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Journal of Clinical Anesthesia 67 (2020) 110039

Contents lists available at ScienceDirect

Journal of Clinical Anesthesia

journal homepage: www.elsevier.com/locate/jclinane

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# Intubation, mortality, and risk factors in critically ill Covid-19 patients: A pilot study

More than 70% of the critically ill Covid-19 patients received intubation and invasive mechanical ventilation (IMV) support [1,2]. Medical professionals throughout the world agree that intubation saves lives. However, there is no direct evidence attesting to the benefit of intubation and IMV in critically ill Covid-19 patients. On the contrary, a report revealed that of 32 Covid-19 patients who received intubation and IMV support, 31 (97%) died [3]. The poor outcome after intubation may be related to the timing of intubation [4]. The role of intubation and IMV amid the Covid-19 pandemic deserves investigation. As it is unethical to perform a randomized controlled trial comparing the outcomes between patients receiving and not receiving intubation and IMV, we conducted a single-center pilot study based on intubated critically ill Covid-19 patients to explore the risks factors associated with mortality.

Patients who received non-resuscitative intubation in the ICU on the Guanggu Campus of Tongji Hospital (Wuhan, China) between February 10, 2020 to March 30, 2020 were included. The ICU was managed by the medical team from Huashan Hospital due to the manpower re-deployment. All patients were diagnosed with Covid-19 and reached the endpoints of either death or survival. Patients who were intubated during resuscitation and did not survive for more than 2 h after resuscitation were excluded. The study was approved by the Internal Review Board of Huashan Hospital (#2020-655). The primary outcome was the rate of ICU mortality, the differences between survivors and non-survivors were investigated, and the risk factors associated with death in intubated critically ill Covid-19 patients were analyzed by means of univariable and multivariable logistic regression models.

A total of 75 critically ill Covid-19 patients were enrolled in this study. Of these 75 patients, 55 patients underwent intubation and received IMV support, 41 intubated patients met the inclusion criteria and were included in the final analysis. The median age of these 41 patients was 70 (60–81) years. 31 (76%) patients did not survive the ICU course, while 10 (24%) did; all three patients who received ECMO support survived. The median ages of non-survivors and survivors were 71 (66–82) and 59 (57–77) years. Of the non-survivors, 32% (10/31) were obese, while none of the survivors were obese ($p = 0.039$). 48% (15/31) of the non-survivors had three or more comorbidities, while none of the survivors had three or more comorbidities ($p = 0.007$).

Comparing with survivors, non-survivors had a lower pH (7.38 vs. 7.45; $p = 0.010$) and platelet count (120 vs. 181; $p = 0.036$), but a higher hs-TnI (77.3 vs. 15.7; $p = 0.009$), NT-proBNP (1959 vs. 337; $p = 0.001$), IL-6 (68.3 vs. 17.1; $p < 0.001$), INR (1.27 vs. 1.11; $p = 0.007$), SOFA score (9.0 vs. 3.0; $p < 0.001$), and APACHE II score (22.0 vs. 11.0; $p < 0.001$) at the time of IMV initiation (Table 1). There were no significant differences between survivors and non-survivors in $PaO_2/FiO_2$ and levels of $PaCO_2$ at the time of intubation and during the early stage of IMV support; however, the differences became significant at the time of IMV weaning for survivals or death (Table 1). The univariable analysis revealed that the odds of ICU mortality were higher in patients with a higher NT-proBNP, INR, SOFA score, and

