Medicina Intensiva xxx (xxxx) 502122

medicina intensiva

http://www.medintensiva.org/en/

ORIGINAL ARTICLE

Did intubation procedures for critically ill patients without SARS-CoV-2 infection change during the pandemic? Secondary analysis of the INTUPROS multicenter study☆

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Received 22 July 2024; accepted 11 September 2024

KEYWORDS
COVID-19;
Pandemic;
Intubation;

Abstract
Objective: To determine the changes in intubation procedures of critically ill patients without SARS-CoV-2 infection induced during the COVID-19 pandemic.
Design: Secondary Analysis of the INTUPROS Prospective Multicenter Observational Study on Intubation in Intensive Care Units (ICUs).

DOI of original article: https://doi.org/10.1016/j.medin.2024.502122
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https://doi.org/10.1016/j.medine.2025.502122

Please cite this article as: J.L. García-Garmendia, J. Trenado-Álvarez, F. Gordo-Vidal et al., Did intubation procedures for critically ill patients without SARS-CoV-2 infection change during the pandemic? Secondary analysis of the INTUPROS multicenter study, Medicina Intensiva, https://doi.org/10.1016/j.medine.2025.502122

Critically ill patient;
Intensive care unit;
Videolaryngoscopy;
First pass success;
Capnography;
Complications;
Mortality

Setting: 43 Spanish ICUs between April 2019 and October 2020.
Patients: 1515 Non-COVID-19 patients intubated before and during the pandemic.
Interventions: None.
Main variables of interest: Intubation procedures and medication, first-pass success rate, complications, and mortality.
Results: 1199 patients intubated before the pandemic and 316 during the pandemic were analyzed. During the pandemic, there were fewer days until intubation (OR 0.95 95% CI [0.92—0.98]), reduced resuscitation bag (OR 0.43 95% CI [0.29—0.63]) and non-invasive ventilation oxygenation (OR 0.51 95% CI [0.34—0.76]), reduced use of capnography (OR 0.55 95% CI [0.33—0.92]) and fentanyl (OR 0.47 95% CI [0.34—0.63]). On the other hand, there was an increase in oxygenation with non-HFNC devices (OR 2.21 95% CI [1.23–3.96]), in use of videolaryngoscopy on the first-pass (OR 2.74 95% CI [1.76–4.24]), and greater use of midazolam (OR 1.95 95% CI [1.39–2.72]), etomidate (OR 1.78 95% CI [1.28–2.47]) and succinylcholine (OR 2.55 95% CI [1.82–3.58]). The first-pass success was higher (68.5% vs. 74.7%; $P = .033$). There were no pre-post differences in major complications (34.7% vs. 34.8%; $P = .970$) and in-hospital mortality (42.7% vs. 38.6%; $P = .137$).
Conclusions: The COVID-19 pandemic modified intubation procedures in non-COVID-19 patients, changing the oxygenation strategy, the medication and the use of videolaryngoscopy, with no impact on complications or mortality.

PALABRAS CLAVE
COVID-19;
Pandemia;
Intubación;
Paciente crítico;
Unidad de cuidados intensivos;
Videolaringoscopia;
Intubación al primer intento;
Capnografía;
Complicaciones;
Mortalidad

¿Cambiaron durante la pandemia los procedimientos de intubación de pacientes críticos sin infección por SARS-CoV-2? Análisis secundario del estudio multicéntrico INTUPROS

Resumen
Objetivo: Determinar los cambios en los procedimientos de intubación que la pandemia COVID-19 generó en la atención de los pacientes críticos sin infección por SARS-CoV-2.
Diseño: Análisis secundario del estudio prospectivo multicéntrico observacional INTUPROS sobre intubación en unidades de cuidados intensivos (UCI).
Ámbito: 43 UCI españolas entre abril 2019 y octubre 2020.
Pacientes: 1515 pacientes No-COVID-19 intubados antes y durante la pandemia.
Intervenciones: Ninguna.
Variables de interés principales: Procedimientos y medicación para la intubación, tasa de intubación a la primera, complicaciones y mortalidad.
Resultados: Se analizan 1199 pacientes intubados antes de la pandemia y 316 en pandemia. En pandemia, hubo menos días hasta la intubación (OR 0,95 IC 95% [0,92–0,98]), menor oxigenación con balón (OR 0,43 IC 95% [0,29–0,63]) y ventilación no invasiva (OR 0,51 IC 95% [0,34–0,76]), menor uso de capnografía (OR 0,55 IC 95% [0,33–0,92]) y de fentanilo (OR 0,47 IC 95% [0,34–0,63]). Por contra, hubo mayor oxigenación con dispositivos no ONAF (OR 2,21 IC 95% [1,23–3,96]), mayor videolaringoscopia al primer intento (OR 2,74 IC 95% [1,76–4,24]), y mayor uso de midazolam (OR 1,95 IC 95%[1,39–2,72]), etomidato (OR 1,78 IC 95%[1,28–2,47]) y succinilcolina (OR 2,55 IC 95%[1,82–3,58]). La tasa de intubación a la primera fue superior (68,5% vs.74,7%; $P = ,033$). No hubo diferencias pre-post en complicaciones mayores (34,7% vs. 34,8%; $P = ,970$) y mortalidad hospitalaria (42,7% vs. 38,6%; $P = ,137$).
Conclusiones: La pandemia COVID-19 modificó los procedimientos de intubación en pacientes No-COVID-19, cambiando la estrategia de oxigenación, la medicación utilizada y el uso de videolaringoscopia, sin generar impacto en complicaciones o mortalidad.

