mechanical ventilation (MV)**: ORa 3.38 (95% CI 1.67–6.83).
- **Obesity**: ORa 6.25 (95% CI 15.3–2.56).
- **Neoplastic pathologies** : ORa 4 (95% CI 13.69–1.14).
- **Diabetes**: ORa 2.55 (95% CI 1.34–4.85).

Other factors, including age, sex, and radiological findings, did not show a significant association with a prolonged stay. **Conclusion:** In this study, it appears highly probable that mechanical ventilation, obesity, and neoplastic pathologies are the factors most strongly associated with a long stay in intensive care for patients with COVID-19 pneumonia. In the absence of local data, identifying these factors can be used to model bed demand for planning ICU and intensive care services, thereby optimizing the management of resources and critical care capacity.

I. INTRODUCTION

As of April 28, 2020, there were more than 3 million confirmed cases of COVID-19 and over 200,000 deaths across 185 countries and territories.[1] Healthcare systems have been challenged by the influx of patients with SARS-CoV-2, the pathogen causing COVID-19, which has spread globally since its emergence in late December 2019.[2–6] The risk of healthcare services being overwhelmed was most dramatically illustrated in Italy, where a rapid increase in COVID-19 cases requiring hospitalization pushed a well-equipped healthcare system—with 3.2 hospital beds per 1,000 inhabitants—to a breaking point.[7] This raised serious concerns about the potential impact on resource-limited healthcare systems in low- and middle-income countries as the epidemic began to spread in Africa and South America.

Understanding and forecasting the demand for hospital beds, as well as the associated needs for staff and equipment, provides crucial evidence for decision-making and emergency planning.[7,8] Predicting the demand for hospital services requires estimating the number of patients who will need hospitalization and the duration of their stay. While hospitalization rates can be modeled based on estimated epidemic curves, estimating the length of stay, especially in intensive care and resuscitation services, requires observing individual patient journeys.

COVID-19 presents with varying levels of severity. Hospital care can range from general ward care to high-dependency units with oxygen assistance, to intensive care where patients may be intubated for mechanical ventilation.[8-10] The length of stay likely depends on the severity of the illness and the required level of care, as well as patient characteristics such as demographics and comorbidities. These factors impact disease severity[8,12–14] and are therefore likely to influence the duration of the stay. As a result, capacity planning may need to consider these characteristics to provide accurate forecasts of the number of beds required at each level of care. The objective of this study is to highlight the various determinants that can influence the length of stay in intensive care and resuscitation services. By conducting this work, we aim to inform the efforts of modelers and policymakers to better anticipate healthcare needs during the evolving COVID-19 pandemic.

II. MATERIALS AND METHODS

1. Study Type, Location, and Period: This was a case-control study conducted in the COVID-19 intensive care unit of HMMV over a 6-month period, from August 2020 to February 2021.

2. Study Sample: The study included patients hospitalized in the intensive care unit for COVID-19 pneumonia, with a diagnosis confirmed by a positive COVID-19 polymerase chain reaction (PCR) test or based on clinical, biological, and radiological findings. These patients met the admission criteria for intensive care and intensive care units as defined by the SFAR (French Society of Anesthesia and Intensive Care Medicine).

3. Data Collection: A medical data sheet was created to collect information from the patients' medical records, which were written by the on-duty physician of the COVID-19 intensive care unit at the time of their admission. The collected data included: age, sex, BMI, diabetes, hypertension (HBP), cardiac pathologies, asthma, COPD, hypothyroidism, neoplastic pathologies, the degree of pulmonary CT scan involvement, recourse to mechanical ventilation (MV), the length of stay in intensive care, and the outcome (survival or death).

