An exploration of oxygenation indices in proned patients

David M. Hannon

Introduction

The Acute Respiratory Distress Syndrome (ARDS) was initially identified as a clinical entity in the 1960s[1]. Pathophysiologically, ARDS consists of diffuse alveolar damage due to the activation of alveolar macrophages to release pro-inflammatory cytokines[2] that attract neutrophils to the lungs where they damage the alveolar and capillary epithelium by release of toxic mediators. This leads to the alveoli being filled with bloody, proteinaceous fluid. Consequently, the surfactant can no longer support the alveoli[3]. The end result is that these damaged alveoli lead to impaired gas exchange, which is the pathophysiolgic hallmark of ARDS.

Patients with certain clinical conditions are at higher risk for developing ARDS. These can broadly be grouped into direct lung injury risk factors like pneumonia, aspiration, pulmonary contusion, inhalational injury, near drowning etc. (heretofore referred to as 'ARDSp') and indirect lung injury risk factors such as sepsis, non-thoracic injuries/hemorrhagic shock, pancreatitis, burns, drugs/toxins, blood transfusions, cardiopulmonary bypass and reperfusion injury after lung transplant or embolectomy (which will now be referred to as 'ARDSexp')[4].

To date, there are no specific drugs or therapies available to directly treat/prevent ARDS. Mechanical ventilation that aims to protect injured lungs and minimize Ventilator Induced Lung Injury (VILI), and management of refractory hypoxaemia, are the keystones in supportive management of ARDS[5]. Part of the above can include placing a patient in the prone (i.e. 'face down') position. This was first described as a therapy for ARDS in the 1970s[6]. The mechanism by which prone positioning improves oxygenation is multifactorial. It reduces the ventral to dorsal transpulmonary pressure difference, ventilation-perfusion mismatch and lung compression[7,8]. Other potential physiological effects of prone positioning include a decrease in proinflammatory cytokines and improvement in RV dysfunction by preserving pulmonary circulation[9].

The first prospective randomized control trial (known as the 'PROSEVA' trial) that showed a mortality benefit from prolonged prone positioning was conducted in France and published in 2013[10]. Earlier randomized control trials failed to show significant mortality benefit , which was likely due inconsistent use of lung protective ventilation, shorter duration of prone positioning and application of prone positioning in patients with mild-moderate ARDS[11]. Prone positioning for at least 12 to 16 hours per day, while administering low tidal volumes (4-6ml/kg of ideal body weight), is now strongly recommended in ventilated patients with severe ARDS[12].

Many questions regarding the utility and efficacy of the prone position remain. An impor-

tant issue lies in identifying patients who, although they fit the criteria to undergo prone positioning, are unlikely to receive a mortality benefit and in whom other therapies may be effective[13].

Population

Initial selection

This section shows details of the population involved in this study. The data was gathered by interrogating the Electronic Health Record system used in the Intensive Care Unit (ICU) of University Hospital Galway (UHG). The system was queried to return all patients on record whp fulfilled the following criteria:

- over 18 years of age
- invasively ventilated
- placed in the prone position whilst invasively ventilated

Results of selection

A total of 133 records were isolated from the servers. These records were between 14/07/2013 and 20/03/2022. They consisted of patients who had been placed in the prone position secondary to a pulmonary insult (ARDSp), and extrapulmonsry insult (ARDSexp), and Covid-19 (C-ARDS). Patients in the dataset were proned between 1 and 13 times. Full details of the demographics can be seen in Table 01.

Oxygenation indices

Explorations & Comparisons

References

1. Ashbaugh D, Bigelow DB, Petty T, Levine B. Acute respiratory distress in adults. *The Lancet*. 1967;290(7511):319323.
2. Martin TR. Lung cytokines and ARDS: Roger s. Mitchell lecture. *Chest*. 1999;116:2S8S.
3. Ware LB, Matthay MA. Alveolar fluid clearance is impaired in the majority of patients with acute lung injury and the acute respiratory distress syndrome. *American journal of respiratory and critical care medicine*. 2001;163(6):13761383.
4. Thompson BT, Chambers RC, Liu KD. Acute respiratory distress syndrome. *New England Journal of Medicine*. 2017;377(6):562572.
5. Fan E, Del Sorbo L, Goligher EC, et al. An Official American Thoracic Society/European Society of Intensive Care Medicine/Society of Critical Care Medicine Clinical Practice Guideline: Mechanical Ventilation in Adult Patients with Acute Respiratory Distress Syndrome. *American journal of respiratory and critical care medicine*. 2017;195(9):1253-1263. doi:10.1164/rccm.201703-0548ST
6. PIEHL MA, BROWN RS. Use of extreme position changes in acute respiratory failure. *Critical care medicine*. 1976;4(1):1314.
7. Cornejo RA, Díaz JC, Tobar EA, et al. Effects of prone positioning on lung protection in patients with acute respiratory distress syndrome. *American journal of respiratory and critical care medicine*. 2013;188(4):440448.
8. Jozwiak M, Teboul JL, Anguel N, et al. Beneficial hemodynamic effects of prone positioning in patients with acute respiratory distress syndrome. *American journal of respiratory and critical care medicine*. 2013;188(12):14281433.
9. Guérin C. Prone ventilation in acute respiratory distress syndrome. *European Respiratory Review*. 2014;23(132):249257.
10. Guérin C, Reignier J, Richard JC, et al. Prone positioning in severe acute respiratory distress syndrome. *The New England journal of medicine*. 2013;368(23):2159-2168. doi:10.1056/NEJMoa1214103
11. Sud S, Friedrich JO, Adhikari NK, et al. Effect of prone positioning during mechanical ventilation on mortality among patients with acute respiratory distress syndrome: A systematic review and meta-analysis. *Cmaj*. 2014;186(10):E381E390.
12. Banavasi H, Nguyen P, Osman H, Soubani AO. Management of ARDS–what works and what does not. *The American Journal of the Medical Sciences*. 2021;362(1):1323.
13. Kawakami A, Yamakawa K, Nishioka D, et al. PaO2 / FiO2 ratio responsiveness to prone positioning in intubated patients with severe COVID-19: A retrospective observational study. *Acute Medicine & Surgery*. 2022;9(1):e765. doi:10.1002/ams2.765