Effects of self-prone positioning method on oxygen saturation and incidence of intubation in COVID-19 patients

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Abstract

Study Objective: The purpose of this study was to determine the effects of self-prone positioning on oxygenation in COVID-19 positive patients utilizing supplemental oxygen and incidence of intubation. Method: A one-year observational cohort pilot study at a major inner-city hospital to evaluate self-proning on independent COVID-19 positive patients. Qualified patients 18 years of age or older were recruited based on inclusion and exclusion criteria. Data collection included vital signs and timing for body position changes, and results were analyzed using descriptive and inferential statistics. Results: Between April 2020 and May 2021, 93 COVID-19 enrolled patients engaged in stomach or lateral self-prone positioning. Eighty-four percent (n=78) of the population did not require intubation, whereas 16% (n=15) were intubated during their hospital stay. SpO2 means were determined for each population and prone position: Non-intubated (stomach) - before proning 93% (IQR 4) and during proning 95% (IQR 3); (lateral) before proning 92% (IQR 4) and during proning 93% (IQR 4). Intubated (stomach) - before proning 90% (IQR 7) and during proning 95% (IQR 4); (lateral) before proning 92% (IQR 5) and during proning 95% (IQR 5). Stomach proning significantly increased oxygenation in the non-intubated ($p < 0.001$) and intubated (p 0.017) populations. Lateral proning significantly improved oxygenation in the intubated population (p 0.002). Conclusion: Self-proning in the independent COVID-19 positive patient on supplemental oxygen was effective in improving SpO2 levels short-term. Further controlled trial studies will elucidate the duration of proning effects and reinforce its use as a noninvasive rescue intervention to prevent intubation.

Introduction

Considering the current global pandemic and the consequential devastating effects on the respiratory function of patients who test positive for the coronavirus disease of 2019 (COVID-19), new ways are being sought to improve health outcomes. Patients with COVID-19 often present with severe hypoxemia and acute respiratory distress, leading to supplemental oxygen therapy and intubation. Self-pronation is one intervention that may improve low oxygen saturation levels (SpO2), relieve shortness of breath (SOB), and potentially reduce intubation rates in patients who develop respiratory symptoms of the virus.

Researchers reported that lying in the prone position improves lung function in hospitalized patients with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (the virus that causes COVID-19) requiring tracheal intubation and assisted ventilation.[1][2][3] As patients practice prone positioning, they mitigate abnormal lung tissue strain and injuries related to mechanical ventilation and decrease their risk of intubation.[2] Another study found that awake early self-proning in the emergency department (ED) resulted in improved oxygenation and decreased respiratory effort in the COVID-19 positive patient.[4] These findings provide evidence-based information beneficial in the clinical setting to improve health outcomes and mortality for COVID-19 positive patients.[5]

There is limited research in the area that directly addresses how a patient's self-prone positioning (i.e., stomach versus lateral recumbent proning) affects their oxygenation and outcomes. To further explore this concept, we conducted an observational study to determine the effects of self-proning on the independent and awake COVID-19 positive patient with oxygen deficits. Our aim was to explore the effects of self-proning methodology on a large population of admitted COVID-19 patients on oxygenation and evaluate their tolerance level for the intervention and the potential to avoid intubation. We hypothesize that all self-proning positioning (including stomach and lateral recumbent proning) improves oxygen saturation, relieves respiratory distress, and may reduce the incidence of intubation in COVID-19 positive patients.

Background

Current research suggests that proning improves oxygenation in patients with severe COVID-19 who are often hypoxemic and undergo endotracheal intubation.[1][2][4] The goal of awake self-proning is to enhance oxygenation, improve respiratory function by equalizing the pleural pressure gradient and distribution of ventilation, and prevent intubation.[6] Patients who practice proning by lying on their stomachs increase aeration of dense posterior lung segments. As they lie in the prone position, gravity pushes secretions from the dense posterior lung segments toward the less dense anterior lung tissue, which results in increased perfusion and oxygenation to the posterior lungs.[7] The improved mobilization and drainage of secretions from the posterior lungs increases oxygen saturation and reduces the risk of intubation and ventilator-associated pneumonia (VAP).[7]

