Association of Ventilator Type with Hospital Mortality in Critically Ill Patients with SARS-CoV2 Infection: A Retrospective Study.

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Abstract

Background: To evaluate the association between ventilator type and hospital mortality in patients with acute respiratory distress syndrome (ARDS) related to COVID-19 (SARS-CoV2 infection) during the first wave of the disease in France.

Methods: We retrospectively included consecutive adults admitted to the intensive care unit (ICU) of a university-affiliated tertiary hospital for ARDS related to proven COVID-19, between March and May 2020. All patients were intubated. We compared two patient groups defined by whether an ICU ventilator or a less sophisticated ventilator such as a transport ventilator was used. Kaplan-Meier survival curves were plotted. Cox multivariate regression was performed to identify associations between patient characteristics and hospital mortality.

Results: We included 82 patients (61 [74.4%] men) with a median age of 64 years [55–74], of whom 23 (28.1%) died before hospital discharge. By multivariate analysis, factors associated with in-hospital mortality were older age (HR, 1.06/year; 95%CI, 1.00–1.11; *P*=0.05) and diabetes mellitus (HR, 3.32; 95%CI, 1.13–9.76; *P*=0.03) but not ventilator type. Using non-ICU ventilator was associated neither with a longer duration of invasive mechanical ventilation (20 [12-36] vs. 25 [15-31] days; *P*=0.87) nor with a longer ICU stay (24 [14-40] vs. 27 [15-37] days; *P*=0.64).

Conclusions: In patients with ARDS due to COVID-19, the use of non-ICU ventilators, such as transport ventilators, was not associated with worse outcomes. Although prospective data are needed to confirm our findings, this study suggests that transport ventilators may be valuable during COVID-19 surges that overwhelm ICU resources.

Take Home Message

During the first COVID-19 wave when many healthcare systems were overwhelmed and ICUs saw huge surges in admissions, using transport ventilators after admission was associated neither with higher in-hospital mortality nor with longer invasive mechanical ventilation duration in critically ill patients with SARS-CoV2 infection-related ARDS. Thus, transport ventilators proved to be safe alternatives to ICU ventilators during this first COVID-19 surge.

Background

The current COVID-19 pandemic, caused by the SARS-CoV2 virus, is evolving in waves that put healthcare systems under severe strain [1–4]. Nearly 10% of patients with COVID-19 have severe acute respiratory distress syndrome (ARDS) that requires admission to the intensive care unit (ICU) and, in many cases, invasive mechanical ventilation (MV) [5–9]. As a consequence, waves of COVID-19 often stretch the available ICU resources far beyond their intended limits [10]. Transient ICU beds must then be created in operating rooms, emergency departments, and other parts of the hospital. These beds need to be equipped, most importantly with competent staff and also with ventilators.

The management of ARDS relies on lung-protective ventilation according to international recommendations [11]. Only sophisticated ventilators have the technical capabilities required for optimal lung-protective ventilation, notably close monitoring of the plateau and driving pressures and of compliance. In many hospitals, surges in ICU admissions during waves of COVID-19 result in a shortage of these sophisticated ICU ventilators. To fill this gap, simpler ventilators such as those designed for patient transport are used. These simpler ventilators could be less efficient for the treatment of ARDS. Moreover, physiological studies have demonstrated an influence of ventilator type on patient comfort, work of breathing, and patient-ventilator asynchronies, with considerable variations across ventilator models [12]. An investigation of the potential association between the use of transport ventilators and the survival of patients with COVID-19-related ARDS was therefore timely.

The primary objective of this study was to look for an association linking the type of ventilator used (ICU or transport) and hospital mortality in patients requiring MV for COVID-19-related ARDS. The secondary objectives were to look for associations linking ventilator type to invasive MV duration, ventilation outcomes (prone positioning, rescue inhaled nitric oxide and extracorporeal membrane oxygenation [ECMO], and ventilator-free days), and day-90 mortality.

Methods

This study was approved by the ethics committee of the French Intensive Care Society (#20–42) and registered at the French National Institute for Health Data (#MR 4109060520). Informed consent was sought from the next of kin, if available, and from the patients upon recovery of competency, in compliance with French law.

Patients

Consecutive adults admitted between March 5 and May 12, 2020, to one of the four Versailles hospital ICUs for severe proven SARS-CoV2 infection were prospectively included in the RESPI-COVID19 registry. For the retrospective analysis of this study, only patients with ARDS related to severe SARS-CoV2 infection requiring invasive MV were eligible. Patients who received MV for causes other than respiratory failure (e.g., non-hypoxic cardiac arrest, neurological disorder, or pregnancy-related disease) were not included.

