Early Self-Proning in Awake, Non-intubated Patients in the Emergency Department: A Single ED’s Experience During the COVID-19 Pandemic

Nicholas D. Caputo, MD, MSc, Reuben J. Strayer, MD, and Richard Levitan, MD

ABSTRACT

Objective: Prolonged and unaddressed hypoxia can lead to poor patient outcomes. Proning has become a standard treatment in the management of patients with ARDS who have difficulty achieving adequate oxygen saturation. The purpose of this study was to describe the use of early proning of awake, non-intubated patients in the emergency department (ED) during the COVID-19 pandemic.

Methods: This pilot study was carried out in a single urban ED in New York City. We included patients suspected of having COVID-19 with hypoxia on arrival. A standard pulse oximeter was used to measure SpO2. SpO2 measurements were recorded at triage and after 5 minutes of proning. Supplemental oxygenation methods included non-rebreather mask (NRM) and nasal cannula. We also characterized post-proning failure rates of intubation within the first 24 hours of arrival to the ED.

Results: Fifty patients were included. Overall, the median SpO2 at triage was 80% (IQR 69 to 85). After application of supplemental oxygen was given to patients on room air it was 84% (IQR 75 to 90). After 5 minutes of proning was added SpO2 improved to 94% (IQR 90 to 95). Comparison of the pre- to post-median by the Wilcoxon Rank-sum test yielded P = 0.001. Thirteen patients (24%) failed to improve or maintain their oxygen saturations and required endotracheal intubation within 24 hours of arrival to the ED.

Conclusion: Awake early self-proning in the emergency department demonstrated improved oxygen saturation in our COVID-19 positive patients. Further studies are needed to support causality and determine the effect of proning on disease severity and mortality.

BACKGROUND

Prolonged and unaddressed hypoxia can lead to poor outcomes in patients with respiratory compromise.1 Boosting inspired oxygen (FiO2) is an effective therapy in many hypoxic patients; however, in patients with significant physiologic shunting, positive pressure may be required.2 This is usually delivered by invasive or non-invasive ventilation (NIV). These types of interventions require resources that under normal circumstances are generally available, however become quickly limited in times of surge. Awake proning has been demonstrated to decrease intubation and improve outcomes in ARDS patients.3

In New York City, during the early stages of the COVID-19 pandemic, patients presented en masse with moderate to severe hypoxia. Some of these patients were distressed, quickly deteriorated and required endotracheal intubation. However, COVID-19 produced
another group of patients whose pathophysiology con-
ounded existing disease patterns. These patients had 
low oxygen saturations (SpO₂ < 90%), but were not in 
significant respiratory distress and often appeared clin-
ically well; this group has been informally referred to as 
happy hypoxemics. Because many of these patients were 
markedly tachypneic, had chest radiographic findings 
similar to acute respiratory distress syndrome (ARDS), 
had hypoxemia not responsive to supplemental oxygen, 
and because of infectious aerosolization fears around 
alternative oxygenation modalities, many of them were 
intubated early in their hospital course. Ventilator stock-
piles and critical care resources were quickly depleted 
the result of widespread early intubation of patients with 
COVID-19 lung disease. Based on prior literature, with 
other causes of ARDS it was speculated that proning of 
awake patients would improve patient’s oxygenation 
and prevent or delay intubation. We sought to describe 
our preliminary experience with the use of early proning 
of awake, non-intubated patients with suspected or con-
firmed COVID-19 disease and its impact on oxygena-
tion in the ED. Our primary outcome was median 
SpO₂ after supplemental oxygen and proning were 
applied in tandem.

METHODS

Study design and setting
We conducted an observational cohort study of a con-
venience sample of patients at an urban, academic ED 
in New York City, USA between March 1st and April 
1st of 2020. This study was approved by the Lincoln 
hospital institutional review board and ethics board.

The average annual volumes of the ED is approxi-
mately 175,000. The department generally performs 
about 40 to 50 intubations a month with the majority 
of intubations being performed by EM trainees under 
the direct supervision of an EM attending.

Selection of Participants
We included the first fifty adult patients (age 
≥18 years old) who presented to the ED with hypoxia 
(SpO₂ <90%) and without resolution (SpO₂ >93%) 
despite supplemental oxygen and who were capable of 
self-proning during the early stages of the COVID-19 
pandemic in March to April 2020. Patients were 
asked to self-prone/change position. We excluded 
patients with DNR/DNI code status, in cardiac arrest, 
receiving non-invasive ventilation (NIV) or those who 
were intubated in the prehospital setting. All patients 
had documented SARS-CoV-2 infection, confirmed by 
nasal/oropharyngeal swab followed by positive reverse 
transcriptase polymerase chain reaction detection of 
viral nucleic acid.

Methods of Measurement
Vital signs were obtained from the cardiac monitor 
(Philips Intellivue, Philips USA) in real time. SpO₂ 
was measured through standard finger oximeters 
(Covidien Oximax, Covidien, USA). Hypoxemia was 
defined as a SpO₂ <90%.

