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.

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Pneumothorax and barotrauma in invasively ventilated patients with COVID-19

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Dear Editor,

We read with great interest the article by Chopra et al. recently published on Respiratory Medicine [1].

In their multicenter study, the Authors present incidence, clinical characteristics and outcome of pneumothorax in critically ill patients with coronavirus disease 2019 (COVID-19). They found that pneumothorax rate among invasively ventilated COVID-19 patients is 80/594 (13 %), and mortality rate for patients who developed pneumothorax is 50/80 (62 %). On the contrary, among 160 randomly selected invasively ventilated COVID-19 patients without pneumothorax, mortality was 78/160 (49 %).

We recently published a systematic review on rate of barotrauma among invasively ventilated COVID-19 patients [2]. Our pooled analysis included data from 13 studies and 1814 patients [3–15] and we found that pooled estimate of pneumothorax rate was 10.7 % (95 % confidence interval [CI] = 6.7 %–14.7 %), while overall rate of barotrauma event was 16.1 % (95 % CI = 11.8 %–20.4 %). In addition, we found an overall mortality rate for COVID-19 patients who developed barotrauma of 61.6 % (95 % CI = 50.2 %–73.0 %), as compared with a mortality of 49.5 % (95 % CI = 41.1 %–58.0 %) for COVID-19 patients who did not develop barotrauma.

We are pleased to read that our findings are further reinforced by another study, that confirms that pneumothorax rate among mechanically ventilated COVID-19 patients is between 10 and 15 %. Indeed, after including the study by Chopra et al. in an updated meta-analysis, the pooled pneumothorax rate is 11.1 % (95 % CI = 7.4 %–14.8 %) (Fig. 1), while the overall barotrauma rate is 15.4 % (95 % CI = 11.7 %–19 %) (Fig. 2). Furthermore, the study by Chopra et al. also confirms a mortality rate above 60 % for COVID-19 patients with barotrauma (updated pooled estimate = 61.4 %; 95 % CI = 52.1 %–70.7 %) (Fig. 3), as compared with a mortality lower than 50 % for patients who did not develop barotrauma (updated pooled estimate = 49.5 %; 95 % CI = 42.8 %–52.3 %) (Fig. 4).

Collectively, these data confirm that barotrauma occur frequently in COVID-19 patients requiring mechanical ventilation, and is associated with a worse outcome and a very high mortality risk. Interestingly, the study by Chopra et al. is one of the few studies that identified worse lung mechanics at start of mechanical ventilation as a risk factor for development of barotrauma [2]. Most of previously published studies reported no significant differences among mechanical ventilation settings/parameters between patients who developed barotrauma and those who did not. They also found a trend towards lower age and higher use of steroids in pneumothorax patients, which were also suggested by other Authors [2,16].

Interestingly, in a recent study by our group, we identified Macklin-like radiological sign [17,18] detected on chest computed tomography (CT) scan as potential predictor of subsequent development of barotrauma about 12 days in advance [3].

Considering the high mortality rate associated with development of barotrauma in COVID-19 patients, and the ongoing debate on optimal timing of intubation in these patients [19–21], we believe that it might be justified to avoid intubation in patients with Macklin-like radiological sign on chest CT, and prefer early support with alternative techniques including awake prone positioning and extracorporeal membrane oxygenation [22–25].