Introduction

Intubation of critically ill patients is a high-risk procedure associated with a high rate of complications.[1,2] Recently, the Spanish multicenter, prospective observational study INTUPROS on intubation in critically ill patients at the intensive care unit (ICU) setting was published, showing a severe adverse event rate of 40.4%, primarily involving hemodynamic instability and severe hypoxemia.[3,4]

The COVID-19 pandemic changed intubation practices, increasing the use of high-flow nasal oxygen therapy (HFNO) prior to intubation, videolaryngoscopy (VL), neuromuscular blocking agents, intubation guides, and stylets.[2,3,5–18] Although was accompanied by the need for personal protective equipment (PPE) donning, a high success rate was achieved on the first-pass.[3,13,14,16,17,19] Few studies have assessed the impact of the COVID-19 pandemic on intubation habits in critically ill patients without SARS-CoV-2 infection after the start of the pandemic, focusing on the different types of VL used,[20] mortality rates,[21] or scheduled patients,[14] all of which were retrospective studies.

The INTUPROS study was conducted from April 2019 through October 2020, so it prospectively included patients before the start of the pandemic, patients with COVID-19, and patients without COVID-19 after the pandemic began. The objective of this secondary analysis is to determine the differences in intubation procedures that the COVID-19 pandemic created in the management of critically ill patients without a SARS-CoV-2 infection.

Methodology

This is a secondary analysis of a multicenter, prospective cohort observational study conducted in 43 Spanish ICUs (INTUPROS study). A detailed description of the methodology is provided in the original publication and its supplementary electronic material.[3] Patients were consecutively included in 6-month periods in each ICU from April 16th 2019 through October 31st 2020. The study protocol was updated in March 2020 to include the presence of COVID-19 as the reason for admission.

The Virgen del Rocío and Virgen Macarena Hospitals Ethics Committee (Seville, Spain) approved the study back on January 14th 2019 (1149-N-18), which was later ratified at each participant center. Given the observational design of the study and the short observation period of the intubation event (events occurring up to 30 min after the procedure), informed consent was not deemed necessary. The Spanish Society of Intensive Care Medicine and Coronary Units (SEMICYUC) endorsed the study.

Inclusion and exclusion criteria: Patients older than 18 years old admitted to intensive care units who were intubated were included, excluding intubations due to cardiac arrest and those performed outside the ICU setting, even if they occurred during the patient's admission process. The procedure was performed by members of the intensive care medical staff or intensive care residents.

Variables: Demographic variables, type and reason for admission, severity on admission measured by APACHE II[22] and SOFA[23] scores, reason for intubation, organ dysfunction on the day of intubation, use of enteral nutrition and non-invasive ventilation or HFNO before intubation, preoxygenation methods before intubation, ramped position, facilitating devices (stylets, Frova® Guide or Eschmann® Guide), Sellick maneuver, use of laryngoscope, VL, or other devices (supraglottic, fiberoptic bronchoscopy, tracheostomy), drugs used, and physiological variables before and after intubation (heart rate, blood pressure, oxygen saturation, and respiratory rate) were analyzed. Whether the operator was a member of the medical staff or a resident was also recorded, along with the MACOCHA intubation difficulty scale[24] and the Cormack glottis visualization difficulty scale. The length of the ICU stay, 28-day and in-hospital mortality rates were assessed. A database was created in RedCap software (Research Electronic Data Capture, Vanderbilt University, Nashville, TN, USA). The study was conducted following the international STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) recommendations for observational studies.

Design: This secondary analysis primarily aims to compare intubation procedures between non-COVID-19 patients before and after the pandemic started, to assess possible pandemic-induced changes in intubation practices. Secondary endpoints include evaluating the possible impact on complications and mortality after intubation. Post-COVID status was considered from the declaration of the state of alarm in March 2020,[25] although the researchers cannot guarantee that there was a sudden change in procedures from that date.

