Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Association between prehospital shock index and mortality among patients with COVID-19 disease

Romain Jouffroy, MD, PhD®, Elise Brami, MD, Marine Scannavino, MD, Yann Daniel, MD, Kilian Bertho, MD, Amandine Abriot, MD, Marina Salomé, CRA, Sabine Lemoine, MD, Daniel Jost, MD, Bertrand Prunet, MD, PhD, Stéphane Travers, MD

Paris Fire Brigade, Emergency Medicine dept, 1 place Jules Renard, 75017 Paris, France

Abstract

Background: There exists a need for prognostic tools for the early identification of COVID-19 patients requiring intensive care unit (ICU) admission and mortality. Here we investigated the association between a clinical (initial prehospital shock index (SI)) and biological (initial prehospital lactatemia) tool and the ICU admission and 30-day mortality among COVID-19 patients cared for in the prehospital setting.

Methods: We retrospectively analysed COVID-19 patients initially cared for by a Paris Fire Brigade advanced (ALS) or basic life support (BLS) team in the prehospital setting between 2020, March 08th and 2020, May 30th. We assessed the association between prehospital SI and prehospital lactatemia and ICU admission and mortality using logistic regression model analysis after propensity score matching with Inverse Probability Treatment Weighting (IPTW) method. Covariates included in the IPTW propensity analysis were: age, sex, body mass index (BMI), initial respiratory rate (iRR), initial pulse oximetry without (SpO2i) and with oxygen supplementation (SpO2i.O2), initial Glasgow coma scale (GCSi) value, initial prehospital SI and initial prehospital lactatemia.

Results: We analysed 410 consecutive COVID-19 patients [254 males (62%); mean age, 64 ± 18 years]. Fifty-seven patients (14%) deceased on the scene, of whom 41 (72%) were male and were significantly older (71 ± 12 years vs. 64 ± 19 years; P < 10^-3). Fifty-three patients (15%) were admitted in ICU and 39 patients (11%) were deceased on day-30. The mean prehospital SI value was 1.5 ± 0.4 and the mean prehospital lactatemia was 2.0 ± 1.7 mmol.l^-1.

Multivariate logistic regression analysis on matched population after IPTW propensity analysis reported a significant association between ICU admission and age (adjusted Odd-Ratio (aOR), 0.90; 95% confidence interval (95% CI): 0.93–0.98; p = 10^-3), SpO2i.O2 (aOR, 1.10; 95%CI: 1.02–1.20; p = 0.002) and BMI (aOR, 1.09; 95% CI: 1.03–1.16; p = 0.02). 30-day mortality was significantly associated with SpO2i.O2 (aOR, 0.92; 95% CI: 0.87–0.98; p = 0.01 P < 10^-3) and GCSi (aOR, 0.90; 95% CI: 0.82–0.99; p = 0.04).

Neither prehospital SI nor prehospital lactatemia were associated with ICU admission and 30-day mortality.

Conclusion: Neither prehospital initial SI nor lactatemia were associated with ICU admission and 30-day mortality among COVID-19 patients initially cared for by a Paris Fire Brigade BLS or ALS team. Further prospective studies are needed to confirm these preliminary results.

© 2022 Published by Elsevier Inc.
The COVID-19 pandemic poses a risk of an inadequate ratio between needs (patients with severe COVID-19 ARF requiring intensive care unit (ICU) admission) and resources (available medical ventilator devices). Thus, the development of simple tools for early severity assessment is useful to optimise the prehospital sorting between emergency departments (EDs) or ICU admission. In this objective, the shock index (SI), which is calculated as the ratio between heart rate and systolic blood pressure (9), is a simple clinical tool, and lactatemia is a simple biological tool validated (10) and available in the prehospital setting allowing early severity assessment of trauma and sepsis (11,12). These clinical and biological tools could be useful to physicians for the decision-making process using evidenced based medicine knowledge without being polluted by the spread of fake news about COVID-19 (13).

In this study, we investigated the association between a clinical (initial prehospital SI) and biological (initial prehospital lactatemia) tool and the ICU admission and 30-day mortality among COVID-19 patients cared for by a Paris Fire Brigade BLS/ALS team in the prehospital setting.