Anatomical and physiological changes occur in the lungs of the COVID-19 patient when they are in the prone position. Published reports from 1988 to 1991 showed computerized tomography (CT) scans of patients with acute respiratory distress syndrome (ARDS) in the prone position, which revealed redistribution of pathological posterobasal lung densities to the new dependent lung positions.[7] The historical evidence led to the development of a pathophysiological "sponge lung" model, which simply means that when a sponge is soaked in water, removed from the water, and placed in a horizontal or vertical position, the water drainage slows to a stop, and the sponge becomes wetter on the bottom with more empty pores on top.[7] The lungs have a sponge-like consistency similar to the sponge model. The model also reflects the mechanism through which the positive end-expiratory pressure (PEEP) opposes compressing forces by changing lung volume and intrathoracic pressure; when PEEP exceeds overlying pressure, it enables the dependent regions of the lung to remain open.[7]

Reports from clinical trials concluded that patients with severe ARDS who lie in the prone position have a significant survival advantage. Lung changes occur in the ARDS patient due to increased weight from fluids (edema) that squeeze out gases from the posterior part of the lungs or the most gravity-dependent regions.[8]Forces that result in compression atelectasis or alveolar collapse in the dependent regions appear as densities on CT scans.[9] The shape of the lungs and thoracic cavity, lung and cardiac mass, and displacement of the abdomen contribute to changes in transpulmonary pressure and the distribution of densities in the lungs due to gravitational forces.[6][9] While prone, the weight of the heart and abdominal contents are removed from the lungs, the production of cytokines associated with inflammation is decreased, pleural pressure and dorsal lung atelectasis decreases, and alveoli are opened with improved oxygenation.[5][7][9] PEEP and lying in the prone position contributes to anterior lung de-recruitment, dorsal lung recruitment with increased ventilation, and diminished ventilator-induced injury (VILI) in ARDS patients due to improved homogenous distribution of inflation and reduced lung strain.[7][9][10]

Methods

Setting and Study Design. This was an observational cohort study to assess the effect of the self-proning intervention on the independent COVID-19 positive patient. It was conducted at Yale New Haven Health Bridgeport Hospital, a 425-bed Level II Trauma center, and approved by the Bridgeport Hospital Institutional Review Board (IRB). Patients admitted to various locations throughout the hospital were considered for this study, including medical and medical-surgical units, the intermediate or Progressive Care Unit (PCU), Intensive Care Units (ICUs), and the ED. Education involved in-servicing 366 hospital staff members to include nurse leadership, nurse management, registered nurses (RNs), physicians, patient care technicians (PCTs), and business associates (BAs). They were informed on the purpose of self-proning and its effects on the lungs in the independent COVID-19 positive patient who did not require assistance with the intervention, how to qualify and educate the patient, and the data collection process.

Patient Population . The study population included 93 out of 98 recruited COVID-19 positive patients admitted to the hospital between April 2020 and May 2021. The population was further subdivided into nonintubated and intubated patients for data collection and comparison purposes. Self-proning data was collected on the intubated patients prior to undergoing mechanical ventilation. The study participants utilized a nasal cannula (N/C) or non-rebreather (NRB) for supplemental oxygenation and were instructed to perform a daily intervention to self-prone over a 4-hour interval. Select COVID-19 positive patients on high flow oxygen (HFO) were also included in the study in a discretionary manner if they met inclusion criteria. Patients in the recruited population who reported an alternative preferred body position and did not engage in proning were excluded from the study.

Materials. In-services on the self-proning protocol were performed for the staff. They were provided with documentation and ready-made packets for use on each patient who met the inclusion criteria. Each packet had a preformed "Self-Proning" label on it with a fill-in space for patient initials and contained the following (Figure 1A-1D): 1) an algorithm with a diagram decision tool for self-proning, 2) a protocol with methods and illustrations for the self-proning procedure designed as a handout for the patient written in English and Spanish, 3) a handout illustration comparing differences in lung secretion placement in the supine and prone positions in the COVID-19 patient in an easy-to-view format, and 4) a documentation log with columns for date, start and stop times, body position, total time, and comments to be taped to the outside of the patient's room and filled in by RNs and PCTs per body repositioning event.

Figure 1A. Contents of the Self-Proning Packet. Algorithm decision tool for self-proning.

Figure 1B. Contents of the Self-Proning Packet. Patient protocol for self-proning (English and Spanish versions were made available).

Figure 1C. Contents of the Self-Proning Packet. Illustration of the lungs comparing differences in secretion placement in the supine and prone positions in the COVID-19 patient.

Figure 1D. Contents of the Self-Proning Packet. Documentation data log.