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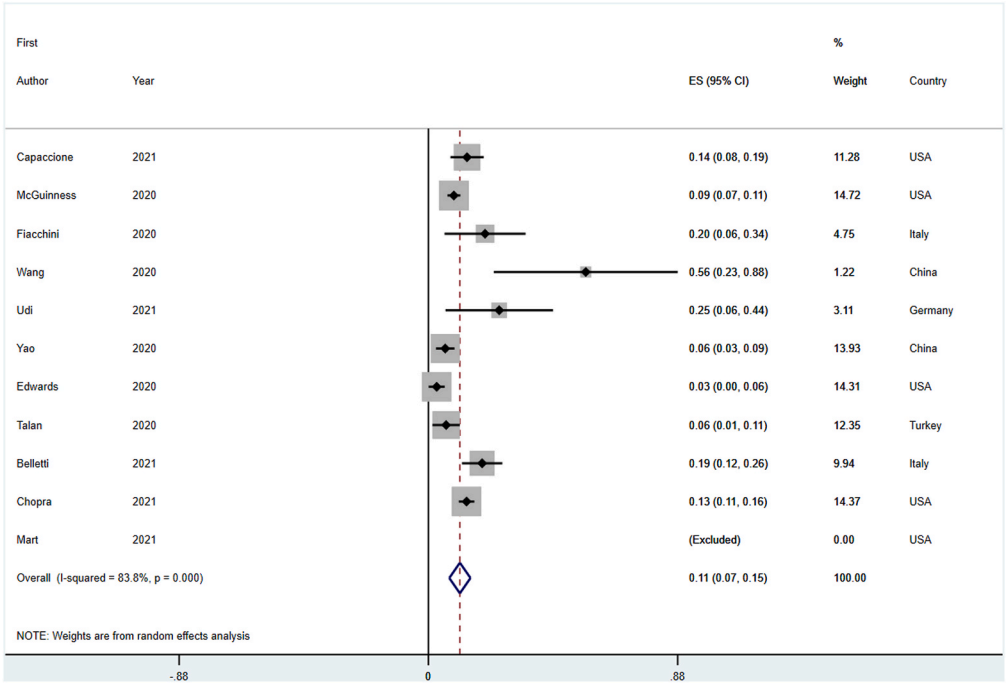

Fig. 1. Forest plot for pneumothorax development in invasively ventilated COVID-19 patients.

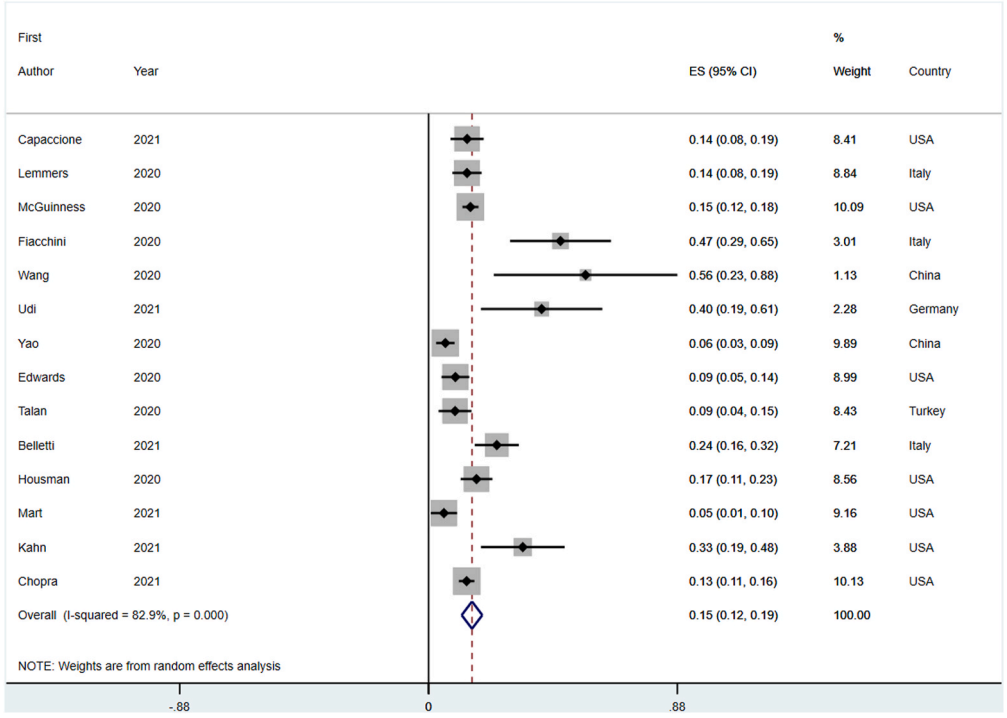

Fig. 2. Forest plot for barotrauma development in invasively ventilated COVID-19 patients.