4. Variable Definitions: The primary outcome was the length of stay in intensive care. The exposure factors were as follows:

- **Age:** Two groups (>59 years and <59 years)
- **Sex:** Male or female
- **Obesity:** Any patient with a BMI > 30 was considered obese.
- **Diabetes:** History of diabetes or fasting blood glucose (FBG) > 1.26 measured twice.
- **Hypertension (HTA):** History of HTA or blood pressure (BP) > 140/90 measured twice after a 15-minute rest interval.
- **Cardiac pathologies:** All subjects followed for ischemic, arrhythmogenic heart disease, or heart failure.
- **Asthma:** History of asthma.
- **COPD:** Cough + expectoration 3 months/year for two consecutive years.
- **Chronic Renal Failure (CRF):** History of CRF (eGFR < 60 mL/min/1.73 m² for more than 3 months).
- **Neoplastic pathology:** History of neoplastic pathologies.
- **Hypothyroidism:** History of hypothyroidism.
- **MV:** Recourse to mechanical ventilation.
- **CT scan:** Two groups (<50% and >50% radiological lesions).
- **Long stay in intensive care:** Measured in days. It was calculated as the date of discharge from the intensive care unit (by death, discharge, or transfer) minus the date of admission. Any patient who stayed for > 5 days was considered to have a long stay.

5. Data Analysis: Statistical analysis was performed using IBM SPSS statistical software (version 10). Continuous variables were expressed as mean +/- standard deviation and compared using the Student's t-test; categorical variables were expressed as percentages and compared using the Chi-square test or Fisher's exact test. Bivariate and multiple logistic regression models were used to generate unadjusted odds ratios (ORc) and adjusted odds ratios (ORa) with 95% confidence intervals (CI) for significance testing. Variables that reached a p-value < 0.05 in bivariate analysis were entered into the multiple logistic regression models.

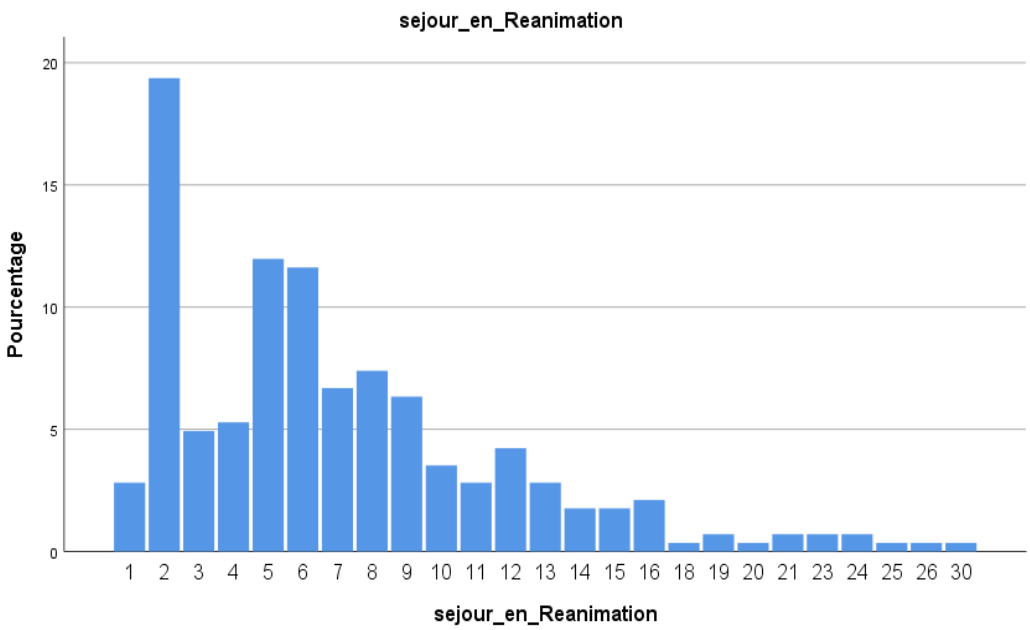
The work was approved by the ethics committee of the Biomedical Research Faculty of the Faculty of Medicine and Pharmacy of Rabat.

III. RESULTS

During the study period, among all patients who tested positive for SARS-CoV-2, 300 were admitted to intensive care. The mean age of the patients was 67 ± 11 years, and 217 were male (72.3%), with a male-to-female ratio of 2.61. The majority of patients had a medical comorbidity (Table I), predominantly diabetes (35.7%), hypertension (31.8%), obesity (29.7%), cardiovascular diseases (20.3%), asthma (4.7%), COPD (7%), hypothyroidism (3.7%), chronic renal failure (3.3%), and neoplastic pathologies (4.3%). The number of patients who received mechanical ventilation was 69 (23%). One hundred seventy-eight (59.3%) had radiological lesions of less than 50%, and 122 (40.7%) had lesions >50%. The length of stay varied between 2 and 30 days, with a mean duration of 7.12 days and a median of 6 days (Graph I).