Inclusion and exclusion criteria: Recruitment for qualified subjects was based on inclusion and exclusion criteria and determined by the medical and research staff. We included patients who met the following criteria: COVID-19 positive and admitted to the hospital, 18 years of age and older, male or female, utilizing a N/C or NRB, ability to self-reposition, mentation intact, unobstructed airway. We excluded patients based on the following criteria: COVID-19 negative, $<$ 18 years old, not utilizing an N/C or NRB, not admitted to the hospital, immediate need for intubation, altered mental status (AMS) or agitation, trauma (spinal, thoracic, facial, or surgical), abdominal surgery, inability to supine immediately, pregnancy, pressure wounds or ulcers.

Data Collection. Vital signs were obtained by RNs or PCTs from a telemonitor, pulse oximeter, or a vitals machine using standard equipment and entered on a preformed documentation log kept outside of the patient's room. The information included the date, vital signs pre-proning, start time for any of four body positions (prone, right side recumbent, sitting up in the Fowler's position, left side recumbent), a second set of vital signs taken no sooner than 10 minutes after each position change, stop time for the body position, total time in the position, and a signature and comments column to denote variances in the body positioning process, oxygenation, disposition, and patient preferences (Figure 1D). The Epic electronic medical record system was used to collect and confirm patient chart data, including demographics, supplemental oxygenation, vital signs, medical history, and disposition.

Outcomes. The primary outcome in this study for the COVID-19 positive patient on supplemental oxygen was the change in SpO2 at least 10 minutes after self-proning. The secondary outcome was the intubation rate for patients who practiced self-proning.

Analysis. We determined the change in SpO2 (including positive and negative changes) before and during proning events for patients who participated in the intervention. The data were analyzed utilizing descriptive statistics in EXCEL to determine measures of central tendency, frequency, variability, and quartile ranks. Further analysis of the data was done utilizing inferential statistics to determine confidence intervals, the coefficient of determination (R^2) through linear regression, a t -test paired two sample for means (assuming unequal variances), and calculated probability (p -value). The independent variable (IV) was the prone position (stomach or side-lying), and the dependent variable (DV) was the oxygen status (SpO2) while in the prone position.

Results

The convenience sample in this observational cohort study included 93 out of 98 recruited patients who were COVID-19 positive and admitted to the hospital in medical or intensive care units. In the nonintubated population (n =78), the median patient age (years) was 59 (interquartile range [IQR] 15, 29-84) and for the intubated population (n =15) it was 65 (IQR 18, 38-84). Length of stay (LOS) in the hospital was 13 days for the nonintubated population with a 1% mortality rate and 22 days for the intubated population with a 73% mortality rate (Table 1). Both populations engaged in stomach, lateral, or a combination of both types of proning. The number of proning events, median time for the event, and SpO2 values were recorded on the documentation log (Figure 2).

Table 1. Sociodemographic and Baseline Clinical Characteristics

Figure 2. Schematic Flowchart. Nonintubated and intubated (post proning) patient populations engaged in self-proning. *Abbreviations:* SpO2 = oxygen saturation.

The means for all documented stomach and lateral proning events for the nonintubated population are reflected in Figure 3. The mean of the starting SpO2 (pre-proning) for the 48 patients who were engaged in stomach proning was 93% (SD 3.3, IQR 4, 95% confidence interval [CI] 92 – 94, 18). The mean for the change in SpO2 during proning was 95% (SD 2.4, IQR 3, 95% CI 95 – 96, 14). Skewness data for the SpO2 was negative before (-0.5) and during proning (-0.9). A comparison of the before and during proning SpO2 values yielded t (170) = -5.22, p <0.001. The mean for changes in SpO2 before lateral proning in this population was 92% (SD 4.3, IQR 4, 95% CI 92 – 93, 25) and during proning 93% (SD 3.6, IQR 4, 95% CI 93 – 94, 21). Skewness was negative (-1.4) before and during proning (-1.8). Comparison of the changes in SpO2 values before and during proning resulted in t (205) = -1.92, p 0.055 (Table 2).

Figure 3. Nonintubated Patient Population (stomach and lateral). Changes in SpO2 are reflected in each graph before and during the proning event. *Upper graph* : Stomach proning (93 recorded SpO2 values) mean before proning 93% and during proning 95%. *Lower graph* : Lateral semi-proning (107 recorded SpO2 values) mean before proning 92% and during proning 93%.