2. Methods

2.1. Design, setting, and participants

As previously described (7), the prehospital Paris Fire Brigade emergency medical system is a 2-tiered response system—comprising a BLS tier served by 200 teams of 3–5 professional rescuers deployed from 77 stations, and an ALS tier served by 44 ambulance teams, each including an emergency physician, a nurse, and a driver (14). Emergency calls are assessed by a dispatch center operator, who may decide to send a BLS and/or ALS team based on the clinical history and symptoms reported by the patient or a witness. Once rescue teams have arrived on the scene, the emergency physician examines the patient, and then the patient can either be left on the scene, admitted to the ED, or admitted directly to the ICU, depending on the level of criticality.

We performed a retrospective observational study that included patients who required intervention by a Paris Fire Brigade BLS or ALS team between 2020, March 08th and 2020, May 30th. No exclusion criteria were applied.

2.2. Ethical considerations

This retrospective study was approved by the French ethics committee Ouest III on 2020/04/08 (Ref: 20.04.30 / SI CNRIPH 20.03.30.62742).

2.3. Data collection

To minimize the bias in data abstraction (15), data collection was performed by a previously investigator (EB) using a previously established standardized abstraction template. From BLS/ALS prehospital reports, we retrieved the patients’ demographic characteristics (age, gender, height and weight), initial (i.e., at the first contact) prehospital vital sign values [systolic, diastolic and mean blood pressure (SBP, DBP, MBP)], heart rate (HRi), pulse oximetry without (SpO2i) and with oxygen supplementation (SpO2i,O2), respiratory rate (RRi), temperature, and Glasgow coma scale (GCSi), administered prehospital treatments (oxygen modality), the means of transport used for admission to hospital and in-hospital service admission (ICU or ED).

Prehospital SI was defined by the initial, i.e., first, assessment ratio between heart rate and systolic blood pressure (SI=HR/SBP) (9,16). Prehospital blood lactatemia assessed by a validated point of care device (9) was retrieved from prehospital reports. We also recorded the date of suspected contamination, the date of first symptoms, and the date of contact. The COVID-19 diagnosis was established after transfer to hospital, and prehospital diagnosis was based on a bundle of arguments: clinical signs and recent contact with a COVID-19 patient.

2.4. Statistical analyses

Results are expressed as mean and standard deviation for quantitative parameters with a normal distribution, as median and interquartile range [Q1–Q3] for parameters with a non-gaussian distribution, and as absolute value and percentage for qualitative parameters.

To reduce the potential effect of cofounders, we performed a propensity score analysis with the Inverse Probability Treatment Weighting (IPTW) method without weight truncation. Covariates included in the IPTW propensity analysis were: age, sex, body mass index (BMI), iRR, SpO2i and SpO2i,O2, GCSi value, initial prehospital SI and initial prehospital lactatemia. Results are expressed with adjusted Odds Ratio (aOR) with 95% confidence interval (95%CI). All analyses were performed using R 4.0.4 (http://www.R-project.org; the R Foundation for Statistical Computing, Vienna, Austria).

3. Results

3.1. Population characteristics

Between 2020, March 08th and 2020, May 30th, 410 consecutive patients suffering from COVID-19 were attended to by a prehospital Paris Fire Brigade ALS team. The mean age was 64 ± 18 years, and 254 patients (62%) were male. A total of 57 patients (14%) were deceased on the scene, of whom 41 (72%) were male. The deceased patients were significantly older than the alive patients (71 ± 12 years vs. 64 ± 19 years; P = 10−3). Fifty-three patients (15%) were admitted in ICU. Thirty-nine patients (11%) were deceased on day-30, e.g., after hospital admission (Fig. 1). Table 1 summarizes the populations’ demographic and prehospital clinical characteristics.

3.2. Main measurements

In the overall population, the mean prehospital SI value was 1.5 ± 0.4 and the mean prehospital lactatemia was 2.0 ± 1.7 mmol.l−1.

3.2.1. ICU admission

Multivariate logistic regression analysis on matched population after IPTW propensity analysis reported a significant association with: age (aOR, 0.90; 95%CI: 0.93–0.98; p = 10−3), SpO2i,O2 (aOR, 1.10; 95%CI: 1.02–1.20; p = 0.002) and BMI (aOR, 1.09; 95% CI: 1.03–1.16; p = 0.02) but not with prehospital SI (aOR, 4.30; 95% CI: 0.79–23.90; p = 0.089) and/or prehospital lactatemia (aOR, 1.14; 95% CI: 0.89–1.43; p = 0.29).

