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Case Report

Prolonged Prone Ventilation in a Rural Community Hospital during COVID 19 Pandemic Surge: Case Report and Literature Review

Yasser Omar* and Ryan Kerrins

Tennova Healthcare Clarksville, Tennessee, United States

***Corresponding Author:** Yasser Omar, Tennova Healthcare Clarksville, Tennessee, United States.

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Abstract

Background: Prone ventilation (PV) has been a standard of care in critically ill patients with acute respiratory distress syndrome (ARDS). However, it is often underutilized in rural intensive care units. This is largely due to staffing issues and lack of resources which have only been made worse during the SARS-CoV-2 pandemic. Current guidelines suggest at least 12 - 16 hours of prone mechanical ventilation per session. However, during a surge of the pandemic, a rural ICU in Tennessee was gravely understaffed and needed to implement prolonged prone positioning (> 48 hours).

Methods: A literature review of current research that has evaluated prolonged proning (>16 hours). Unfortunately, none of the studies included rural intensive care units. A case report of a patient who underwent prolonged proning in a rural intensive care unit during the SARS-CoV-2 pandemic.

Results: After a three-week hospitalization, the patient was discharged to a subacute rehabilitation center. He did not require a tracheostomy. He did have skin breakdown to the right maxilla and shins. He did not report blurred vision or ocular pain.

Conclusion: Prolonged prone ventilation may be a more feasible option for rural intensive care units that do not have adequate staffing or resources. More research that does not exclude rural intensive care units is needed.

Keywords: *Prone Ventilation (PV); Acute Respiratory Distress Syndrome (ARDS); SARS-CoV-2 Pandemic*

Introduction

Severe acute respiratory distress syndrome coronavirus 2 (SARS-CoV-2), the trigger of coronavirus disease 2019 (COVID 19) continues to spread throughout the United States [1]. The death toll of people admitted to the intensive care unit with SARS-CoV-2 infection is staggering. COVID 19 in its worst cases is characterized by severe pneumonia, respiratory failure requiring mechanical ventilation, refractory hypoxemia and death [2]. A few interventions for the SARS- CoV-2 patients requiring mechanical ventilation are associated with increased odds of survival, Prone ventilation is one of them [3]. Prone ventilation mitigates lung stress and strain and alleviates ventilator associated lung injury [4].

More than 60 million Americans live rural America and they have been disproportionately impacted by SARS-CoV-2 pandemic [5]. Meanwhile the vast majority of prone ventilation trials did not include rural intensive care units (ICU). Therefore, the generalizability of the evidence to rural intensive care units is in question. Rural ICUs capabilities and patients care processes are unique and are poorly studied [6,7]. Understating how intensivists manage critically ill patients with COVID 19 in rural settings is of paramount importance.

We report a case of COVID 19 severe acute respiratory distress syndrome (ARDS) requiring prone ventilation. To our knowledge this is the first report to shed some light on the practice of prone ventilation for a COVID 19 patients with ARDS in an intensive care unit in a rural hospital with scarce resources during a COVID 19 surge.

Case Report

September 2021, a major influx of COVID cases transpired in the state of Tennessee. Our unit is a 21 bed intensive care unit serving a rural community in middle Tennessee. We are staffed by board-certified intensivists day and night. A 53-year-old Caucasian male with a past medical history of non-insulin dependent diabetes mellitus presented to the emergency room with a one week history of shortness of breath, cough, and fever. He tested positive for SARS-CoV-2 polymerase chain reaction. Chest radiograph showed extensive patchy bilateral nodular and interstitial airspace opacities. His oxygen requirements increased to 100% $Fi0_2$, 40 L/min high- flow nasal cannula (Vapotherm) alternating with bilevel positive airway pressure (BIPAP). On hospital day 6 he was transferred to the ICU. He developed severe acute respiratory distress syndrome (ARDS) after He was intubated and started on invasive mechanical ventilation. Initial ventilator setting: volume control, tidal volume 6 ml/kg ideal body weight tidal volume, respiratory rate 26 breath per minute, positive end-expiratory pressure (PEEP) 14 cmH_2O, FiO_2 90%, peak inspiratory pressure 31 cmH_2O, dynamic compliance 16 ml/cm H_2O, plateau pressure is not documented, ratio of partial pressure of oxygen in arterial blood to fractional inspirated oxygen PaO_2/FiO_2 62. Started on continuous neuromuscular blockade (Cisatracurium and Vecuronium alternating according to availability of the pharmacy. On ICU day 2 decision was made to employ prone ventilation. Due to the overwhelming number of critically ill patients at the 16 hours mark, we didn't have the staff to supine position the patient. He was kept in prone position with head elevation. Checking for facial swelling and skin break down performed every shift and observed to be minimal. After 72 hours of prone ventilation his oxygen requirement improved to 50% FiO_2 and PEEP of 8. He was supinated for 12 hours. His oxygen requirement increased to 70% FiO_2 and PEEP of 10 to sustain oxygen saturation around 90%. He was transitioned to prone ventilation for another 72 hours. Then supine position for 12 hours. Then another session of prone ventilation for an additional 48 hours. After a 3 weeks hospital course he was successfully discharged to a rehabilitation center. Upon discharge, skin exam showed a 1 cm healed scab on right cheek, two similar on his left shin. Patient did not report blurry vision or eye discomfort.