Table 2. Self-Proning Patient Statistical Data

For the intubated population (Figure 4), the mean of the pre-proning SpO2 values for stomach proning (n =15) was 90% (SD 5.0, IQR 7, 95% CI 87 – 93, 17). The mean for the change in SpO2 during proning was 95% (SD 3.3, IQR 4, 95% CI 92 – 97, 11). Skewness data for the SpO2 was negative before (-0.8) and during proning (-0.1). A comparison of the before and during proning SpO2 values yielded t (19) = -2.62, p <0.017. The mean for changes in SpO2 before lateral proning in this population was 92% (SD 4.0, IQR 5, 95% CI 90 – 93, 17) and during proning 95% (SD 2.8, IQR 5, 95% CI 94 – 96, 9). Skewness was positive (0.004) before and during proning (0.1) and t (39) = -3.32, p 0.002 (Table 2).

Figure 4. Intubated Patient Population (stomach and lateral). Changes in SpO2 are reflected in each graph before and during the proning event. *Upper graph* : Stomach proning (12 recorded SpO2 values) mean before proning 90% and during proning 95%. *Lower graph* : Lateral semi-proning (23 recorded SpO2 values) mean before proning 92% and during proning 95%.

R^2 values (Table 2) representing the percentage of variance for the changes in SpO2 (DV) explained by the prone position (IV) are reflected in linear regression models for the nonintubated (stomach proning R^2 <0.001, lateral proning R^2 <0.001) and intubated populations (stomach proning R^2 0.028, lateral proning R^2 0.011) (Figure 5).

Figure 5. Linear Regression Models and R^2 . Illustrations of the relationship between proning and the changes in SpO2 for the patient populations. *Upper and lower left* : Nonintubated population - stomach R^2<0.001, lateral R^2 <0.001.*Upper and lower right* : Intubated population - stomachR^2 0.028, lateral $R^2$0.011.

Discussion

The world is currently facing many challenges associated with the COVID-19 pandemic and its potentially devastating systemic health effects. The disease affects several body systems (i.e., respiratory, cardiovascular, renal, hematological, neurological) with consequences that manifest in multiple dimensions: mental health and substance abuse issues, job loss, and social inequities.[11][12] Clinicians are seeking alternative strategies to manage the disease before it progresses into severe ARDS, invasive mechanical ventilation, and increased mortality rates.[4][13] Prone positioning is a life-saving intervention recommended in evidence-based guidelines for managing patients with ARDS as it reduces the risk of VILI and improves respiratory mechanics.[14][15]

The data from our study on awake self-proning raise several points for discussion. The R^2 values for the change in SpO2 that occurred during a proning event (stomach or lateral) reflected the linear relationship between the DV (change in SpO2) and the IV (prone position). The percent variation in the data for the nonintubated population for both stomach and lateral proning was < 0.1%, and for the intubated population, it was > 1% for both body positions (stomach 2.8%, lateral 1.1%). The low effect sizes for these variations may be due to outliers or the exclusion of other variables such as patient comorbidities. Additionally, the t -stat values for the change in SpO2 during stomach proning events for both populations and lateral proning in the intubated population were low (all were < -2.0, p <0.05). For the change in SpO2 during lateral proning in the nonintubated population,t -stat was > -2.0, p 0.055. The absolute$t$ -stat values were less than the df for both stomach and lateral proning in both populations. Based on the results, we can conclude that a significant difference exists between the change in SpO2 before proning and when a nonintubated patient assumes the stomach position and when a patient who was subject to intubation engages in either stomach or lateral positioning.

Although self-proning is widely practiced as a standard of care for improving oxygenation, it is uncertain how long the effects last, if it accelerates recovery time, and if it decisively prevents or delays the need for intubation.[16] Reports indicate that proning longer throughout the day decreases the risk of lung damage.[16] The patients in our study engaged in short-term proning (stomach and lateral), but the long-term effects are not apparent. We included data for lateral positioning because of patient preference and that it is associated with drainage of lung secretions and improvement in pulmonary gas exchange in critically ill patients.[17] Based on our data, lateral proning was more effective in the patients who were later intubated than those who did not undergo mechanical ventilation. This may be due to other unexplored conditions, such as differences in disease states and medications. It is also important to note that the requirement for mechanical ventilation for the intubated patients in this study (16% of the total population) cannot be related to a single proning event. These patients were independent and able to perform awake self-proning before intubation. The patient protocol was to change positions every 2 hours (stomach, right and left lateral, and sitting up); however, proning events were inconsistent and based on the patient's tolerance and position preferences. As a result, it is unclear if more consistent self-proning would have decreased the incidence of intubation in the patient population. A dedicated team who could consistently monitor the independent awake self-proner throughout each shift during their hospital stay would help minimize or avoid non-conforming proning times and events.