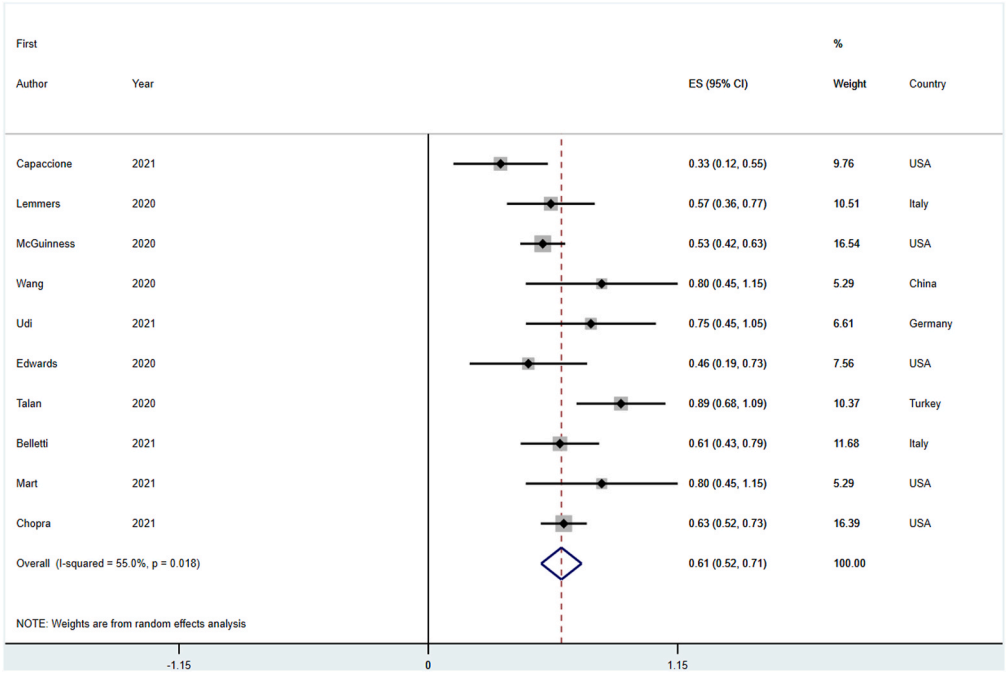

Fig. 3. Forest plot for longest follow-up mortality in invasively ventilated COVID-19 patients who developed barotrauma.