Statistical analysis: After applying the Kolmogorov-Smirnov test to quantitative variables, which did not guarantee normal distribution, the Mann-Whitney *U* test was used for univariate analysis, and data were expressed as median and quartiles. Categorical variables were analyzed using the chi-square test or Fisher's exact test as appropriate, and data were expressed as numbers and percentages. Two-tailed comparisons were drawn with a significance level of $P < .05$. A multivariate analysis was performed using stepwise logistic regression, including variables with a significance level < 0.20, using the odds ratio criterion. Global validity was analyzed using Nagelkerke's R2, and the Hosmer-Lemeshow test was applied to assess goodness of fit. A variance inflation factor (VIF) < 4 and a tolerance test > 0.25 were considered indicators of low multicollinearity. The study was performed using the SPSS® version 22 statistical package (Chicago, IL, USA).

Results

A total of 322 out of the 1837 patients included in the original analysis were diagnosed with COVID-19, as opposed to 1515 who were non-COVID-19 patients (1199 pre-pandemic and 316 during the pandemic). The flow diagram is detailed in Fig. S1 of the Supplementary Electronic Data (SED).

Table 1 shows the comparison of demographic characteristics, comorbidities, type of hospital, type of admission, severity scores, and diagnosis on admission. Non-COVID-19 patients during the pandemic had a higher weight, fewer difficult airway events, lower APACHE II scores on admission, a higher proportion of admissions, and fewer emergency surgical admissions.

Table 1 Admission characteristics of non-COVID-19 patients pre- and during the pandemic.

Variables	Pre-Pandemic (n = 1199)	Non-COVID-19 during the pandemic (n = 316)	OR (95%CI)	*P*
Age (years)	64 (54–74)	63 (53–72)		.178
Gender (male)	762 (63.6%)	212 (67.1%)	1.17 (0.90–1.52)	.243
Weight (kg)	75 (65–88)	80 (68–90)		.040
Body Mass Index	26.6 (23.5–30.3)	27.5 (24.2–31.1)		.051
Comorbidities				
COPD	180 (15.0%)	43 (13.6%)	0.89 (0.62–1.27)	.531
Heart failure	157 (13.1%)	37 (11.7%)	0.88 (0.60–1.29)	.512
Chronic kidney disease	111 (9.3%)	30 (9.5%)	1.03 (0.67–1.57)	.898
Liver cirrhosis	83 (6.9%)	26 (8.2%)	1.21 (0.76–1.91)	.424
History of difficult airway	34 (2.8%)	2 (0.6%)	0.21 (0.05–0.87)	.022
Hospital Level				.989
Primary	51 (4.3%)	14 (4.4%)		
Secondary	386 (32.2%)	101 (32.0%)		
Tertiary	762 (63.6%)	201 (63.6%)		
APACHE II at ICU admission	20 (15–26)	19 (13–25)		.041
SOFA at ICU admission	6 (4–9)	6 (4–9)		.527
Admission type				.130
Medical	903 (75.3%)	258 (81.6%)	1.46 (1.07–2.00)	.018
Emergency surgery	120 (10.0%)	17 (5.4%)	0.51 (0.30–0.86)	.012
Severe trauma	82 (6.8%)	18 (5.7%)	0.82 (0.49–1.39)	.467
Elective surgery	61 (5.1%)	13 (4.1%)	0.80 (0.43–1.48)	.476
Coronary	28 (2.3%)	8 (2.5%)	1.09 (0.49–2.41)	.839
Burn	5 (0.4%)	2 (0.6%)	1.52 (0.29–7.88)	.617
Diagnosis at ICU admission				.273
Respiratory failure	414 (34.5%)	111 (35.1%)	1.03 (0.79–1.33)	.843
Coma/Intoxication	213 (17.8%)	54 (17.1%)	0.95 (0.69–1.32)	.779
Sepsis	188 (15.7%)	46 (14.6%)	0.92 (0.65–1.30)	.623
Postoperative	92 (7.7%)	17 (5.4%)	0.69 (0.41–1.18)	.174
Severe trauma	81 (6.8%)	18 (5.7%)	0.83 (0.49–1.41)	.498
Other diagnosis at ICU admission*	211 (17.6%)	70 (22.2%)	1.33 (0.98–1.81)	.065

Quantitative variables are expressed as median (25th–75th percentile); categorical variables expressed as absolute number and percentage.

APACHE: Acute Physiology, Age, Chronic Health Evaluation score; COPD: chronic obstructive pulmonary disease; SOFA: Sequential Organ Failure Assessment score; ICU: intensive care unit; OR: odds ratio; CI: confidence interval.

* Non-septic shock, cardiac arrest (not as a reason for intubation), metabolic disorders, heart failure, procedure, acute coronary syndrome, arrhythmia, and others.