Outcomes
The primary outcome was the change in SpO₂, deter-
mained prior to proning, after application of supple-
mental oxygen and after 5 minutes of proning without 
change in inspired oxygen. The secondary outcome 
was rate of patients who were proned but then 
required intubation within 24 hours of presentation to 
the ED. A patient was deemed to have failed proning 
if they showed respiratory failure defined as persistent 
SpO₂ < 90% in the setting of unresolved or worsen-
ting tachypnea with either accessory muscle use, altered 
mental status or hypercarbia on blood gas.

Analysis
The primary dependent variable was the SpO₂ which 
was not normally distributed (P> 0.1 by Shapiro– 
Wilk), necessitating the reporting of median values. 
For the clinical series, we analyzed the data using 
descriptive techniques. We determined median SpO₂ 
before proning and after proning. We determined 
the proportion of patients achieving SpO₂ >93% with 
proning. We compared the pre to post median values 
using the Wilcoxon Rank Sum test. We also deter-
mined the proportion of patients that failed proning 
(assuming explicit definition of respiratory failure) and 
required intubation. All analyses were performed 
using XLStat (Addinsoft, New York, NY).

RESULTS
We included 50 patients in this convenience sample 
cohort, most with respiratory complaints leading to 
their visit to the ED. All patients were observed in the 
ED until admission to the floors. The median time 
observation of the cohort in the ED was 29 minutes 
(range 63 to 1620).

The median age of the cohort was 59 (IQR 50 to 
68) with 60% of the group being male. Eighty percent
of the cohort were tachypneic on arrival (RR > 20). On arrival to the ER, over half of this cohort, 56% (28), had no supplemental oxygen being delivered (e.g., were on room air). Eighty percent of these patients arrived as “walk-ins” and 20% arrived by EMS. The remaining 44% (22) of these patients arrived to the ER with supplemental oxygen being provided, usually non-rebreather mask (n = 8) or nasal cannula at approximately 5 liters per minute (n = 14). The median SpO2 of patients who arrived without supplemental oxygen was 75% (IQR 62 to 82) and for those patients with supplemental oxygen in place was 82% (IQR 72 to 85). Overall, the median SpO2 at triage was 80% (IQR 69 to 85). This improved to 84% (IQR 75 to 90) after application of supplemental oxygen (non-rebreather mask [n = 38] or nasal cannula at approximately 5 liters per minute [n = 12]). After 5 minutes of proning was added, the media SpO2 increased to 94% (IQR 90 to 95). Comparison of the pre- to post-median by the Wilcoxon Rank–sum test yielded P = 0.001.

Thirteen patients (24%, 95% CI 14.6 to 40.3%) met the definition of respiratory failure plus clinical signs of respiratory distress within 24 hours of presenting to the ED and required endotracheal intubation. Of these 13 patients who required intubation, four patients were intubated within 30 minutes of proning, three patients were intubated between 30 and 60 minutes after proning and the remaining six were intubated after 60 minutes of initiation of proning but within 24 hours. Of those patients who were not intubated within 24 hours (n = 37), five were subsequently intubated (three between 24 and 48 hours and two after 72 hours) as inpatients.

**LIMITATIONS**

This study is a non-experimental sequential case series that reports an association between proning patients with COVID-19 and improvement in oxygen saturation. Though the effect size is significant and consistent with existing models of physiologic shunt, causal inferences arising from descriptive studies can only be hypothesized, not concluded. The patients described come from a convenience sample presenting to a single hospital and therefore may not represent other populations or the population at large. All aspects of care were uncontrolled; therefore the effect seen may be due not to proning, but to an unrecognized alternative treatment. In order to make a strong claim to causality, proning should be studied in a prospective trial that randomizes similar patients to proning or not, and where other aspects of care are congruent in both arms. Lastly, though oxygen saturation contributes to patient-oriented outcomes such as endotracheal intubation, vital signs are themselves a disease-oriented endpoint; attributing value to the treatment requires that it be measured against more important consequences such as duration of hospitalization or death.

**DISCUSSION**

COVID-19 is a novel disease arising from a novel pathogen, SARS-CoV-2. Frontline physicians working in New York City have been confronted with unprecedented challenges around resource scarcity and disease infectivity; however, the most enduring tribulation may be caring for patients who become critically ill and succumb to an illness that does not fit into existing models, does not respond to usual therapies, and for which there are no treatments established by rigorous science.

Clinicians managing the earliest cases of COVID-19 in China and Italy were faced with extraordinary levels of hypoxemia, and serious concerns that viral particles would be aerosolized during oxygenation therapies such as noninvasive ventilation and high flow nasal cannula. This led to a recommendation that patients who do not adequately respond to low-flow oxygen therapies (such as conventional nasal cannula or venturi mask) be intubated without the usual trial of pressurized oxygen modalities.