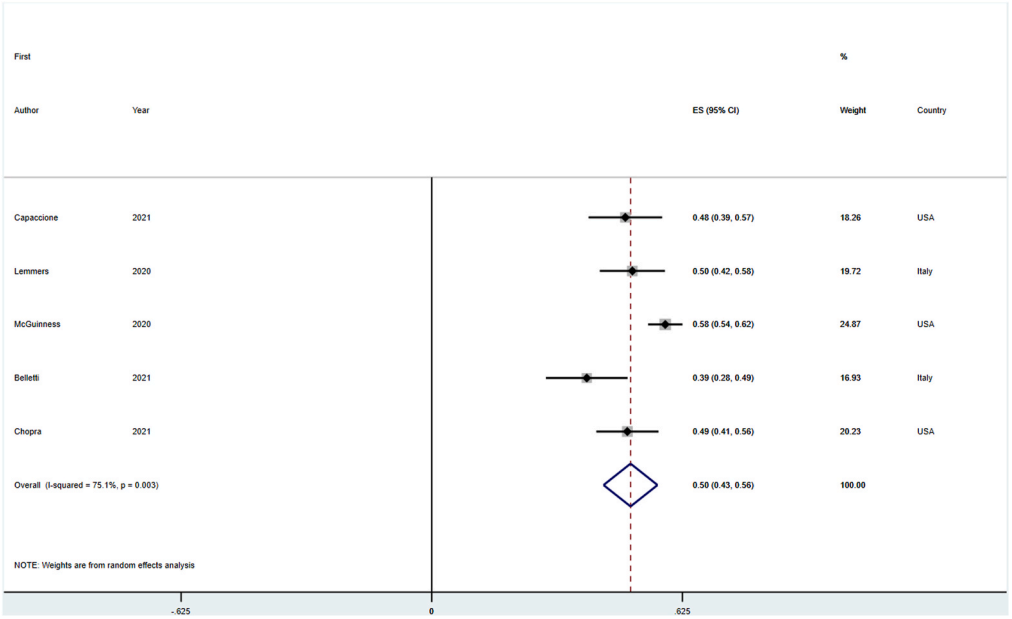

Fig. 4. Forest plot for longest follow-up mortality in invasively ventilated COVID-19 patients who did not developed barotrauma.

Declaration of competing interest

None.

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None.

References

[1] A. Chopra, A.H. Al-Tarbsheh, N.J. Shah, et al., Pneumothorax in critically ill patients with COVID-19 infection: incidence, clinical characteristics and outcomes in a case control multicenter study, Respir Med 184 (2021), 106464, https://doi.org/10.1016/j.rmed.2021.106464.

[2] A. Belletti, G. Todaro, G. Valsecchi, et al., Barotrauma in COVID-19 patients undergoing invasive mechanical ventilation: a systematic literature review, Crit Care Med (2021), https://doi.org/10.1097/CCM.0000000000005283. In press.

[3] A. Belletti, D. Palumbo, A. Zangrillo, et al., Predictors of pneumothorax/pneumomediastinum in mechanically ventilated COVID-19 patients, J Cardiothorac Vasc Anesth (2021), https://doi.org/10.1053/j.jvca.2021.02.008. In press.

[4] K.M. Capaccione, B. D'souza, J. Leb, et al., Pneumothorax rate in intubated patients with COVID-19, Acute Crit Care 36 (1) (2021) 81–84, https://doi.org/10.4266/acc.2020.00689.

[5] D.H.L. Lemmers, M. Abu Hilal, C. Bnà, et al., Pneumomediastinum and subcutaneous emphysema in COVID-19: barotrauma or lung frailty? ERJ Open Res 6 (4) (2020) https://doi.org/10.1183/23120541.00385-2020, 00385-02020.

[6] G. Fiacchini, D. Tricò, A. Ribechini, et al., Evaluation of the incidence and potential mechanisms of tracheal complications in patients with COVID-19, JAMA Otolaryngol Neck Surg 147 (1) (2021) 70–76, https://doi.org/10.1001/jamaoto.2020.4148.