Study setting and COVID-19 surge

The Versailles Hospital is a university-affiliated tertiary hospital in the Paris area with 800 medical and surgical beds. The 28-bed closed ICU has 20 ICU beds and 8 intermediate-care beds for continuous monitoring. In March 2020, the first wave of COVID-19 produced a sudden and massive increase in the numbers of patients with ARDS requiring critical care. Transient ICU beds for COVID-19 patients were set up in the intermediate-bed unit, the post-anesthesia care units, and the cardiology ICU. The total number of ICU beds was then 49, in four different places in the hospital. ICU ventilators were available for 27 beds. The remaining 22 beds were equipped with transport ventilators.

The choice of the place of ICU admission was made based on individual patient needs and on bed availability. Renal replacement therapy was available only in the conventional ICU.

Standardized ICU management of patients with COVID-19-related ARDS

The same standardized management protocol was used at all four ICU sites. At this early phase of the pandemic, whether virus aerosolization could occur with non-invasive ventilation (NIV) and/or high-flow nasal oxygen (HFNO) was unknown. Consequently, conventional oxygen therapy via a face mask was the preferred, albeit not exclusive, modality of initial oxygen administration [13]. The criteria for invasive MV initiation were persistent severe hypoxemia (SpO_2 < 90% despite 12–15 L/min face-mask oxygen or FiO_2 = 100% on NIV or HFNO) or persistent clinical signs of acute respiratory distress. Patients with ARDS as defined by the Berlin classification received neuromuscular blockade and prone positioning in compliance with recent international guidelines [11, 14–17]. Inhaled nitric oxide and/or recruitment maneuvers were performed as rescue therapy if deemed necessary by the physician in charge. The appropriateness of using rescue ECMO was discussed collegially with referral center specialists (ICU, Pitié-Salpêtrière Teaching Hospital, Paris, France) in all patients with prespecified criteria [18–20]. Prophylactic anticoagulation was given in a standard dosage based on patient weight until March 25 and in an intermediate dosage thereafter [21–23]. Bacterial co-infection at admission or during the ICU stay was carefully screened for and treated as appropriate. Rescue intravenous dexamethasone therapy, 20 mg/day for 5 days followed by 10 mg/day for 5 days was initiated on ICU day 7 in patients with persistent moderate-to-severe ARDS (PaO_2/FiO_2 < 150) and low respiratory dynamic compliance (< 30 mL/cmH_2O) despite ventilator setting optimization, intravenous neuromuscular blocking agent infusion, and prone positioning, according to international guidelines [14, 24, 25].

Definitions

Severe COVID-19 was defined as severe hypoxemia (either face mask with ≥ 6 L/min oxygen to maintain SpO_2 > 94% and symptoms of acute respiratory distress or face mask with ≥ 10L/min oxygen to maintain SpO_2 > 94%) requiring ventilatory assistance by NIV, HFNO, or invasive MV.

Proven SARS-CoV2 infection was defined as a positive RT-PCR result for SARS-CoV2 obtained on a respiratory tract sample (nasal or nasopharyngeal swab, tracheal aspirate, or bronchial aspirate).

We defined two groups based on comparative bench test results [26, 27]. The ICU group comprised the high-performance devices generally used in ICUs (e.g., Evita XL or Evita Infinity C500®, Dräger, Lübeck, Germany; Carescape R860®, General Electrics Healthcare, Boston, MA) or in operating rooms (e.g., Aisys CS2®, Datex Ohmeda, General Electrics Healthcare). The transport group comprised simpler ventilators generally designed for mobile interventions but used in transient ICUs set up to handle the surge of patients with severe COVID-19 (e.g., Monnal T60 and T75®, Air Liquide Healthcare, Paris, France; Elisée 350® and Elisée 250®, ResMed, Saint-Priest, France).

Data collection

Data for each patient were collected into an electronic file (Excel®, Microsoft, Redmond, WA) whose access was restricted by a code known only by the data collector [AF] and statistician [MD]). The data files were anonymized by assigning a number to each patient. We collected age, sex,, body mass index (BMI), chronic comorbidities (e.g., cancer, immune deficiency, diabetes mellitus, liver disease, heart failure, arterial hypertension, chronic respiratory disease, chronic kidney disease), and alcohol and tobacco use. We also recorded the clinical manifestations on the first day of COVID-19 symptoms, upon emergency team arrival, and during transport to the hospital, as well as the pre-hospital treatments given. Clinical and laboratory findings at ICU admission and during the ICU stay were recorded. The last PaO_2/FiO_2 ratio during spontaneous breathing just before intubation was calculated using the following formula: $PaO_2/(FiO_2 = 0.21 + 0.03 \cdot O_2$ in L/min delivered nasally or through a face-mask) [28]. The following data describing the ICU and hospital management were also collected: severity and description of organ failures according to the Simplified Acute Physiology Score II (SAPS-II) [29] and use of prone positioning, vasoactive drugs, sedation, neuromuscular blocking agents, renal replacement therapy, and ECMO.