Table I: Distribution of comorbidities in patients.

		N	Pourcentage marginal
Décès	Oui	180	60,0%
	Non	120	40,0%
Sexe	F	82	27,3%
	M	218	72,7%
Age	<59	57	19,0%
	>59	243	81,0%
Obésité	Non	211	70,3%
	Oui	89	29,7%
Diabète	Non	193	64,3%
	Oui	107	35,7%
Hypothyroïdie	Oui	11	3,7%
	Non	289	96,3%
IRC	Oui	10	3,3%
	Non	290	96,7%
Pathologie néoplasique	Oui	13	4,3%
	Non	287	95,7%
Asthme	Oui	14	4,7%
	Non	286	95,3%
BPCO	Oui	21	7,0%
	Non	279	93,0%
Pathologie cardiaque	Oui	60	20,0%
	Non	240	80,0%
HTA	Non	205	68,3%
	Oui	95	31,7%



Graphique I: disproportion de la durée de séjour.

Bivariate and multiple logistic regression models were used to generate unadjusted odds ratios (ORc) and adjusted odds ratios (ORa) with 95% confidence intervals (CI) for significance testing. Variables that achieved a p-value of <0.05 in the bivariate analysis were then entered into the multiple logistic regression models (Table II and III).

Table II: Caractéristiques des patients hospitalisés présentant un COVID-19 grave par rapport à la durée de séjour.

Variable	Categories	Total N (%)	Long séjour N (%) (LoS)	Court séjour N (%)	p-value
Age	<59	57 (19%)	38(19.8%)	19(17.6%)	0.64
	>59	243(81.3%)	154(80.2%)	89(82.4%)	
Sexe	Female	82(27.3%)	52(63.4%)	30(36.6%)	0.89
	Male	218(72.7%)	140(64.2%)	78(35.8%)	
Diabete	No	193(64.3%)	113(58.5%)	80(41.5%)	0.008
	Yes	107(35.7%)	79(73.8%)	28(26.2%)	
HTA	No	205(68.3%)	121(59%)	84(41%)	0.008
	Yes	95(31.7%)	71(74.7%)	24(25.3%)	
Obesité	No	211(70.3%)	117(55.5%)	94(44.5%)	<0.001
	Yes	89(29.7%)	75(84.3%)	14(15.7%)	
Pathologies cardiovasculaires	No	240(80%)	146(60.8%)	94(39.2%)	0.02
	Yes	60(20%)	46(76.7%)	14(23.3%)	
Asthme	Yes	14(4.7%)	7(50%)	7(50%)	0.26
	No	286(95.3%)	185(64.7%)	101(35.3%)	
BPCO	Yes	21(7%)	12(57.1%)	9(42.9)	0.49
	No	279	180(64.5%)	99(35.5)	
Hypothyroidism	Yes	17(5.7%)	11(64.4%)	6(35.3%)	0.95
	No	289	181(64%)	102(36%)	
Pathologies neoplasique	Yes	14(4.7%)	5(35.7%)	9(64.3)	0.024
	No	287	187(65.4%)	99(34.6%)	
IRC	Yes	17(5.7%)	11(64.7%)	6(35.3%)	0.95
	No	290	181(64%)	102(36%)	
VM	Yes	69(23%)	55(79.7%)	14(20.3%)	0.02
	No	231(77%)	137(59.3%)	94(40.7%)	
TDM	<50%	178(59.3%)	121(68%)	57(32%)	0.083
	>50%	122(40.7%)	71(58.2%)	51(41.8%)	

Table III: Analyse de régression logistique multivariés pour le risque de long séjour en réanimation pour les patients COVID 19 grave.