[7] L. Talan, F.G. Şaşal Solmaz, U. Ercan, et al., COVID-19 pneumonia and pneumothorax: case series, Tuberk Toraks 68 (4) (2020) 437–443, https://doi.org/10.5578/tt.70355.
[8] J. Udi, C.N. Lang, V. Zotzmann, et al., Incidence of barotrauma in patients with COVID-19 pneumonia during prolonged invasive mechanical ventilation – a case-control study, J Intensive Care Med 36 (4) (2021) 477–483, https://doi.org/10.1177/0885066620954364.
[9] W. Yao, T. Wang, B. Jiang, et al., Emergency tracheal intubation in 202 patients with COVID-19 in Wuhan, China: lessons learnt and international expert recommendations, Br J Anaesth 125 (1) (2020) e28–e37, https://doi.org/10.1016/j.bja.2020.03.026.
[10] X. Wang, J. Duan, X. Han, et al., High incidence and mortality of pneumothorax in critically Ill patients with COVID-19, Heart Lung 50 (1) (2021) 37–43, https://doi.org/10.1016/j.hrtlng.2020.10.002.
[11] B. Housman, A. Jacobi, A. Carollo, et al., COVID-19 ventilator barotrauma management: less is more, Ann Transl Med 8 (23) (2020), 1575, https://doi.org/10.21037/atm-20-3907.
[12] G. McGuinness, C. Zhan, N. Rosenberg, et al., Increased incidence of barotrauma in patients with COVID-19 on invasive mechanical ventilation, Radiology 297 (2) (2020) E252–E262, https://doi.org/10.1148/RADIOL.2020202352.
[13] M.F. Mart, S.G. Norfolk, L.N. Flemmons, et al., Pneumomediastinum in acute respiratory distress syndrome from COVID-19, Am J Respir Crit Care Med 203 (2) (2021) 237–238, https://doi.org/10.1164/rccm.202008-3376IM.
[14] M.R. Kahn, R.L. Watson, J.T. Thetford, J.I. Wong, N. Kamangar, High incidence of barotrauma in patients with severe coronavirus disease 2019, J Intensive Care Med 36 (6) (2021) 646–654, https://doi.org/10.1177/0885066621989959.
[15] J.A. Edwards, I. Breitman, J. Bienstock, et al., Pulmonary barotrauma in mechanically ventilated coronavirus disease 2019 patients: a case series, Ann Med Surg 61 (2021) 24–29, https://doi.org/10.1016/j.amsu.2020.11.054.
[16] D. Palumbo, C. Campochiaro, A. Belletti, et al., Pneumothorax/pneumomediastinum in non-intubated COVID-19 patients: differences between first and second Italian pandemic wave, Eur J Intern Med 88 (2021) 144–146, https://doi.org/10.1016/j.ejim.2021.03.018.
[17] C.C. Macklin, Transport of air along sheaths of pulmonic blood vessels from alveoli to mediastinum: clinical implications, Arch Intern Med 64 (5) (1939) 913–926, https://doi.org/10.1001/archinte.1939.00190050019003.
[18] S. Murayama, S. Gibo, Spontaneous pneumomediastinum and Macklin effect: overview and appearance on computed tomography, World J Radiol 6 (11) (2014) 850–854, https://doi.org/10.4329/wjr.v6.i11.850.
[19] Siempos, E. Xourgia, T.K. Ntaidou, et al., Effect of early vs. Delayed or No intubation on clinical outcomes of patients with COVID-19: an observational study, Front Med 7 (2020), 614152, https://doi.org/10.3389/fmed.2020.614152.
[20] L. Cabrini, L. Ghislanzoni, P. Severgnini, et al., Early versus late tracheal intubation in COVID-19 patients: a pro-con debate also considering heart-lung interactions, Minerva Cardioangiol (2020), https://doi.org/10.23736/S0026-4725.20.05356-6. In press.
[21] Y.H. Lee, K.-J. Choi, S.H. Choi, et al., Clinical significance of timing of intubation in critically ill patients with COVID-19: a multi-center retrospective study, J Clin Med 9 (9) (2020), 2847, https://doi.org/10.3390/jcm9092847.
[22] C. Sartini, M. Tresoldi, P. Scarpellini, et al., Respiratory parameters in patients with COVID-19 after using noninvasive ventilation in the prone position outside the intensive care unit, JAMA 323 (22) (2020) 2338–2340, https://doi.org/10.1001/jama.2020.7861.
[23] M. Schmidt, M. Pineton de Chambrun, G. Lebreton, et al., Extracorporeal membrane oxygenation instead of invasive mechanical ventilation in a patient with severe COVID-19-associated acute respiratory distress syndrome, Am J Respir Crit Care Med (April 2021), https://doi.org/10.1164/rccm.202102-0259le. In press.
[24] P. Loyalka, F.H. Cheema, H. Rao, J.E. Rame, K. Rajagopal, Early usage of extracorporeal membrane oxygenation in the absence of invasive mechanical ventilation to treat COVID-19-related hypoxemic respiratory failure, ASAIO J 67 (4) (2021) 392–394, https://doi.org/10.1097/MAT.0000000000001393.
[25] J. Tang, W. Li, F. Jiang, T. Wang, Successfully treatment of application awake extracorporeal membrane oxygenation in critical COVID-19 patient: a case report, J. Cardiothorac. Surg. 15 (1) (2020), 335, https://doi.org/10.1186/s13019-020-01376-9.

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