Table 2 compares the procedures prior to intubation, reasons for intubation, and pre-intubation conditions. During the pandemic, non-COVID-19 patients had less prior use of non-invasive ventilation (NIV) and enteral nutrition in the 24 h prior, shorter admissions before intubation, more frequent instability and procedural reasons for intubation, and fewer failed extubation cases. Reintubation as a cause of intubation (failed extubation, or change of endotracheal tube) was significantly lower in the non-COVID-19 group during the pandemic (OR, 0.44 [95%CI, 0.27–0.72]; $P = .001$). There was less use of NIV and resuscitation bags for pre-oxygenation and more use of other non-HFNO devices.

Table 3 compares the devices, maneuvers, and drugs used in the intubation procedure, as well as the findings, number of attempts, and operator performing the intubation. Notably, non-COVID-19 patients during the pandemic had a lower frequency of residents as the first operator, lower use of the laryngoscope, and greater use of VL both overall and at first attempt, with less use of capnography, achieving a higher first-pass intubation success rate. The use of capnography in non-COVID-19 patients before (OR 2.31 [95%CI, 1.29–4.15]) and during the pandemic (OR 3.95 [95%CI, 1.56–9.98]) was higher when VL was used. There was also greater use of neuromuscular blocking agents, especially succinylcholine, and less use of fentanyl. Fig. S2 shows the changes in drug usage between pre-pandemic patients, COVID-19 patients, and non-COVID-19 patients during the pandemic.

Fig. 1 shows the differences in intubation strategies by attempts between the pre-pandemic and pandemic phases for non-COVID-19 patients, highlighting the greater use of VL at first attempt during the pandemic. The intubation success rate with laryngoscope improved during the pandemic, both at the first attempt (75% vs 68%; $P = .029$) and in the cumulative first 3 attempts (76% vs 69%; $P < .001$) [Fig. S3].

Table 4 compares the post-intubation vital signs, immediate complications, and 28-day mortality rate at the ICU and hospital settings. A significantly higher mean blood pressure

Table 2 Prior procedures, reason, and clinical status before intubation: comparison of non-COVID-19 patients before and during the pandemic.

Variables	Pre-Pandemic (n = 1199)	Non-COVID-19 during the pandemic (n = 316)	OR (95%CI)	*P*
HFNC before intubation	299 (24.9%)	76 (24.1%)	0.95 (0.71–1.27)	.745
NIV before intubation	371 (30.9%)	70 (22.2%)	0.64 (0.47–0.85)	.002
Vasopressors before intubation	397 (33.1%)	102 (32.3%)	0.96 (0.74–1.25)	.779
Enteral nutrition 24 h before intubation	228 (19.0%)	43 (13.6%)	0.67 (0.47–0.95)	.026
SOFA on intubation day	7 (4–10)	7 (4–10)		.728
MACOCHA scale	1 (1–2)	1 (1–2)		.571
Admission to intubation days	0 (0–3)	0 (0–1)		<.001
Reason for intubation				.002
Acute respiratory failure	634 (52.9%)	178 (56.3%)	1.15 (0.90–1.48)	.274
Coma	277 (23.1%)	62 (19.6%)	0.81 (0.60–1.11)	.187
Hemodynamic instability	86 (7.2%)	33 (10.4%)	1.57 (1.04–2.38)	.033
Extubation failure	88 (7.3%)	10 (3.2%)	0.43 (0.29–0.64)	<.001
Procedure	51 (4.3%)	24 (7.6%)	1.85 (1.12–3.06)	.016
Orotracheal tube exchange	37 (3.1%)	5 (1.6%)	0.50 (0.20–1.30)	.155
Unplanned extubation	26 (2.2%)	4 (1.3%)	0.58 (0.20–1.67)	.311
Work shift during intubation				.269
Morning	448 (37.4%)	132 (41.8%)		
Afternoon	371 (30.9%)	83 (26.3%)		
Night	379 (31.6%)	101 (32.0%)		
Pre-oxygenation methods				
Bag-valve-mask	1009 (84.2%)	239 (75.6%)	0.58 (0.43–0.79)	<.001
HFNC	172 (14.3%)	52 (16.5%)	1.18 (0.84–1.65)	.348
NIV	260 (21.7%)	47 (14.9%)	0.63 (0.45–0.89)	.008
Other devices*	45 (3.8%)	29 (9.2%)	2.59 (1.60–4.21)	<.001
GCS before intubation	13 (8–15)	13 (8–15)		.195
Respiratory rate before intubation	27 (20–35)	26 (19–32)		.226
Mean arterial pressure before intubation	75 (63–90)	76 (61–90)		.894
O2 saturation before intubation	92 (87–96)	93 (87–97)		.355

Quantitative variables are expressed as median (25th–75th percentile); categorical variables as absolute number and percentage. GCS: Glasgow Coma Scale; MACOCHA: Risk scale for difficult intubation; HFNC: High-flow nasal cannula; SOFA: Sequential Organ Failure Assessment score; NIV: non-invasive ventilation; OR: odds ratio; CI: confidence interval.