Variable	Categories	Total N(%)	Long séjour N(%)	Court séjour N(%)	ORc (IC95%)	ORa (IC95%)
age	<59	57 (19%)	38(19.8%)	19(17.6%)	1.15(0.62-2,12)	
	>59	243(81.3%)	154(80.2%)	89(82.4%)		
sex	Female	82(27.3%)	52(63.4%)	30(36.6%)	0.96(0,57-1.63)	
	Male	218(72.7%)	140(64.2%)	78(35.8%)		
Diabetes	No	193(64.3%)	113(58.5%)	80(41.5%)	2(3.44-1.19)	2,55 (1,34-4,85) *
	Yes	107(35.7%)	79(73.8%)	28(26.2%)		
HBP	No	205(68.3%)	121(59%)	84(41%)	2.08(3.57-1.20)	0.86(0.44-1.67)
	Yes	95(31.7%)	71(74.7%)	24(25.3%)		
obesity	No	211(70.3%)	117(55.5%)	94(44.5%)	4.34 (8.33-2,32)	6.25(15.3-2.56)
	Yes	89(29.7%)	75(84.3%)	14(15.7%)		
Hearth diseases	No	240(80%)	146(60.8%)	94(39.2%)	2.12 (4.16-1.11)	1.34(0.54-3.14)
	Yes	60(20%)	46(76.7%)	14(23.3%)		
Asthma	Yes	14(4.7%)	7(50%)	7(50%)	0.54(0,18-1.60)	

	No	286(95.3%)	185(64.7%)	101(35.3%)		
BPCO	Yes	21(7%)	12(57.1%)	9(42.9)	0,73(0,29-1,80)	
	No	279	180(64.5%)	99(35.5)		
Hypothyroidism	Yes	17(5.7%)	11(64.4%)	6(35.3%)	1,033(0,37-2.87)	
	No	289	181(64%)	102(36%)		
Pathologie neoplasique	Yes	14(4.7%)	5(35.7%)	9(64.3)	3.44(10.41-1.11)	4(13.69-1.14)*
	No	287	187(65.4%)	99(34.6%)		
IRC	Yes	17(5.7%)	11(64.7%)	6(35.3%)	0.47(0,24-0,90)	
	No	290	181(64%)	102(36%)		
VM	Yes	69(23%)	55(79.7%)	14(20.3%)	2.69(1.41-5.12)	3.38(1.67-6.83)*
	No	231(77%)	137(59.3%)	94(40.7%)		
TDM	<50%	178(59.3%)	121(68%)	57(32%)	1.63(2.63-1.005)	
	>50%	122(40.7%)	71(58.2%)	51(41.8%)		

IV. DISCUSSION

It is essential to understand how long COVID-19 patients stay in the hospital to plan and forecast bed occupancy, as well as the associated needs for staff and equipment. Observations of the length of stay (LOS) for COVID-19 patients published in the literature to date have ranged from less than one week to almost two months. ICU stays were shorter and less variable, with studies reporting a median of 1 to 3 weeks. When LOS was reported by discharge status, the stay was found to be shorter for deceased patients than for those discharged alive; however, this difference was only apparent in terms of total LOS, not for the ICU stay (no statistical comparison was made) (13). In terms of practical implications, knowing the difference between survivors and non-survivors is less useful because the outcome is not known in advance to influence decision-making.

The ICU LOS in our study was between 2 and 30 days with a mean duration of 7.12 days, compared to other studies where the duration varied from 5 (IQR 2-9) to 19 days (no IQR reported). There appears to be less difference based on discharge status (alive or dead) than there was for the total LOS. In total, 8 studies have reported ICU LOS estimates, with the same number of studies reporting estimates from within China and outside of China, and the resulting overall estimates are very similar.