The intubate early approach was adopted in the first wave of critically ill COVID-19 patients seen in New York City hospitals, but early outcomes data from overseas demonstrated shockingly high mortality for intubated patients, and the inevitability of resource scarcity, if early intubation was continued, caused clinicians to seek strategies to delay or prevent the initiation of mechanical ventilation in COVID-19 patients.

Little was known of the pathophysiology of COVID-19 disease in the early days of the pandemic. An Italian described two patient subtypes that has framed management approaches across different phases of illness.

The conventional alternatives to mechanical ventilation–NIV and HFNC–have been used successfully in COVID-19 but their implementation is hindered by several factors in addition to the aforementioned aerosolization concerns. For reasons presently not understood, COVID-19 lung disease patients frequently
demonstrate hypoxia out of proportion to dyspnea or distress, diminishing the utility of perhaps the most important indicator of respiratory function: pulse oximetry. Furthermore, COVID-19 patients requiring hospitalization often have huge oxygenation deficits, requiring very high oxygen flows that are difficult to maintain on awake patients who do not tolerate staying in one position and may inadvertently knock off their oxygen masks. Awake patients who are very ill with COVID therefore in some respects require a higher level of care than those on mechanical ventilation.

Maneuvers that can safely improve oxygenation without the need for additional resources are thus of immense value during a surge of COVID-19 patients. Our experience suggests that the use of rotating or proning is a valuable tool in improving oxygenation and decreasing respiratory effort in many patients with moderate or severe COVID-19. Proning is simple (many patients can rotate or prone themselves, without assistance, is without cost, and utilizes no additional personnel or departmental resources. Some patients, when attempting to prone, benefit from the strategic placement of blankets or pillows.

Any COVID-19 patient with respiratory embarrassment severe enough to be admitted to the hospital should be considered for rotation and proning. Care must be taken to not disrupt the flow of oxygen during patient rotation, but we recommend proning regardless of oxygenation modality. Typical protocols include 30–120 minutes in prone position, followed by 30–120 minutes in left lateral decubitus, right lateral decubitus, and upright sitting position. Positioning is guided by patient wishes—salutary effects are generally noticed within 5–10 minutes in a new position; do not maintain a position that does not improve the patient’s breathing and comfort. Healthcare providers that may be otherwise less active during the pandemic, such as physical medicine clinicians, may be mobilized to do “proning rounds” to great effect.

In conclusion, our series of patients with moderate to severe hypoxemia related to COVID-19 lung disease demonstrated an improvement in their SpO2 after being placed in prone position. Until further studies indicate alternative oxygenation strategies or specific treatments that address the underlying hypoxic insult, we recommend early and frequent use of patient proning, with the hope that it will delay or prevent intubation.

It is critical to re-emphasize that patients with COVID-19 may desaturate precipitously and dangerously when disconnected from their oxygen source; patients with high oxygen requirements who are managed with alternatives to mechanical ventilation require vigilant monitoring and frequent, careful reassessment.

References

1. Martin LD, Mhyre JM, Shanks AM, Tremper KK, Kheterpal S. 3,423 emergency tracheal intubations at a university hospital: airway outcomes and complications. Anesthesiology 2011;114:42–8.
2. O’Driscoll BR, Howard LS, Davison AG, British Thoracic Society. BTS guideline for emergency oxygen use in adult patients. Thorax 2008;63:v1–vi68.
3. Ding L, Wang L, Ma W, et al. Efficacy and safety of early prone positioning combined with HFNC or NIV in moderate to severe ARDS: a multi-center prospective cohort study. Crit Care 2020;24:28.
4. Scholten EL, Beitler JR, Prisk GK, Malhotra A. Treatment of ARDS With prone positioning. Chest 2017; 151(1):215–24.
5. Fauci AS, Lane HC, Redfield RR. Covid-19 – navigating the uncharted. N Engl J Med 2020;382(13):1268–9.
6. Guan W, Ni Z, Hu Y, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2019. https://doi.org/10.1056/NEJMoa2002032.
7. Livingston E, Bucher K. Coronavirus disease 2019 (COVID-19) in Italy. JAMA 2020;323(14):1335–https://doi.org/10.1001/jama.2020.4344.
8. Onder G, Rezza G, Case-Fatality BS. Case-fatality rate and characteristics of patients dying in relation to COVID-19 in Italy. JAMA 2020; https://doi.org/10.1001/jama.2020.4683.
9. Gattinoni L, Chiumello D, Caironi P, et al. COVID-19 pneumonia: different respiratory treatment for different phenotypes? Intensive Care Med 2020; https://doi.org/10.1007/s00134-020-06033-2.
10. Xu Z, Shi L, Wang Y, et al. Pathological findings of COVID-19 associated with acute respiratory distress syndrome. Lancet Respir Med 2020;8(4):420–2. doi: https://doi.org/10.1016/S2213-2600(20)30076-X. 2020 Feb 18.
11. Accessed April 11, 2020: https://www.who.int/docs/default-source/coronaviruse/clinical-management-of-novel-cov.pdf