Our study population (N=93) is one of the largest in size in the area of self-proning in COVID-19 positive patients over a one-year interval. The candidates for this minimal risk intervention were acutely suffering

SOB from the systemic effects of COVID-19, and the results from this study indicated that changes in SpO2 were significant when self-proning on the stomach or in the lateral position. The lack of consistency in our data may weaken the argument for short-term and long-term proning as a potential rescue intervention; however, based on the results, self-proning (stomach or lateral) resulted in improved gas exchange and was widely and effectively utilized in accordance with safety guidelines during the pandemic throughout the hospital where this study took place. Although the benefit of proning in the nonintubated patient may not be solely related to improved oxygenation, it is advantageous as a low-cost, scalable intervention that is easily implemented and may save the lives of those at risk of intubation.[18] When safely guided and controlled, proning may be beneficial as a rescue strategy and may help avoid endotracheal intubation and its potentially harmful effects on hypoxemic COVID-19 patients.[16]

Implications

The results from this pilot study provide evidence-based information beneficial to the clinical setting and have implications for an effective rescue intervention for COVID-19 positive patients in respiratory distress that can be performed independently. As research expands in the area that directly addresses the health crisis and what hospitals and the multidisciplinary team can do using a simple measure to alleviate respiratory symptoms associated with the virus and avoidance of extraneous interventions, we suggest a more comprehensive, protocolized, and guided study that focuses on short-term and long-term effects from stomach and lateral proning in patients who are respiratory compromised.

Limitations

Several limitations in this study may have influenced the outcomes. Recruitment of qualified patients was minimized due to nursing staff concerns about increased workload and exposure to COVID-19 and overuse of personal protective equipment (PPE) to obtain vital signs before and after position changes. Nurses were thus instructed to gather data on patient adherence to the protocol once per shift in alignment with scheduled nursing tasks and to document vital signs from patient monitors that could be viewed through a glass window on the door of the room (not all rooms had glass windows, so this alternative was limited). Not all staff were in-serviced on the protocol, so changing shifts and turnover in nursing staff also contributed to inconsistencies and limited potential for recruiting newly admitted qualified patients. Patient comments regarding proning events were not consistently entered on the documentation log, so lack of this personal information limited feedback that may have helped optimize the protocol and increase compliance. The patients in this study came from a convenience sample presenting to one inner-city hospital and may not represent other populations. Their treatment plans and aspects of care were not controlled, which may have introduced confounding variables that influenced changes in SpO2 levels (the effects may result from an unrecognized alternate treatment rather than from proning). The lack of a control group also increases selection bias, decreases study power, threatens internal and external validity, and weakens the ability to draw conclusions about self-proning in these patients. A randomized prospective study that observes outcomes of proning in the COVID-19 positive patient and other aspects of their care would help determine a causal relationship between self-proning, improved oxygenation, and incidence of intubation. It would also be prudent to group patients with similar case mix index profiles and comorbidities to assess overall outcomes for those who perform proning.

Conclusion

Based on the data in this study, the type of self-proning positioning, whether stomach or lateral recumbent, in the awake independent patient effectively improved oxygenation; however, the duration of the effect and prevention of intubation is unclear. Further controlled studies would help strengthen the support of self-proning as a cost-effective, practical consideration, and noninvasive modality in the early management of COVID-19 positive patients with respiratory compromise.