	$Pa0_2/Fi0_2$ (mmHg)	$PaCO_2$ (mmHg)	P_{peak} (cmH_20)
Day 1- supine	69	49	31
Day 2- prone	120	61.3	26
Day 3- prone	128	60.7	27
Day 4- supine	51	58	31
Day 5- prone	142	72	28
Day 6- prone	138	55.8	30
Day 7- prone	118	58	31
Day 8- supine	109	51.6	30
Day 9- prone	113	63.2	27
Day 10- prone	91	63.2	33

Table 1: *Oxygenation, ventilation, and peak airway pressure.*
$Pa0_2/Fi0_2$: Arterial Oxygen Partial Pressure/Fractional Inspired Oxygen;
$PaC0_2$: Partial Pressure of Carbon Dioxide; P_{peak}: Peak Airway Pressure.

Discussion

Rural hospitals have been facing financial struggle even before the COVID 19 pandemic [8]. With the COVID surge a massive shock was generated. The tremendous burden caused by the rapid influx of patients requiring mechanical ventilation and mainly resulted in severe staffing shortage including intensivists, nurses, respiratory therapists. At our hospital the nurse to patient ratio suffered the most and

increased to 1:3 and even 1:4. Our staff was overwhelmed and worked tirelessly. When patients develop refractory hypoxemia We did not have Extra Corporeal Membrane Oxygenation ECMO capacity. We used PV as a rescue method to improve oxygenation. Some patients responded nicely to prone ventilation. Since we were working with a skeleton staff. Frequent re-positioning was not an option and those responders kept in prone position for longer duration.

The practice of prone ventilation varies greatly around the world [9]. Before the pandemic, it was under-utilized with only 16% of the patients in LUNG SAFE study received PV. During the COVID pandemic, round the world intensivists strived to utilized prone ventilation and the percentage of prone patients improved from 16% in the LUNG SAFE study to 77% in Italian ICUs [10]. In a recent meta-analysis Behesht., *et al*. performed a systematic review of 28 studies of prone ventilation in 2021. 6 studies conducted in the USA, including Chicago, New York city. Unfortunately, none of them included rural ICUs [11]. Even collaborations like the study of the treatment and outcomes in critically ill patients with corona virus disease investigators STOP COVID, a nationwide study of patients admitted to 68 U.S hospitals rural ICUs were left out [12].

The effect of prone ventilation appears to be time dependent. In the early studies it was implemented for 4 - 8 hours and consequently achieved improvement in oxygenation and better secretion management [13]. The utmost survival benefit of prone ventilation was attained with 12 hours and longer [14]. The landmark study PROSEVA recruited patients in 26 ICUs in France and 1 ICU in Spain. all of the centers previously had experience exploiting prone ventilation for at least 5 years. Patients were prone ventilated up to 16 - 20 hours, then supinated for 4 hours, depending their oxygen requirement decision was made to re-prone or not [15]. Current guideline by American Thoracic Society duration of at least 12 hours prone ventilation for patients with severe ARDS [16]. The frequent positioning necessitates adequately staffed unit with well- prepared clinical teams which is rarely available in rural ICUs. And it imposes the risk of hemodynamic perturbation and dislodgement of endotracheal tube or vascular catheters. To our knowledge currently there are 3 retrospective studies and a small randomized controlled study that look at prolonged PV (> 24 hours) in patients with COVID 19 ARDS and none of them are in rural settings [17-20]. Page., *et al*. conducted a randomized pilot study at a large academic center which enrolled 1,157 patients with severe COVID induced ARDS. The control group was assigned to standard duration of 16 hours. The experimental arm received 24 hours of PV. No adverse outcomes were associated with longer PV duration. Also, prolonged PV was associated with reduced PPE usage and reduced workload for bedside clinical staff [20]. Similarly, Carsetti., *et al*. conducted a retrospective review of 10 patients in Italy where 9 of the patients were prone position for up to 36 hours. The authors did not disclose what type of settings this took place in. However, they did suggest that that prolonged PV up to 36 hours could be safe and feasible [19]. Douglas., *et al*. performed a retrospective single-center study in an academic center in Denver, Colorado which examined prolonged PV without interruption until oxygen requirement improved. The authors concluded that prolonged PV might come with increased risk of central line-associated bloodstream infections (CLABSI) and brachial plexus injury. However, they did not report mortality rates higher than those who received standard duration (16-hours) [17]. Parker., *et al*. reviewed data of 12 patients who experienced PV sessions 39 hours. Despite not reporting mortality difference a continuous betterment of P/F ratio beyond the 16 hours mark was reported [18].

Conclusion

Prolonged prone ventilation has potential to increase prone ventilation compliance in rural hospitals. Further research that does not exclude rural ICU setting is crucial.

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