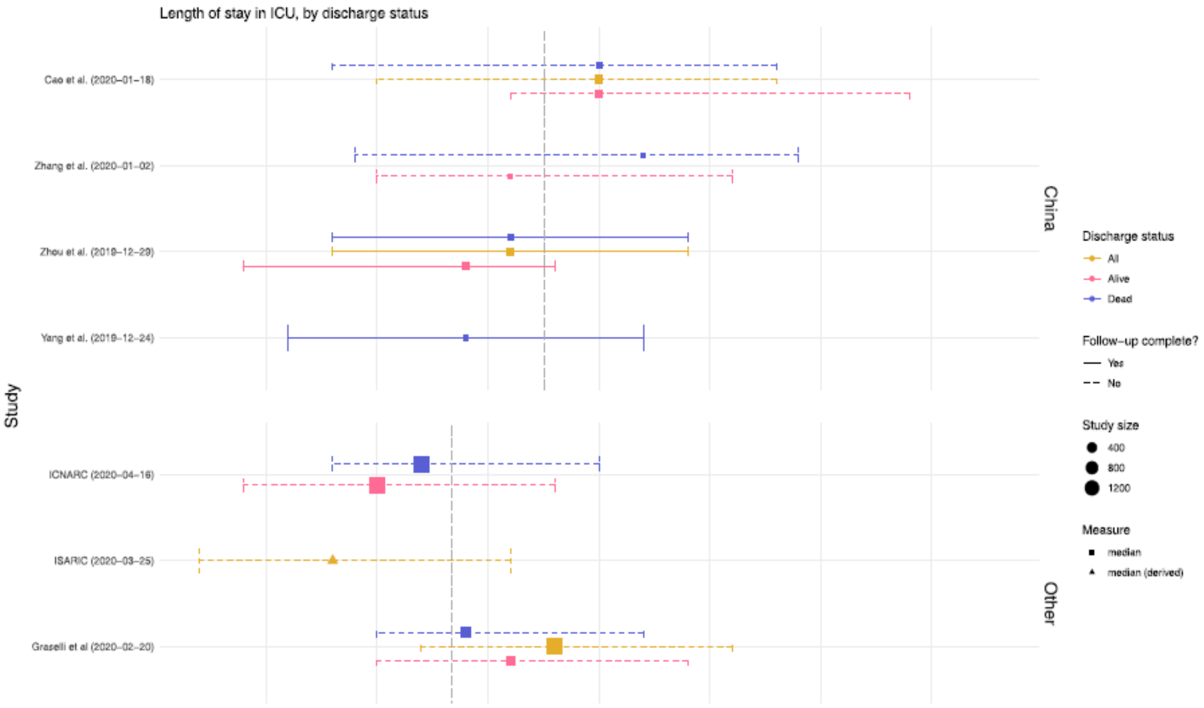


Fig. 1: Length of stay in intensive care, by discharge status. Medians (squares) are presented with the interquartile range (IQR). When estimates were reported as mean and standard deviation, the equivalent quantiles were calculated assuming a Weibull distribution (triangle); if no measure of variation was reported, only the original mean is presented (circle). The gray dotted lines represent the average value of all point estimates within this framework, weighted by sample size. Studies are ranked by study start date.

Very few studies have been conducted to determine the determinant factors of a long ICU LOS. To the authors' knowledge, this is the first formal review conducted in a hospital setting for COVID-19. Comparisons with other countries are less informative due to differences in populations and healthcare systems. Differences between countries may result from local capacities and the pressure on the healthcare system. It is also important to note that there can be significant differences between ICUs in China and other countries, and a definition of what constitutes an intensive care unit has rarely been reported. Previous studies have shown that ICU characteristics vary considerably by geographical region.[16]

Age We found that the length of stay was not monotonic with age (i.e., it did not consistently increase or decrease), with a non-significant p-value and an adjusted OR (ORa) of 1.15 (0.62–2.12), concluding the absence of an association between age and prolonged LOS. This is contrary to the relationship between age and the severity and mortality of COVID-19.[14] Our findings are consistent with a study conducted in England.[15] It should be noted that our sample was very selective (i.e., it included patients who were sick enough to be in the ICU), for example, for patients with the same level of severe COVID-19 symptoms, younger patients were more likely to be hospitalized than older and more frail patients.[15]

Sex We found no evidence that the ICU length of stay is related to the patient's sex with p=0.89 and ORa 0.96 (0.57–1.63), and this was consistent with other studies conducted in China and England.[15,20]

Obesity Obesity was among the main determinants of an ICU LOS, with a very significant p-value and an ORa of 4.34 (8.33–2.32). Any patient with a BMI >30 is 4.34 times more likely to have a prolonged stay in intensive care compared to others.