We recorded the ventilator device used from ICU admission to ICU discharge, total MV duration, and total NIV and/or HFNO duration if relevant. Finally, we collected ICU and hospital lengths of stay, ICU mortality, in-hospital mortality, and day-90 mortality.

Statistical analysis

Quantitative parameters were described as median [interquartile range] and qualitative parameters as number (percentage). We compared categorical variables using Fisher's exact tests and continuous variables using Wilcoxon rank-sum tests.

Survival curves were obtained using the Kaplan-Meier estimator. To identify associations between patient characteristics and hospital mortality, a Cox proportional hazard analysis was performed for each variable. A multivariate model was then built with variables that yielded *P* values smaller than 0.05 by univariate analysis and/or were clinically relevant. Missing data were imputed using multivariate imputation by chained equations.

All tests were two-sided and *P* values < 0.05 were considered significant. Analyses were performed using the R statistical program version 4.0.3 (R Foundation for Statistical Computing, Vienna, Austria)*

*http://www.R-project.org. Accessed April 02, 2021.

Results

Patients

Figure 1 is the patient flowchart. Of the 101 critically ill patients with a positive RT-PCR for SARS-CoV2 managed in the four COVID-19 ICUs between March 5 and May 12, 2020, 82 were included in the study.

Table 1 reports the main patients characteristics. There were 61 (74.4%) men with a median age of 64 [IQR, 55–74] years. Obesity (BMI $\geq$ 30 kg/m^2) was present in 29 (35.8%) patients and a history of arterial hypertension and diabetes mellitus in 42 (51.2%) and 22 (26.8%) patients, respectively. Median time from symptom onset to ICU admission was 9 [IQR, 7–12] days.

Table 1
Baseline and ICU admission characteristics according to ventilator type in patients with acute respiratory distress syndrome due to COVID-19.

	N (%) or Median [interquartile range]				
	All patients n = 82	ICU ventilator n = 65 (79.3%)	Transport ventilator n = 17 (20.7%)	*P* value	N missing†
Demographic characteristics					
Age (years)	64 [55–74]	64 [55–74]	62 [55–74]	0.91	
Male sex	61 (74.4)	48 (73.9)	13 (76.5)	1	
Active smoking	5 (6.2)	5 (7.8)	0 (0.0)	0.58	1
Comorbidities					
Coronary artery disease	5 (6.1)	5 (7.8)	0 (0.0)	0.58	
Treated arterial hypertension	42 (51.2)	34 (52.3)	8 (47.1)	0.79	
Diabetes mellitus	22 (26.8)	17 (26.1)	5 (29.4)	0.77	
Immunodeficiency	7 (8.5)	7 (10.8)	0 (0.0)	0.34	
Obesity (BMI ≥ 30 kg/m^2)	29 (35.8)	22 (34.4)	7 (41.2)	0.78	1
BMI (kg/m^2)	27.8 [24.6–31.8]	27.7 [24.8–31.9]	28.5 [24-31.7]	0.93	1
Respiratory disease (COPD/Asthma/Bronchiectasis)	12 (14.6)	11 (16.9)	1 (5.9)	0.44	
Characteristics at ICU admission					
Simplified Acute Physiology Score II at ICU admission	40 [35–49]	40 [35–49]	38 [34–45]	0.47	
Time from symptom onset to ICU admission (days)	9 [7–12]	8 [7–12]	10 [8–11]	0.17	
Time from hospitalization to ICU admission (days)	1 [0–3]	1 [0–2]	2 [0–4]	0.15	
Pulmonary co-infection at ICU admission	4 (4.9)	4 (6.1)	0 (0.0)	0.58	
Oxygen requirements at ICU admission (L/min)	15 [13–15]	15 [14–15]	15 [13–15]	0.84	12*