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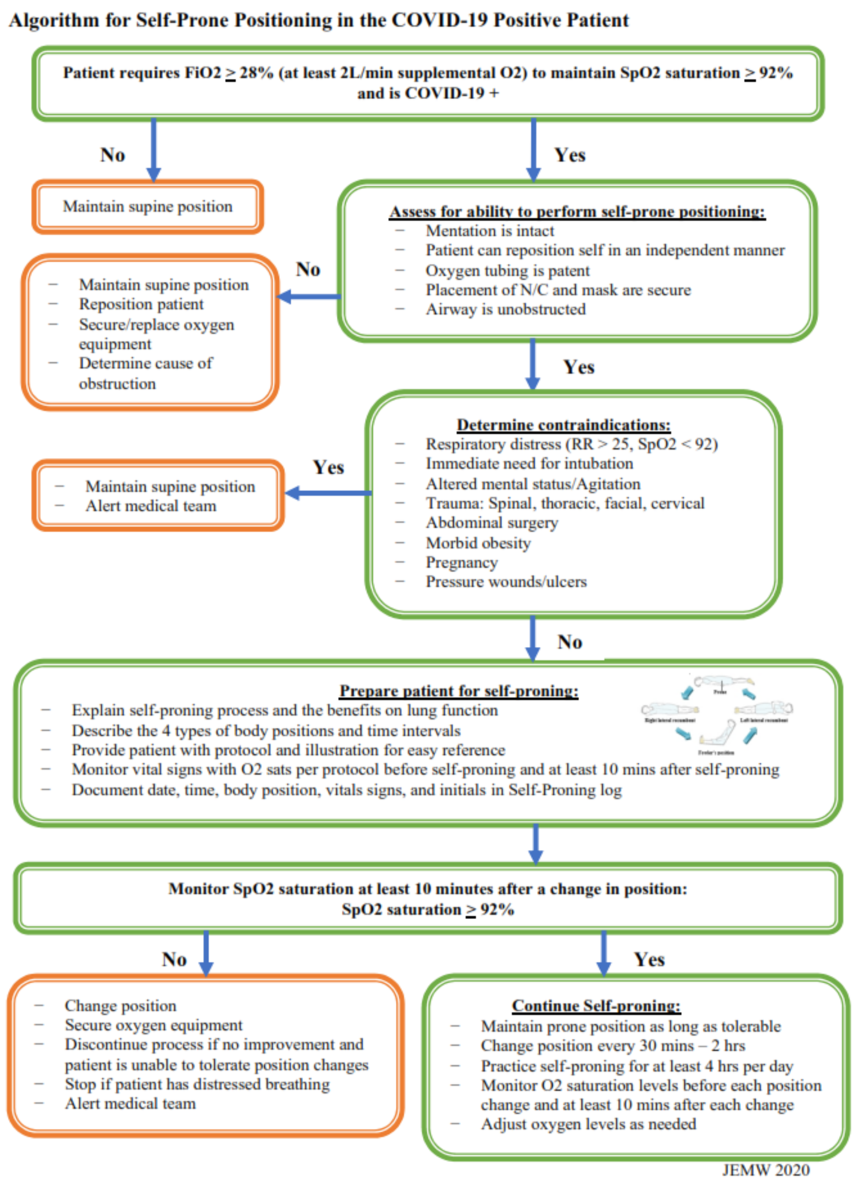


Figure 1A. Contents of the Self-Proning Packet. Algorithm decision tool for self-proning.

Self-Proning Protocol (English)

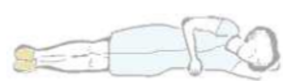
Objective: To improve oxygen saturation in the COVID-19 positive patient.

Method: Patient will change positions at various intervals for at least 4 hours per day. Monitor oxygen saturation levels before and at least 10 minutes after each position change.

Location: Emergency Department and all hospital units with COVID-19 positive patients who are using a nasal cannula (N/C) or non-rebreather (NRB).

Instructions

To help get air into all parts of your lungs, you need to change positions rather than just lying flat on your back. Try to lay on your stomach, right and left sides, and sit up for a while. Change your position every 30 minutes to 2 hours for at least 4 hours a day and repeat the cycle. Here's how:

Time	Bed position	Body position	Body Position Example
30 mins - 2 hrs	Bed flat	Lie on your stomach (Prone)	
30 mins - 2 hrs	Bed flat	Lie on your right side (Right lateral recumbent)	
30 mins - 2 hrs	HOB 45-60°	Sitting up (Fowler's position)	
30 mins - 2 hrs	Bed flat	Lie on your left side (Left lateral recumbent)	