* Non-rebreather mask, oropharyngeal oxygen cannula.

was detected after intubation in non-COVID-19 patients during the pandemic, with no other differences being reported in the remaining variables. Moreover, the length of ICU and hospital stays was significantly shorter during the pandemic.

In the multivariate analysis, several variables were independently associated with intubation in non-COVID-19 patients after the pandemic (Fig. 2). Notably, the lengths of stay were shorte before intubation; a different method of pre-oxygenation with less use of resuscitation bags and NIV, and more use of other types of devices; drug changes with more use of midazolam, etomidate, and succinylcholine, and less fentanyl; and more use of VL initially, but less capnography.

Discussion

This study shows that the COVID-19 pandemic modified intubation procedures for both COVID-19 and non-COVID-19 critically ill patients, changing pre-oxygenation strategies, drug usage, and the use of VL, at least, during the period when COVID-19 patients coexisted.

The recommendations made for intubation of critically ill COVID-19 patients at the start of the pandemic led to a change in intubation procedures.[26,27] These recommendations aimed to address the severity of critical hypoxemia in these patients while trying to minimize the professional risk associated with it. In the early phases of the pandemic, diagnosis was not as fast as it later became, so many patients were intubated without having been able to rule out SARS-CoV-2 infection.[28]

Non-COVID-19 patients during the pandemic had higher weight than before, and although changes in lifestyle habits in Spain during the pandemic were documented,[29] this is most likely a random finding. The slightly lower APACHE II score and the shift in the patient profile with more medical admissions and fewer emergency surgical procedures could have to do with organizational changes in Spanish ICUs,[28] which found themselves having to handle a surge of COVID-19 patients and the involvement of other facilities for the management of non-COVID-19 critically ill patients. However, diagnoses upon admission were similar, and distribution across hospital levels was the also the same.

Table 3 Devices, maneuvers, drugs used during intubation, and findings: non-COVID-19 patients before and during the pandemic.

Variables	Pre-Pandemic (n = 1199)	Non-COVID-19 during the pandemic (n = 316)	OR (95%CI)	*P*
1st attempt by resident	838 (70.3%)	195 (61.7%)	0.69 (0.54–0.90)	.006
Ramped position	197 (16.4%)	44 (14.0%)	0.82 (0.58–1.17)	.279
Sellick maneuver	407 (34.2%)	112 (35.4%)	1.07 (0.82–1.39)	.618
Cormack-Lehane grade				.794
Grade I	661 (55.0%)	176 (55.7%)		
Grade II	333 (27.8%)	93 (29.4%)		
Grade III	150 (12.5%)	36 (11.4%)		
Grade IV	53 (4.4%)	11 (3.5%)		
Adjuncts for intubation				
Stylet	678 (56.9%)	174 (55.1%)	0.94 (0.73–1.21)	.636
Frova® bougie	61 (5.1%)	15 (4.7%)	0.93 (0.52–1.65)	.805
Eschmann® bougie	20 (1.7%)	4 (1.3%)	0.76 (0.26–2.23)	.612
Devices				
Laryngoscope	1117 (93.2%)	271 (85.8%)	0.44 (0.30–0.65)	<.001
Videolaryngoscope usage	155 (12.9%)	60 (19.0%)	1.58 (1.14–2.19)	.006
Videolaryngoscope on 1st attempt	76 (6.3%)	43 (13.6%)	2.33 (1.57–3.46)	<.001
Capnography	136 (11.3%)	19 (6.0%)	0.50 (0.30–0.82)	.005
Drugs				
Midazolam	762 (63.6%)	218 (69.0%)	1.28 (0.98–1.66)	.073
Propofol	264 (22.0%)	59 (18.7%)	0.81 (0.59–1.11)	.197
Etomidate	317 (26.4%)	101 (32.0%)	1.31 (1.00–1.71)	.051
Fentanyl	917 (76.5%)	197 (62.3%)	0.51 (0.39–0.66)	<.001
Ketamine	68 (5.7%)	23 (7.3%)	1.31 (0.80–2.13)	.285
Succinylcholine	126 (10.5%)	80 (25.3%)	2.89 (2.11–3.95)	<.001
Rocuronium	675 (56.3%)	164 (51.9%)	0.84 (0.65–1.07)	.162
Presence of secretions, blood, or vomit	387 (32.6%)	108 (34.2%)	1.09 (0.83–1.42)	.522
Difficult airway	165 (13.9%)	37 (11.7%)	0.83 (0.57–1.22)	.340
Attempts at intubation	1 (1–2)	1 (1–1)		.017
Success after 1st attempt	821 (68.5%)	236 (74.7%)	1.36 (1.03–1.80)	.033
Success after 2nd attempt	1096 (91.4%)	299 (94.6%)	1.65 (0.97–2.80)	.063
Success second 3rd attempt	1169 (97.5%)	313 (99.1%)	2.67 (0.82–8.83)	.106

Quantitative variables are expressed as median (25th–75th percentile); categorical variables as absolute number and percentage. OR: odds ratio; CI: confidence interval.