	N (%) or Median [interquartile range]				
Laboratory tests at ICU admission					
Lactate (mmol/L)	1.4 [1.2–1.9]	1.5 [1.2–1.9]	1.4 [1.2–1.7]	0.47	
LDH (IU/L)	833 [688–1121]	897 [694–1156]	820 [679–877]	0.21	2
Lymphocytes (G/L)	0.75 [0.5–1.04]	0.81 [0.51–1.08]	0.63 [0.43–0.92)	0.23	1
C-reactive protein (mg/L)	185 [107–255]	212.5 [129–259]	112 [79–186]	0.05	14
Procalcitonin (ng/mL)	0.46 [0.2–1.5]	0.6 [0.24–1.81]	0.27 [0.17–0.36]	0.03	22
D-dimers (ng/mL)	1755 [1143–2740]	1870 [1290–2838]	1215 [873–1693]	0.09	16
Creatinine (µmol/L)	72.5 [59–97]	75 [63–99]	60 [54–69]	0.02	
Troponin (ng/mL)	0.01 [0.01–0.03]	0.01 [0.01–0.03]	0.01 [0.01–0.02]	0.70	17
NT-proBNP (pg/mL)	495 [184–1181]	486 [171–1115]	919.5 [317–1919]	0.53	50

† Number of missing observations, unless Ø

BMI: Body Mass Index; COPD: chronic obstructive pulmonary disease; ICU: intensive care unit; LDH: lactate dehydrogenase; CRP: NT-proBNP: NT-pro B-type natriuretic peptide

ICU management

At ICU admission, 12 (14.6%) of the 82 patients received orotracheal intubation and MV before ICU admission because of on-scene life-threatening respiratory distress and 70 (85.4%) patients received face-mask supplemental oxygen at a median rate of 15 [IQR, 13–15] L/min; of these 70 patients, 15 (21.4%) were switched to HFNO after ICU admission. All patients received MV within 24 h after ICU admission. The last PaO_2/FiO_2 ratio before intubation was 114 [IQR, 89–150], corresponding to a median FiO_2 of 66% [IQR, 51%-66%].

Comparison according to ventilator type

Of the 82 patients, 65 were managed with ICU ventilators and 17 with transport ventilators (Table 1). The only baseline differences between the two groups were for C-reactive protein, procalcitonin, and serum creatinine, which indicated more severe illness in the ICU-ventilator group. The two groups were not significantly different for the use of prone positioning, number of prone position sessions per patient, rescue use of inhaled nitric oxide, rescue use of ECMO, or frequency of ventilator-associated pneumonia (Table 2).

Table 2
ICU management and outcomes according to ventilator type in patients with COVID-19-related acute respiratory distress syndrome.

	N (%) or Median [interquartile range]				
	All patients n = 82	ICU ventilators n = 65 (79.3%)	Transport ventilators n = 17 (20.7%)	*P* value	N missing†
ICU management					
High-flow nasal oxygen	15 (18.3)	13 (20)	2 (11.8)	0.73	
Non-invasive ventilation	1 (1.2)	1 (1.5)	0 (0.0)	1	
Last PaO_2/FiO_2 ratio before intubation	114 [89–150]	114 [88–148]	120.7 [98–160]	0.61	17
First PaO_2/FiO_2 ratio under invasive MV	151 [106–192]	158 [121–195]	113 [88–150]	0.02	
Time from ICU admission to orotracheal intubation (days)	0 [0–0]	0 [0–0]	0 [0–0]	0.19	
Prone positioning	49 (59.8)	28 (58.3)	2 (40.0)	0.53	
Number of prone position sessions	4.0 [3-7.8]	4.0 [3-7.8]	4.5 [2.8–7.3]	0.78	
Inhaled nitric oxide	13 (15.9)	12 (18.5)	1 (5.9)	0.28	
ECMO	6 (7.3)	5 (7.7)	1 (5.9)	1	
Ventilator-associated pneumonia	44 (53.7)	34 (52.3)	10 (58.8)	0.79	
Weaning failure (≥ 2 orotracheal intubations)	13 (15.9)	9 (13.9)	4 (23.5)	0.45	
Tracheostomy	14 (17.1)	11 (16.9)	3 (17.7)	1	
Need for vasoactive drugs in the ICU	77 (93.9)	60 (92.3)	17 (100.0)	0.58	
Need for renal replacement therapy in the ICU	16 (19.5)	14 (21.5)	2 (11.8)	0.50	
Intravenous dexamethasone	17 (20.8)	16 (24.6)	1 (5.9)	0.11	
Outcomes					
Duration of invasive MV, days	21 [12–35]	20 [12–36]	25 [15–31]	0.87	