**Table 1**
Laboratory data, clinical scores, and timing and duration of invasive mechanical ventilation.

| | Total (n = 41) | Non-survivor (n = 31) | Survivor (n = 10) | *p* value |
|---|---|---|---|---|
| Initiation of invasive mechanical ventilation | | | | |
| pH* | 7.40 (7.29–7.46) | 7.38 (7.23–7.43) | 7.45 (7.42–7.51) | 0.010 |
| Lactate, mmol/L | 1.8 (1.3–2.3) | 1.8 (1.3–2.4) | 2.0 (1.2–2.3) | 0.931 |
| $PaO_2/FiO_2$, mmHg* | 105 (85–143) | 102 (84–144) | 117 (90–177) | 0.347 |
| $PaCO_2$, mmHg* | 47.8 (37.1–60.3) | 48.1 (37.5–65.3) | 42.8 (31.1–52.6) | 0.215 |
| WBC, $\times 10^9$/L | 12.5 (8.7–14.7) | 12.9 (9.8–14.9) | 10.0 (7.7–15.0) | 0.367 |
| Neutrophils, utr$^9$/L | 11.0 (7.9–13.7) | 11.9 (9.1–13.7) | 9.1 (7.1–14.1) | 0.434 |
| Lymphocytes, $\times 10^9$/L | 0.51 (0.30–0.73) | 0.46 (0.27–0.69) | 0.57 (0.46–0.83) | 0.141 |
| hs-TnI, pg/mL | 67.4 (16.5–355.9) | 77.3 (24.5–451.6) | 15.7 (10.4–67.9) | 0.009 |
| hs-TnI, > 28 pg/mL | 26 (63%) | 22 (71%) | 4 (40%) | 0.077 |
| NT-proBNP, pg/mL | 1290 (536–3175) | 1959 (769–3339) | 337 (129–1153) | 0.001 |

(*continued on next page*)

https://doi.org/10.1016/j.jclinane.2020.110039
Received 31 May 2020; Received in revised form 14 August 2020; Accepted 5 September 2020
Available online 07 September 2020

**Table 1** (*continued*)

| | Total (n = 41) | Non-survivor (n = 31) | Survivor (n = 10) | *p* value |
|---|---|---|---|---|
| IL-2R, unit/mL | 922 (711–1497) | 1215 (720–1532) | 754 (580–1364) | 0.275 |
| IL-6, pg/mL | 52.2 (19.2–167.6) | 68.3 (34.8–278.1) | 17.1 (9.8–26.0) | < 0.001 |
| ALT, unit/L | 32.0 (16.0–43.5) | 31.0 (14.0–44.0) | 34.0 (19.8–43.3) | 0.486 |
| Creatinine, μmol/L | 85.0 (67.0–105.5) | 85.0 (70.0–110.0) | 80.0 (63.0–100.3) | 0.714 |
| Albumin, g/L | 31.8 (31.0–33.7) | 31.8 (31.0–33.7) | 31.7 (31.0–34.3) | 0.911 |
| Haemoglobin, g/L | 124 (111–136) | 124 (107–133) | 124 (115–140) | 0.544 |
| INR | 1.22 (1.11–1.34) | 1.27 (1.15–1.41) | 1.11 (1.06–1.19) | 0.007 |
| Platelet, $10^9$/L | 148 (98–215) | 120 (94–198) | 181 (154–368) | 0.036 |
| Platelet, < 100 $10^9$/L | 11 (27%) | 9 (29%) | 2 (20%) | 0.575 |
| D-Dimer, μg/ML | 6.2 (2.1–16.9) | 6.2 (2.3–20.0) | 3.0 (1.7–12.5) | 0.302 |
| SOFA score | 7.0 (5.0–9.0) | 9.0 (6.0–11.0) | 3.0 (3.0–4.5) | < 0.001 |
| APACHE II score | 18.0 (14.0–24.5) | 22.0 (16.0–28.0) | 11.0 (4.8–14.8) | < 0.001 |
| Time from ICU admission to IMV, days | 2.0 (0.5–5.0) | 3.0 (0–5.0) | 1.5 (0.75–3.25) | 0.284 |
| Weaning of invasive mechanical ventilation or death | | | | |
| pH* | 7.26 (7.08–7.43) | 7.14 (7.04–7.30) | 7.48 (7.41–7.50) | < 0.001 |
| Lactate, mmol/L | 2.3 (1.2–3.9) | 2.5 (1.5–4.7) | 1.2 (0.8–1.6) | < 0.001 |
| $PaO_2/FiO_2$, mmHg* | 72 (49–215) | 59 (45–77) | 336 (245–412) | < 0.001 |
| $PaCO_2$, mmHg* | 55.0 (42.9–102.8) | 76.0 (52.8–112.9) | 38.8 (31.0–45.9) | < 0.001 |
| WBC, $\times 10^9$/L | 11.3 (7.5–15.7) | 12.6 (8.4–18.2) | 8.3 (6.6–11.6) | 0.068 |
| Neutrophils, utr$^9$/L | 9.8 (6.0–14.0) | 11.0 (7.3–17.4) | 6.5 (5.1–10.3) | 0.038 |
| Lymphocytes, $\times 10^9$/L | 0.59 (0.35–0.86) | 0.44 (0.27–0.69) | 0.89 (0.65–1.13) | 0.002 |
| hs-TnI, pg/mL | 63.5 (23.0–446.4) | 185.7 (38.6–523.5) | 7.5 (5.6–39.4) | < 0.001 |
| hs-TnI, > 28 pg/mL | 30 (73%) | 27 (87%) | 3 (30%) | < 0.001 |
| NT-proBNP, pg/mL | 4095 (879–8573) | 6128 (1858–11,407) | 377 (116–801) | < 0.001 |
| IL-2R, unit/mL | 1299 (861–3083) | 2676 (1215–3360) | 725 (604–1036) | < 0.001 |
| IL-6, pg/mL | 247.4 (62.1–2190) | 398.2 (156.0–5000) | 13.1 (9.6–69.7) | < 0.001 |
| ALT, unit/L | 139.1 (9.0–3959) | 170.6 (9.0–3959) | 41.5 (10.0–100) | 0.569 |
| Creatinine, μmol/L | 105.0 (74.5–223.5) | 145.0 (99.0–267.0) | 66.0 (55.0–80.0) | < 0.001 |
| Albumin, g/L | 31.2 (26.2–35.3) | 29.6 (25.1–32.7) | 38.7 (35.4–44.9) | < 0.001 |
| Haemoglobin, g/L | 96.0 (82.5–107.0) | 92.0 (79.0–110.0) | 96.0 (89.0–103.8) | 0.397 |
| INR | 1.30 (1.18–1.55) | 1.34 (1.25–1.69) | 1.17 (1.12–1.24) | 0.001 |
| Platelet, $10^9$/L | 126 (60–196) | 108 (53–151) | 196 (154–225) | 0.003 |
| Platelet, < 100 $10^9$/L | 15 (48%) | 14 (45%) | 1 (10%) | 0.045 |
| D-Dimer, μg/mL | 5.1 (2.8–9.3) | 5.5 (3.0–18.0) | 4.3 (2.2–9.1) | 0.414 |
| SOFA score | 15.0 (7.5–17.0) | 15.0 (13.0–17.0) | 2.0 (1.8–4.3) | < 0.001 |
| APACHE II score | 33.0 (17.0–37.5) | 35.0 (30.0–39.0) | 8.0 (6.0–10.0) | < 0.001 |
| Length of IMV, days | 8.0 (4.0–12.5) | 6.0 (2.0–10.0) | 13.5 (9.5–16.5) | < 0.001 |