The reasons for intubation varied slightly, though in both periods, 75% were for respiratory failure and coma. The higher proportion of procedures and hemodynamic instability may be related to reduced accessibility during the pandemic, and the lower rate of reintubations may be due to nursing staff ratios and physician workload, which could have delayed or prevented timelier extubations.

In our study, there was greater use of VL in non-COVID-19 patients during the pandemic, which, temporarily, was associated with a greater use in COVID-19 patients,[2,3,9,14–16,19,30–36] with a high first-pass intubation success rate. Our interpretation is that the increased availability of the resource, training in its use, pressure on health care workers, and the positive outcomes influenced this higher utilization rate. Additionally, in many cases, patients were intubated before confirming SARS-CoV-2 infection.

In contrast, we found a significant reduction in the use of capnography, which was already low in the overall INTUPROS study population,[3] and even further reduced in non-COVID-19 patients intubated after the onset of the pandemic, contrasting with the results of other studies.[1,36] This may be related to low prior adherence rates, but not with the increased use of VL, as capnography was more widely used in those patients despite direct visualization of intubation. Furthermore, the study excluded patients who were intubated for cardiorespiratory arrest, in which to the use capnography is recommended beyond confirming the proper placement of the endotracheal tube.[37]

The pre-oxygenation strategy was a point of controversy during the COVID-19 pandemic due to recommendations issued to protect healthcare workers from aerosol exposure, especially during intubation.[38] This led to recommendations to avoid HFNO, NIV, and manual ventilation. This resulted in the use of systems generating fewer aerosols, such as non-rebreather masks or oropharyngeal cannulas. The coexistence of COVID-19 and non-COVID-19 patients in the units, delayed SARS-COV-2 diagnosis, and fear among healthcare workers in the early months may have led to changes in pre-oxygenation for intubations in non-SARS-COV-2-infected patients. This also justifies the finding of shorter time to intubation.