	N (%) or Median [interquartile range]				
ICU length of stay (days)	25 [14–39]	24 [14–40]	27 [15–37]	0.64	
ICU mortality	23 (28.1)	20 (30.8)	3 (17.7)	0.37	
Post-ICU hospital length of stay (days)	10 [7–14]	10 [8–14]	7 [6–11]	0.15	
Hospital mortality	23 (28.1)	20 (30.8)	3 (17.7)	0.37	
Rehabilitation-unit length of stay (days)	29 [19–42]	28 [19–41]	34 [22–45]	0.49	49
Day-90 mortality	24 (29.3)	21 (32.3)	3 (17.8)	0.37	

† Number of missing observations, unless Ø

ICU: intensive care unit; MV: mechanical ventilation; ECMO: extracorporeal membrane oxygenation

Determinants of hospital mortality

Figure 2 reports the Kaplan-Meier survival curves in the two ventilator-type groups. Overall in-hospital mortality was 28.1% (23/82) with no significant between-group difference ($P = 0.26$). By multivariate analysis (Fig. 3), the only variables significantly associated with hospital mortality were older age (hazard ratio [HR], 1.06; 95% confidence interval [95%CI], 1.00–1.11; $P = 0.05$) and diabetes mellitus (HR, 3.32; 95%CI, 1.13–9.76; $P = 0.03$).

Other outcomes

Table 2 reports the patient outcomes in the two ventilator-type groups. MV duration, ICU mortality, hospital mortality, and day-90 mortality showed no significant between-group differences. The median number of MV-free days on day 28 was non-significantly higher in the transport-ventilator group (2 [IQR, 0–9] days vs. 0 [IQR, 0–10] days in the ICU-ventilator group; $P = 0.38$).

Discussion

To our knowledge, this study is the first to provide detailed information regarding ICU outcomes according to the type of ventilator device used in patients with COVID-19-related ARDS managed during epidemic spikes. Using less sophisticated ventilators instead of ICU ventilators was not significantly associated with ICU, in-hospital, or day-90 mortality. Neither was there any between-group difference in MV duration or in ICU or hospital lengths of stay.

At the time of our study (March to May 2020), no etiological treatment had demonstrated efficacy against severe COVID-19. Consequently, the treatment relied solely on MV, other organ-supportive interventions, and symptomatic medications. We focused on patients admitted for COVID-19-related ARDS requiring

MV. Their baseline characteristics, with a median age of 64 years, three-fourths of males, and high prevalences of obesity, arterial hypertension, and diabetes are consistent with earlier data [30–33]. Among critically ill patients admitted for COVID-19 during the first wave in Europe, the proportion that required invasive MV was remarkably similar across countries, despite potential variability in national guidelines, suggesting a uniform clinical presentation [30–35]. Of 101 patients admitted to our four ICUs, 86% required invasive MV in keeping with previous reports of proportions ranging from 76–87% [30–35].

ICU mortality in patients with COVID-19-related ARDS has ranged across studies from 29–53% [30–34]. The mortality rate in our study of patients requiring MV was 28.1%, i.e., lower than in previous studies of populations with similar baseline characteristics [36, 37]. Differences in mortality may be related to differences in selection criteria for ICU admission and/or in bed availability. A German observational study had a median age of 71 years, compared to 64 years in our cohort [34]. Median MV duration was 21 days compared to 12 and 10 days in previous French and Italian ICU studies, respectively [33, 34]. This longer MV duration may have resulted in extubation being performed only after the end of virus shedding and/or of clinically significant lung inflammation. Severity scores were generally similar across cohorts, with a median SAPSII of 40 in our study and 37 in a French nationwide cohort with 38% hospital mortality [33]. The higher SAPS II score in our population compared to others may be related to the inclusion only of patients who required MV, whereas other cohorts included patients who received respiratory assistance of any type. The 29.3% day-90 mortality indicates that our survivors had good outcomes after hospital discharge, in keeping with an earlier study [33].

Our study suggests that, when no ICU ventilators are available, the use of transport ventilators to treat patients with COVID-19-related ARDS may be a valid alternative. A recent bench study used a Michigan test lung to evaluate the performances of four transport ventilators compared to an ICU ventilator [38]. In assist-control mode, three of the four transport ventilators both accurately controlled the volume delivered and had acceptable trigger delays; two of the three were the Monnal T60® (Air Liquide Healthcare, Paris, France) and Elisée 350® (ResMed, Saint-Priest, France) used in our transient ICUs.