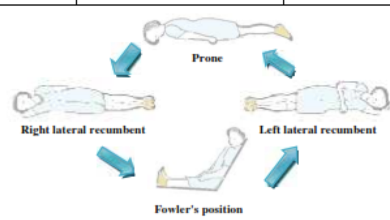


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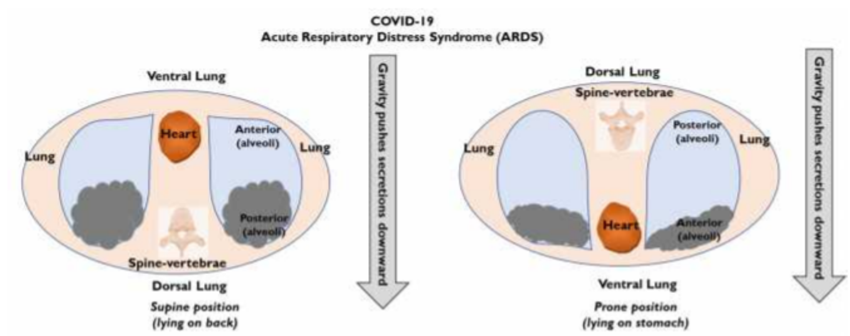
Figure 1B. Contents of the Self-Proning Packet. Patient protocol for self-proning (English and Spanish versions were made available).

Comparison of Differences in Lung Secretion Placement in Supine and Prone Positions



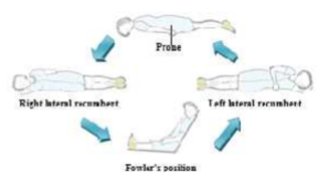
JEMW 2020

Figure 1C. Contents of the Self-Proning Packet. Illustration of the lungs comparing differences in secretion placement in the supine and prone positions in the COVID-19 patient.

Self-Proning Documentation Log

Patient initials: _______ MR# _______________________ Unit/Room# _________________________

	Date	Vital signs 1 Before position change	Start Time / Stop Time	Body Position Check one box only per entry	Vital signs 2 Wait at least 10 mins to take Vitals 2	Total Time in the position Hr(s)/Mins	RN/PCT/MD/PA initials (Comments)
EXAMPLE	Example for any single attempt: 6/1/2020	BP: 120/80 HR: 78 O2: 91% RR: 18 T: 98.2	3:00PM / 4:45PM	☑ Stomach – prone ☐ Right side –lateral recumbent ☐ Sitting up - Fowler's position ☐ Left side – lateral recumbent	BP: 125/78 HR: 82 O2: 98% RR: 18 T: 98.3	1 hr(s) 45 mins	M.W., RN Pt liked this position. O2=N/C 3L
START HERE		BP: HR: O2: RR: T:		☐ Stomach – prone ☐ Right side –lateral recumbent ☐ Sitting up - Fowler's position ☐ Left side – lateral recumbent	BP: HR: O2: RR: T:	___ hr(s) ___ mins	
		BP: HR: O2: RR: T:		☐ Stomach – prone ☐ Right side –lateral recumbent ☐ Sitting up - Fowler's position ☐ Left side – lateral recumbent	BP: HR: O2: RR: T:	___ hr(s) ___ mins	
		BP: HR: O2: RR: T:		☐ Stomach – prone ☐ Right side – lateral recumbent ☐ Sitting up - Fowler's position ☐ Left side – lateral recumbent	BP: HR: O2: RR: T:	___ hr(s) ___ mins	
		BP: HR: O2: RR: T:		☐ Stomach – prone ☐ Right side – lateral recumbent ☐ Sitting up - Fowler's position ☐ Left side – lateral recumbent	BP: HR: O2: RR: T:	___ hr(s) ___ mins	
		BP: HR: O2: RR: T:		☐ Stomach – prone ☐ Right side – lateral recumbent ☐ Sitting up - Fowler's position ☐ Left side – lateral recumbent	BP: HR: O2: RR: T:	___ hr(s) ___ mins	
		BP: HR: O2: RR: T:		☐ Stomach – prone ☐ Right side – lateral recumbent ☐ Sitting up - Fowler's position ☐ Left side – lateral recumbent	BP: HR: O2: RR: T:	___ hr(s) ___ mins	
		BP: HR: O2: RR: T:		☐ Stomach – prone ☐ Right side – lateral recumbent ☐ Sitting up - Fowler's position ☐ Left side – lateral recumbent	BP: HR: O2: RR: T:	___ hr(s) ___ mins	



JEMW 2020

Figure 1D. Contents of the Self-Proning Packet. Documentation data log.

Table 1. Sociodemographic and Baseline Clinical Characteristics

Sociodemographic and Baseline Clinical Characteristics	**Nonintubated population**	**Intubated population***
Population size	n=78	n=15
Age (years): Median IQR Range	59 15 29 - 84	65 18 38 - 84
Sex: Female Male	29% 71%	53% 47%
LOS (days)	13	22
Deceased	1%	73%

IQR = Interquartile range; LOS = Length of stay. * Proning event data for intubated patients were collected prior to intubation.