Comorbidities Of all the comorbidities studied, only diabetes 2 (3.44–1.19), HTA 2.08 (3.57–1.20), cardiovascular diseases 2.12 (4.16–1.11), and neoplastic pathologies 3.44 (10.41–1.11) were significant. After their integration into multivariate logistic regression models, it appears that diabetes ORa 2.55 (1.34–4.85) and neoplastic pathologies are the factors associated with a long stay in intensive care.

Mechanical Ventilation It appears that mechanical ventilation is strongly associated with a long stay in intensive care ORa 3.38 (1.67–6.83).

TDM Radiological lesions seem to have no influence on the length of stay in intensive care, with a non-significant ORc of 1.63 (2.63–1.005).

Included studies provide some evidence of a difference between total hospital stays observed in China and outside of China, with shorter stays in the latter group (14 days (10–19) vs. 5 days (3–9), respectively). However, only five studies were identified that reported length of stay outside of China, making the comparison less conclusive.

Differences between countries may result from local capacities and the pressure on the healthcare system. We attempted to capture this difference by recording the delay between symptom onset and admission; however, only one study outside of China reported this difference, and a comparison was not possible. It is also possible that after witnessing the Chinese epidemic, other countries set less strict discharge criteria in anticipation of a stretch of capacities. It is also possible that other countries used Chinese data to improve treatment methods and thus shorten the time to care. Unfortunately, this seems unlikely, as we did not observe a trend when examining estimates of admission times over time. In contrast, no difference was observed between the settings for the length of stay in intensive care, for which an equal number of studies from China and elsewhere were included. It is important to note that there can be significant differences between intensive care units in China and other countries, but a definition of what constitutes an intensive care unit has rarely been reported. Previous studies have shown that ICU characteristics vary considerably by geographical regions.[17] It is important to better understand the characteristics of ICUs reporting LOS for COVID-19 patients to provide context for the reported estimates and to examine them in future studies. In our results, there appears to be little difference in the observed LOS based on age, except for the fact that studies that reported deaths tended to have older patient populations. However, if a trend does exist, it is unlikely that we can see strong evidence of it among these studies, since the majority of them include a similar mix of ages, often tending toward older cohorts, and the age distribution was not always provided for the specific subgroup for which LOS had been recorded. Two studies[16,17,18,19,20] were included in the review that reported length of stay based on age, and they both found a longer length of stay associated with higher age groups. In addition, two U.S. studies on disease duration, published after the search dates, also reported a trend toward longer disease duration in higher age groups.[16,17,18,19,20] The studies also reported LOS based on disease severity; however, the definitions of disease severity were not consistent from one study to another, and we therefore did not synthesize on this topic. This comparison is not very conclusive. It is possible that the length of stay is longer in China than in other countries due to the different admission and discharge criteria. There is a consensus between the guidelines, such as ensuring the resolution of symptoms and evidence of two negative PCR samples at least 24 hours apart before discharge.

For England, the median ICU stay varied from 5 (IQR 2–9) to 19 days (no IQR reported). There appears to be less of a difference based on discharge status (alive or dead) than there was for the total lifespan. In total, 8 studies have reported ICU LOS estimates, with an equal number of studies from China and outside of China, and the resulting overall estimates are very similar. There were too few studies to make a comparison based on age or disease severity.

Our estimate of the average length of stay for patients in intensive care was more than sixteen days. The median, nearly eleven days, is similar to the values reported by the ICNARC for England (twelve days for survivors, nine for non-survivors; or 10.8 for either outcome on July 3; 10.1 on June 5). Our estimates are adjusted for censored cases, which have a longer-than-average lifespan in the sample. Comparisons with other countries are less informative due to differences in populations and healthcare systems.[17]

That is, areas with more vulnerable elderly populations may require more medical resources to cope with longer hospital stays.

CONCLUSION

In this approach to identifying the determinant factors of a long stay in intensive care, it seems highly probable that mechanical ventilation, obesity, and neoplastic pathologies would be the factors most associated with a long stay in intensive care for patients with COVID-19 pneumonia. In the absence of local data, the identification of these factors can be used for modeling bed demand for the planning of ICUs and resuscitation services, thereby optimizing resource management and capacity, particularly in critical care.

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