The important limitations of our study must be acknowledged. First, patients with the greatest severity of critical illness were given priority for admission to the conventional ICU. The worse C-reactive protein, procalcitonin, and serum creatinine values in the ICU-ventilator group probably reflect this patient selection bias. The extent to which the more severe critical illness may have cancelled each other out cannot be determined. Second, the transient ICUs had fewer cubic meters per patient with no wall separations between beds, and could not offer renal replacement therapy. Thus, being treated with a transport ventilator was associated with many other management differences. Third, our study was done at the beginning of the COVID-19 pandemic, at a time when the disease was unknown, the benefits of early dexamethasone had not yet been identified, NIV and HFNO were believed to be unsafe for the staff due to virus aerosolization, and computed tomography prognostic criteria had not yet been described. Fourth, the sample size of 82 patients provided limited statistical power to detect significant differences between the two groups. Fifth, although the data were collected prospectively, we analyzed them retrospectively. This resulted in the absence of data that would have been of interest, for instance to

compare ventilatory mechanics such as plateau pressure, driving pressure or compliance. Finally, our study was done in a single center that may not reflect all ICUs in countries that have similar health resources. However, our population was comparable to those in studies done elsewhere.

Conclusion

In our population of critically ill patients with COVID-19-related ARDS managed at the beginning of the pandemic, ventilator type as one of several differences in ICU care was not associated with mortality, MV duration, or length of stay. Multicenter studies of larger populations managed based on the current knowledge of COVID-19-related ARDS are needed to further compare associations between ventilator type and patient outcomes.

Abbreviations

ARDS	**Acute respiratory distress syndrome**
BMI	**Body Mass Index**
COVID-19	**Coronavirus disease-2019**
CRP	C-reactive protein
ECMO	Extracorporeal membrane oxygenation
ICU	**Intensive care unit**
IQR	**Interquartile range**
LDH	Lactate dehydrogenase
MV	Mechanical ventilation
NT-proBNP	NT-pro B-type natriuretic peptide
PCT	Procalcitonin
RT-PCR	Reverse transcriptase-polymerase chain reaction
SAPS II	Simplified Acute Physiology Score II
SARS-CoV2	Severe acute respiratory syndrome-coronavirus 2

Declarations

Ethics committee approval and consent to participate

This study was approved by the ethics committee of the French Intensive Care Society (#20-42) and registered at the French National Institute for Health Data (#MR 4109060520). Informed consent was

sought from the next of kin, if available, and from the patients upon recovery of competency, in compliance with French law.

Consent for publication

Not applicable to this study of anonymized data

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of interest statement

None of the authors has any conflicts of interest to declare.

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Authors' contributions

AF contributed to design the study, collected the study data, and contributed to draft the manuscript.

SL contributed to design the study and to draft the manuscript.

FB contributed to design the study.

MD performed the statistical analysis.

All authors revised the manuscript for important intellectual content and approved the final version of the manuscript and its submission for publication.