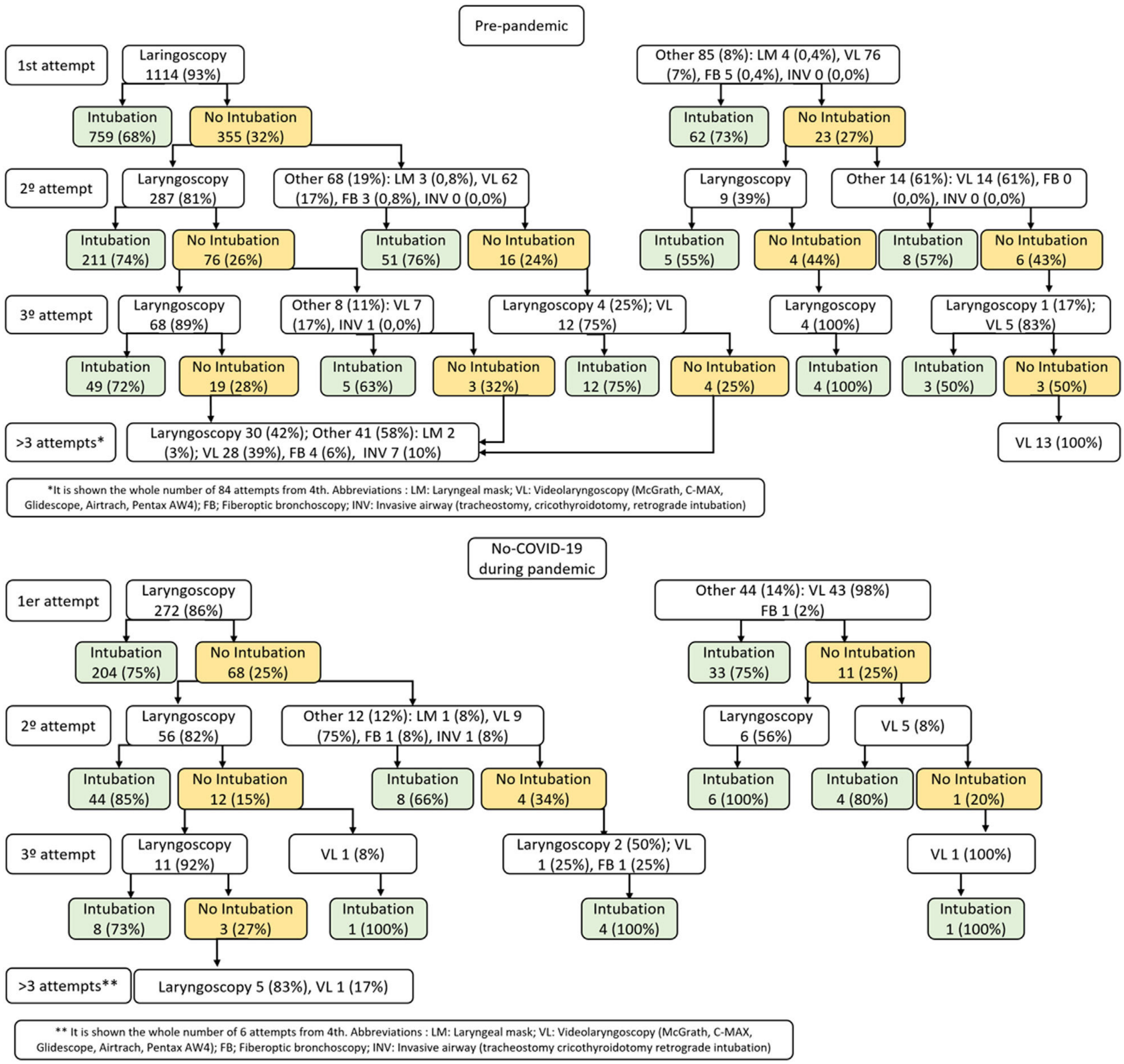

Figure 1 Use of devices in the intubation steps of Non-COVID-19 patients before and during the pandemic.

The multivariate analysis showed greater use of midazolam and etomidate in non-COVID-19 patients during the pandemic, with less use of fentanyl. The medication guidelines recommended for COVID-19 patients may have increased the use of midazolam and neuromuscular blocking agents,[3] but the lower use of fentanyl and the higher use of etomidate in non-COVID-19 patients do not seem to have an explanation based on the analyzed data. Unlike other studies,[7] no increased hypotension or higher in-hospital mortality rates were detected in patients on etomidate, whether COVID-19 or non-COVID-19, during any period.

The higher rate of first-pass intubation during the pandemic can be attributed to a greater use of VL and neuromuscular blocking agents, although it was also better with the laryngoscope, possibly due to a lower rate of first attempts by residents, who have fewer acquired skills.[39] Of note, the complication and mortality rates were similar across both periods, which may be surprising given the higher first-pass intubation rate. Nonetheless, several studies have shown equally high rates of major complications in critically ill patients,[1,40] even with higher first-pass intubation success rates than in our series. Reducing complications in intubation of critically ill patients remains challenging and likely cannot be solely addressed by improving first-pass intubation rates. It should be combined with appropriate timing of intubation, oxygenation devices, pharmacological measures, better use of capnography, etc.

It is also important to note that during the pandemic, there was limited access to certain drugs and medical supplies, as well as differences in resource management, which was heterogeneously distributed across the centers, possibly affecting the observed differences.

Table 4 Post-intubation vital signs, complications, and mortality: non-COVID-19 Patients before and during the pandemic.

Variables	Pre-Pandemic (n = 1199)	Non-COVID-19 during the pandemic (n = 316)	OR (95%CI)	*P*
Post-intubation respiratory rate	18 (16–20)	18 (16–20)		.412
Post-intubation mean arterial pressure	67 (55–80)	70 (58–82)		.030
Post-intubation O_2 saturation (%)	98 (94–100)	98 (94–100)		.510
Change in respiratory rate	−9 (−15, −1)	−8 (−14, −1)		.167
Change in mean arterial pressure	−8 (−22, 5)	−5 (−16, 5)		.446
Change in O_2 saturation (%)	4 (0, 9)	4 (0, 8)		.180
Complications (total)	491 (41.0%)	135 (42.7%)	1.08 (0.84–1.38)	.570
Major complications	416 (34.7%)	110 (34.8%)	1.01 (0.77–1.30)	.970
Severe hypotension	301 (25.1%)	84 (26.6%)	1.08 (0.82–1.43)	.591
Severe hypoxemia	180 (15.0%)	48 (15.2%)	1.01 (0.72–1.43)	.937
Cardiac arrest	27 (2.3%)	6 (1.9%)	0.84 (0.34–2.05)	.702
Bradycardia	39 (3.3%)	11 (3.5%)	1.07 (0.54–2.12)	.840
Pulmonary aspiration	27 (2.3%)	6 (1.9%)	0.84 (0.34–2.05)	.702
28-day mortality	417 (35.0%)	105 (34.0%)	0.93 (0.72–1.21)	.606
ICU mortality	433 (36.1%)	106 (33.5%)	0.89 (0.69–1.16)	.396
In-hospital mortality	511 (42.7%)	120 (38.6%)	0.82 (0.64–1.06)	.137
Length of ICU stay (days)	13 (5–26)	9 (4–19)		<.001
Length of hospital stay (days)	21 (10–41)	18 (8–30)		.001

Quantitative variables are expressed as median (25th–75th percentile); categorical variables as absolute values and percentage. OR: odds ratio; CI: confidence interval.