Fig. 1. Patient flowchart.
Early medical assessment of patients with COVID-19 is crucial in the triage decision-making process for the optimal orientation between the ED or intensive care unit, with ICU admission and 30-day mortality among COVID-19 patients. In this retrospective analysis of 410 COVID-19 patients cared for by a Paris Fire Brigade BLS or ALS team, we observed that neither prehospital initial shock index nor prehospital lactatemia are associated with ICU admission and 30-day mortality among COVID-19 patients.

4. Discussion

Multivariate logistic regression analysis on matched population after IPTW propensity analysis reported a significant association with: SpO2I (aOR, 0.92; 95%CI: 0.87–0.98; p = 0.01 P < 10–3) and GCSi (aOR, 0.90; 95% CI: 0.82–0.99; p = 0.04) but not with prehospital SI or lactatemia. Moreover, SI increase may be decreased by beta-blocker therapy.

4.2. 30-day mortality

Multivariate logistic regression analysis on matched population after IPTW propensity analysis reported a significant association with: SpO2I (aOR, 0.92; 95%CI: 0.87–0.98; p = 0.01 P < 10–3) and GCSi (aOR, 0.90; 95% CI: 0.82–0.99; p = 0.04) but not with prehospital SI or lactatemia. Moreover, SI increase may be decreased by beta-blocker therapy.

4.2.3. 30-day mortality

Multivariate logistic regression analysis on matched population after IPTW propensity analysis reported a significant association with: SpO2I (aOR, 0.92; 95%CI: 0.87–0.98; p = 0.01 P < 10–3) and GCSi (aOR, 0.90; 95% CI: 0.82–0.99; p = 0.04) but not with prehospital SI or lactatemia. Moreover, SI increase may be decreased by beta-blocker therapy.

5. Conclusion

Prehospital initial SI and prehospital lactatemia are not associated with ICU admission and 30-day mortality among COVID-19 patients initially cared for by a Paris Fire Brigade BLS or ALS team. These preliminary data suggest that SI and lactatemia are not useful to identify ARF COVID-19 patients. However, further prospective studies are needed to confirm these preliminary results.

Ethics approval and consent to participate

This retrospective analysis was approved by the French ethics committee Ouest III on 2020/04/08 (Ref: 20.04.30 / SI CNRIPH 2003.30.62742).

Consent for publication

The ethical committee considered that consent of patients was waived for participation in this retrospective observational study.

Availability of data and material

yes, on reasonable request.

Funding

None.

Authors’ contributions

RJ, EB, YD, KB, MS, AA, FL, DJ, BP and ST collected data. RJ and DJ analysed data.

RJ drafted the manuscript.

All authors read and approved the final manuscript.

Authors’ information

Romain Jouffroy, Elise Brami, Yann Daniel, Kilian Bertho, Marine Scannavino, Amandine Abrati, Frederic Lemoine, Daniel Jost, Bertrand Prunet, Stéphane Travers - Paris Fire Brigade, Emergency Medicine dept, 1 place Jules Renard, 75017 Paris – France.
CRediT authorship contribution statement

Romain Jouffroy: Writing – review & editing. Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization.

Elise Brami: Data curation. Marine Scannavino: Data curation. Yann Daniel: Writing – review & editing, Data curation. Kilian Bertho: Data curation. Amandine Abriat: Writing – review & editing. Daniel: Writing, Project administration, Methodology. Sabine Lemoine: Writing – project administration, Formal analysis, Data curation. Daniel Jost: Writing – review & editing. Prunet: Project administration, Formal analysis, Conceptualization. Sabine Jean: Writing – review & editing, Data curation, Conceptualization. Daniel Jost: Writing – review & editing. Prunet: Project administration, Formal analysis, Conceptualization. Bertrand Prunet: Writing – review & editing, Data curation, Conceptualization. Stéphane Traverse: Writing – review & editing. Conceptualization.

Declaration of Competing Interest

None.

Acknowledgements

Thanks to the Paris Fire Brigade Basic and Advanced Life Support Teams for their daily engagement during the pandemic.