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Figures

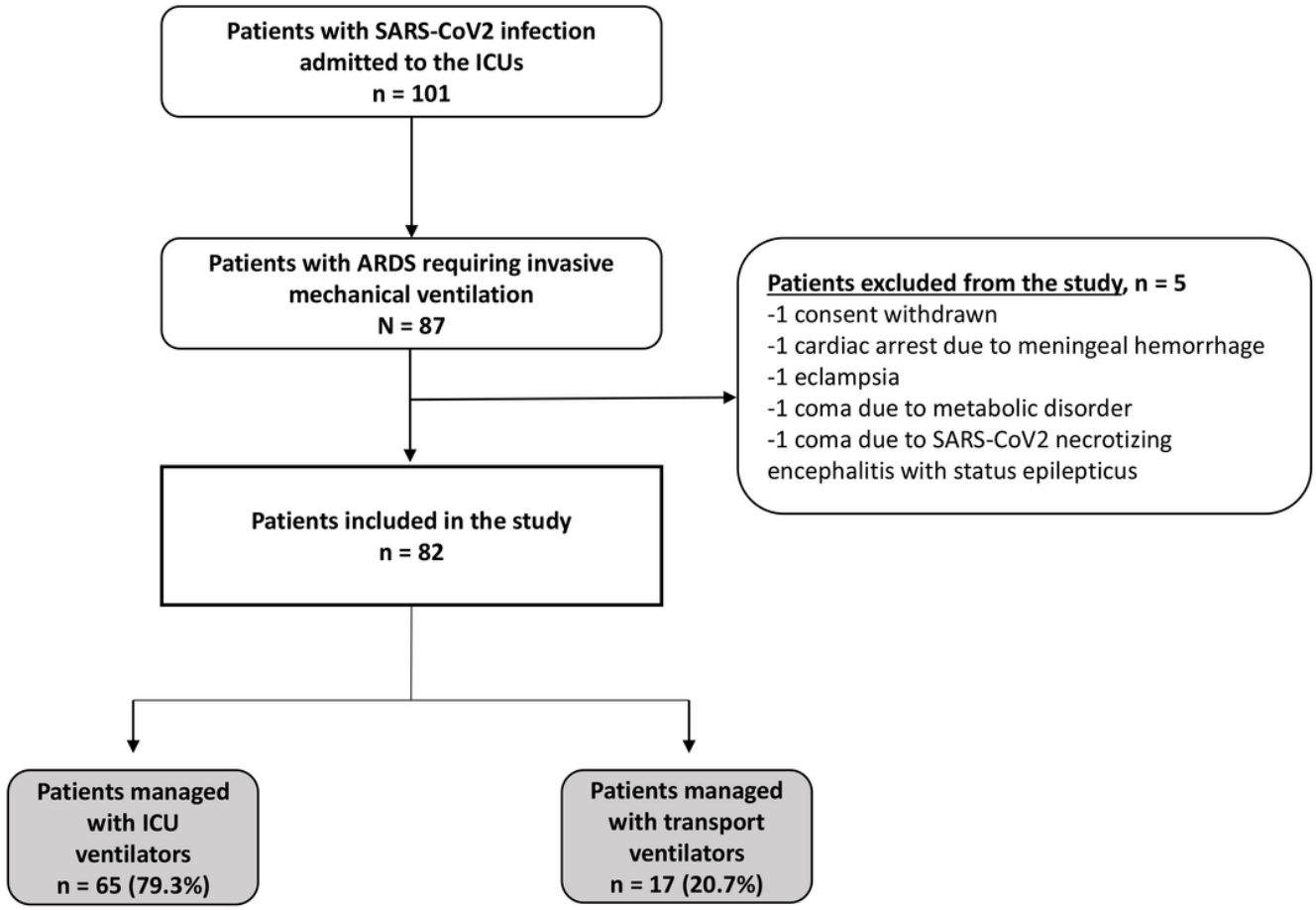

Figure 1

Patient flowchart SARS-CoV2: severe acute respiratory syndrome-coronavirus type 2; ARDS: acute respiratory distress syndrome; ICU: intensive care unit

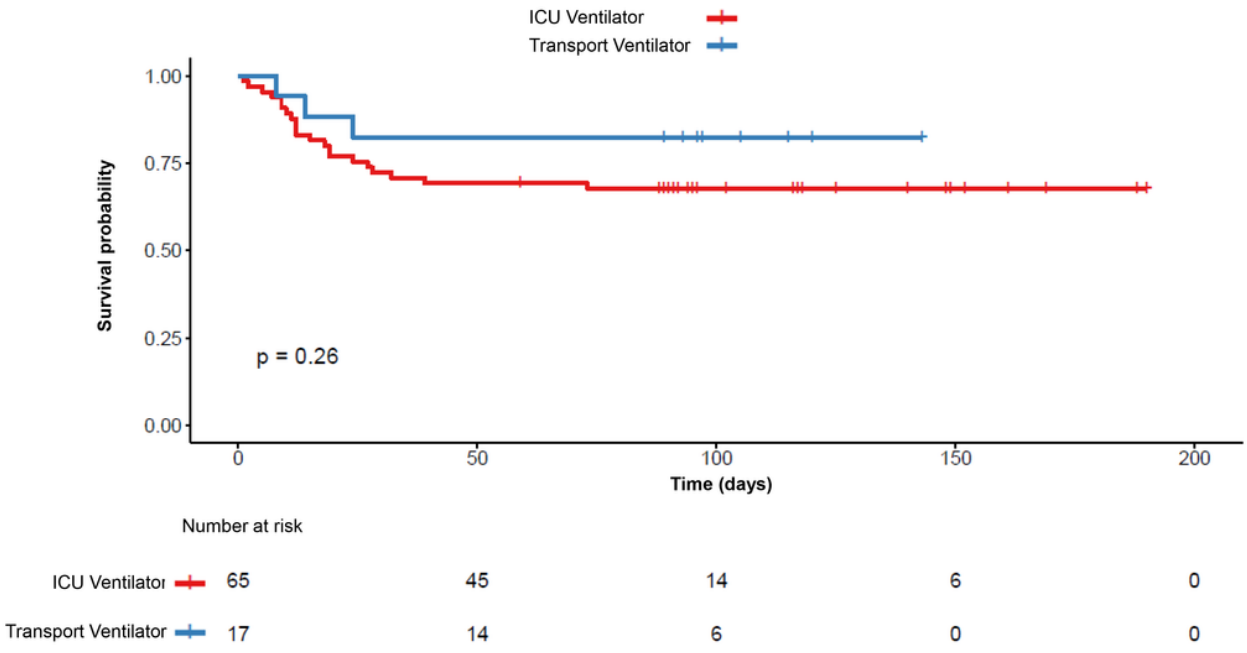

Figure 2

Kaplan-Meier survival curves according to ventilator type in 82 patients with COVID-19-related acute respiratory distress syndrome Data marker sizes reflect the relative size of each covariate. Hazard ratios were computed after adjustment on the SAPS II. Error bars indicate 95% confidence intervals of hazard ratios. 95%CI denotes 95% confidence interval.