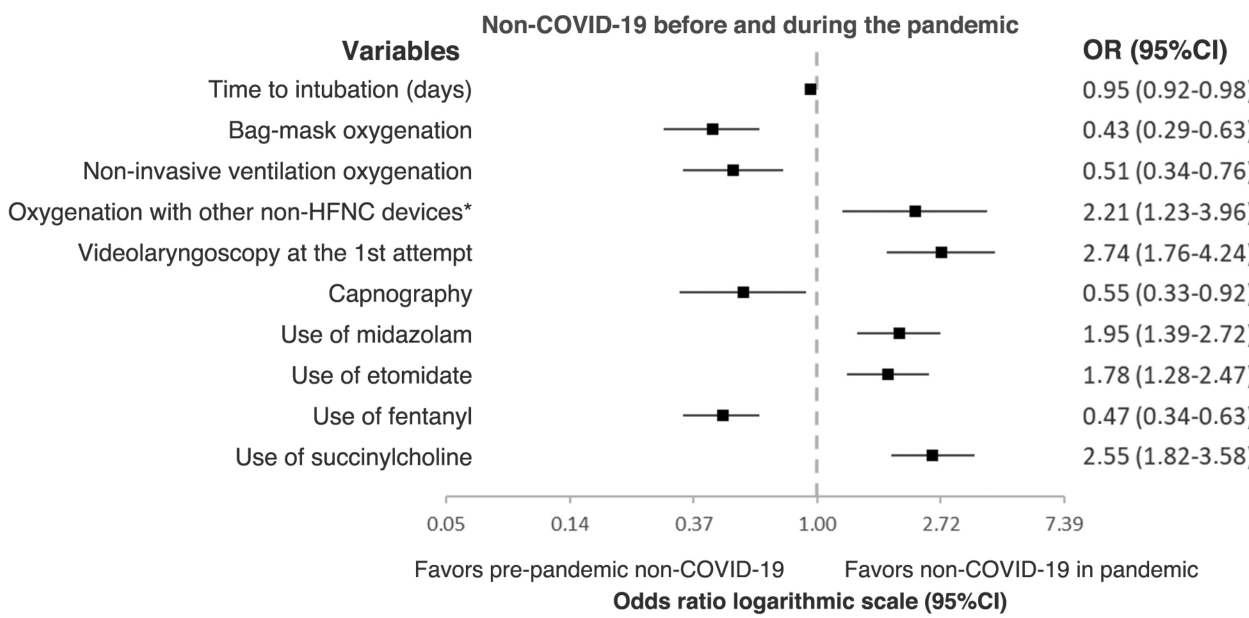

Figure 2 Forest plot of the multivariate analysis of variables associated with the intubation of non-COVID-19 patients after the onset of the pandemic, *Other non-HFNO oxygenation devices: non-rebreather masks or oropharyngeal cannulas.

The study has several limitations. It is a secondary study that does not answer an original research question. The period division is not exact, and as the study was conducted in 6-month cycles, one or both periods could have been included in each hospital. Furthermore, the sample size of non-COVID-19 patients during the pandemic is limited, and the heterogeneity in the case mix of patients and units may hide uncontrollable biases. Additionally, although all units were required to have intubation protocols, these were not standardized. On the other hand, the prospective and multicenter design of the study, which preceded and coincided with the onset of the pandemic, strengthens the data obtained.

Conclusions

COVID-19 pandemic-driven procedures influenced the way non-COVID-19 critically ill patients were intubated, altering the pre-oxygenation strategy, drug used, and the utilization of videolaryngoscopy, at least, during the period when COVID-19 patients were coexisting. However, this did not result in changes in complications or mortality.

CRediT authorship contribution statement

JLGG: original idea, design, analysis, writing; JTA: original idea, design, database, study monitoring, writing; FGV: original idea, design, writing; EGE: design, data collection, study monitoring, manuscript review; EMB: data collection, manuscript review; FOC: data collection, manuscript review; VSM: data collection, manuscript review; ERR: data collection, manuscript review; RABA: data collection, manuscript review; JMQ: data collection, manuscript review; MIRG: data collection, manuscript review; JGM: original idea, design, study monitoring, writing.

Informed consent

The original study was conducted after the approval of Virgen Macarena and Virgen del Rocío Hospitals Ethics Committee in Seville (Spain) which was later ratified in the various hospitals. The obtaining of informed consent was deemed unnecessary.

Declaration of Generative AI and AI-assisted technologies in the writing process

No artificial intelligence tools have been used in the generation of figures or in the creation or refinement of the text.

Funding

We received funding to work on this document.

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Appendix B. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.medine.2025.502122.

Declaration of competing interest

We declared no conflicts of interest whatsoever.

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