References

[1] World Health Organization. WHO director-generals opening remarks at the media briefing on COVID-19. 11 March. https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19–11-march-2020; 2020.
[2] Onder G, Rezza G, Brusaferro S. Case-fatality rate and characteristics of patients dying in relation to COVID-19 in Italy. JAMA. 2020;323(18):1775–6.
[3] Rajgor DD, Lee MH, Archuleta S, Bagdasarian N, Quek SC. The many estimates of the COVID-19 case fatality rate. Lancet Infect Dis. 2020;20(7):776–7.
[4] Verity R, Okell LC, Dorigatti I, Winskill P, Whittaker C, Imai N, et al. Estimates of the severity of coronavirus disease 2019: a model-based analysis. Lancet Infect Dis. 2020;20(6):669–77.
[5] Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72314 cases from the Chinese Center for Disease Control and Prevention. JAMA. 2020;323(13):1239–42.
[6] Rothan HA, Byrareddy SN. The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. J Autoimmun. 2020;109:102433.
[7] Jouffroy R, Jost D, Prunet B. Prehospital pulse oximetry: a red flag for early detection of silent hypoxemia in COVID-19 patients. Crit Care. 2020;24(1):313.
[8] Dhont S, Devroyn E, Van Braeckel E, Depuydt P, Lambrecht BH. The pathophysiology of silent hypoxemia in COVID-19. Respir Res. 2020;21(1):198.
[9] Berger T, Green J, Horeczko T, Hagar Y, Garg N, Suarez A, et al. Shock index and early recognition of sepsis in the emergency department: pilot study. West J Emerg Med. 2013;14(2):168–74.
[10] Leguillier T, Jouffroy R, Boisson M, Boussaroque A, Chevnevier-Gobeaux C, Chaabouni T, et al. Lactate POCT in mobile intensive care units for septic patients? A comparison of capillary blood method versus venous blood and plasma-based reference methods. Clin Biochem. 2018;55:9–14.
[11] Regnier MA, Raux M, Le Manach Y, Aescioni Y, Gaillard J, Devillers C, et al. Prognostic significance of blood lactate and lactate clearance in trauma patients. Anesthesiology. 2012;117(6):1276–88.
[12] Jouffroy R, Leguillier T, Gilbert B, Tourtier JP, Bleich-Laine E, Ecollan P, et al. Prehospital lactatemia predicts 30-day mortality in patients with septic shock: preliminary results from the LAPHSUS study. J Clin Med. 2020;9(10).
[13] Orso D, Federici N, Copetti R, Vetrugno L, Bove T. Infodemic and the spread of fake news in the COVID-19-era. Eur J Emerg Med. 2020;27(5):327–8.
[14] Adnet F, Lapostolle F. International EMS systems: France. Resuscitation. 2004;63(1):7–5.
[15] Gearing RE, Mian I, Barber J, Ickowicz A. A methodology for conducting retrospective chart review research in child and adolescent psychiatry. J Can Acad Child Adolesc Psychiatry. 2006;15(3):126–34.
[16] Allgower M, Burri C. Shock index. Dtsch Med Wochenschr. 1967;92(43):1947–50.
[17] Mohr NM, Wu C, Ward MJ, McNaughton CD, Richardson K, Kaboli PJ. Potentially avoidable inter-facility transfer from veterans health administration emergency departments: a cohort study. BMC Health Serv Res. 2020;20(1):110.
[18] Ghaffari M, Kazemi E, Sanelli S, Sameni H, Zaker E, Soudi H, et al. Analysis of overtriage and undertriage by advanced life support transport in a mature trauma system. J Trauma Acute Care Surg. 2020;88(5):704–9.
[19] Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The third international consensus definitions for sepsis and septic shock (Sepsis-3). JAMA. 2016;315(8):801–10.
[20] Rady MY, Nightingale P, Little RA, Edwards JD. Shock index: a re-evaluation in acute circulatory failure. Resuscitation. 1992;23(3):227–34.
[21] Vincent JL, Moreno R, Takala J, Willatts S, De Mendonca A, Bruining H, et al. The SOFA (Sepsis-related organ failure assessment) score to describe organ dysfunction/failure. On behalf of the working group on Sepsis-related problems of the European Society of Intensive Care Medicine. Intensive Care Med. 1996;22(7):707–10.
[22] Ait-Oufella H, Bige N, Boeille PY, Pichereau C, Alves M, Bertonchamp R, et al. Capillary refill time evaluation during septic shock. Intensive Care Med. 2014;40(7):958–64.
[23] Ait-Oufella H, Lemonne S, Boeille PY, Galbois A, Baudel JL, Lemant J, et al. Motting score predicts survival in septic shock. Intensive Care Med. 2011;37(5):801–7.
[24] Jouffroy R, Saade A, Tourtier JP, Gueye P, Boissoin M, Bousaroque A, Chenevier-Gobeaux C, Chaabouni T, et al. Lactate POCT in mobile intensive care units for septic patients? A comparison of capillary blood method versus venous blood and plasma-based reference methods. Clin Biochem. 2018;55:9–14.