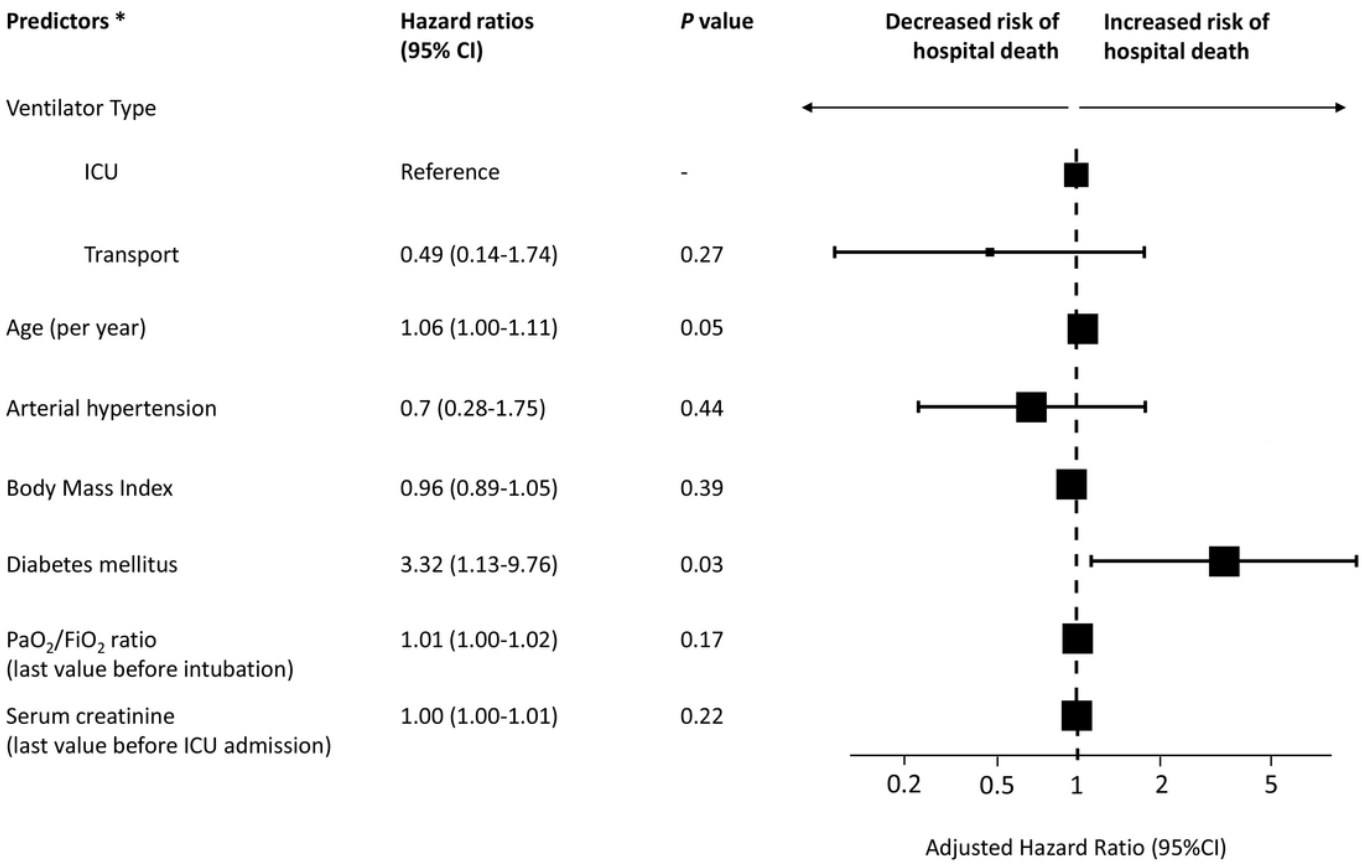

Figure 3

Multivariate analysis: association of ventilator type with probability of ICU survival

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