$PaO_2$ = arterial oxygen partial pressure; $FiO_2$ = inspired oxygen fraction; $PaCO_2$ = arterial carbon dioxide partial pressure; WBC = white blood cell; hs-TnI = high-sensitivity Troponin I; NT-proBNP = N-terminal pro b-type natriuretic peptide; IL-2R = interleukin-2 receptor; IL-6 = interleukin-6; ALT = alanine amino-transferase; INR = international normalized ratio; SOFA = sequential organ failure assessment; APACHE = acute physiologic assessment and chronic health evaluation; ICU = intensive care unit.

* Data missing in 2 non-survivors.

APACHE II score at the time of IMV initiation. A higher SOFA score at the time of IMV initiation was independently associated with an increased risk of death in intubated Covid-19 patients based on multivariable analysis (Supplementary eTable 1).

In conclusion, 76% of critically ill Covid-19 patients died after non-resuscitative intubation and IMV support. Non-survivors had more comorbidities than survivors. Mortality after non-resuscitative intubation in critically ill Covid-19 patients is associated with the disease severity at the time of IMV initiation.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclinane.2020.110039.

## Funding

This work was supported by the National Natural Science Foundation, People's Republic of China (Grant Nos. 81730031 and 81671058 to Yingwei Wang).

## Declaration of competing interest

None.

## Acknowledgments

None.

## Compliance with ethical standards

Yes.

## Informed consent

Informed consent was waived by the Internal Review Board of Huashan Hospital, Fudan University, Shanghai, China.

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