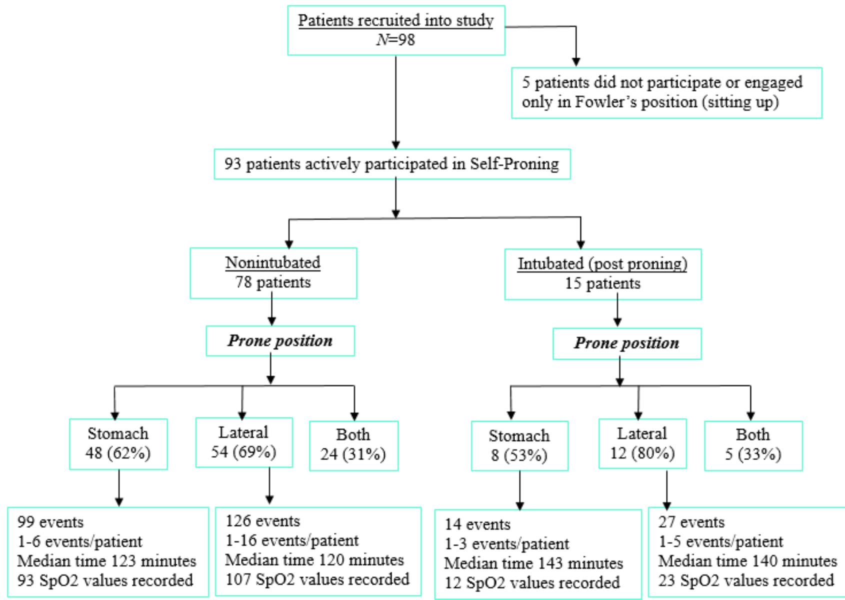
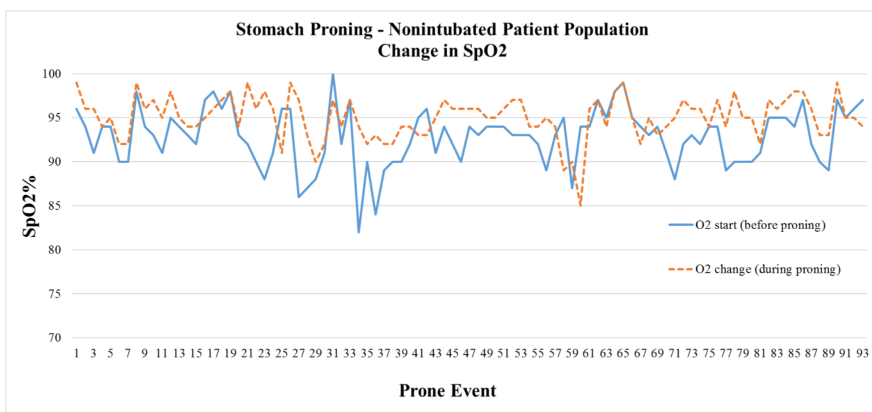


Figure 2. Schematic Flowchart. Nonintubated and intubated (post proning) patient populations engaged in self-proning. *Abbreviations:* SpO2 = oxygen saturation.



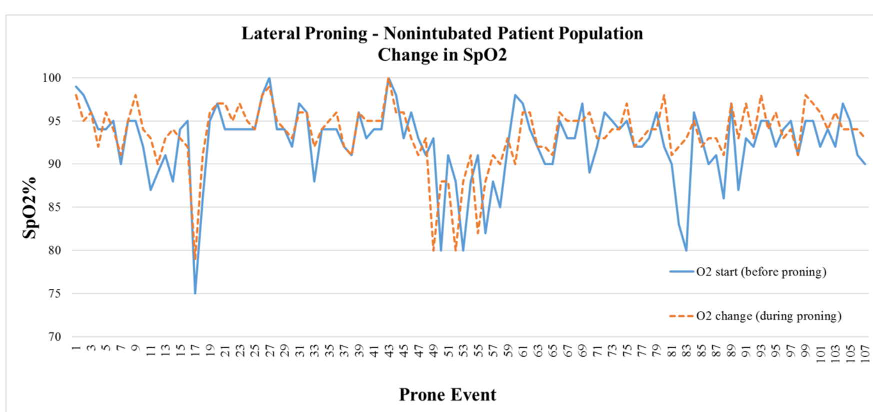
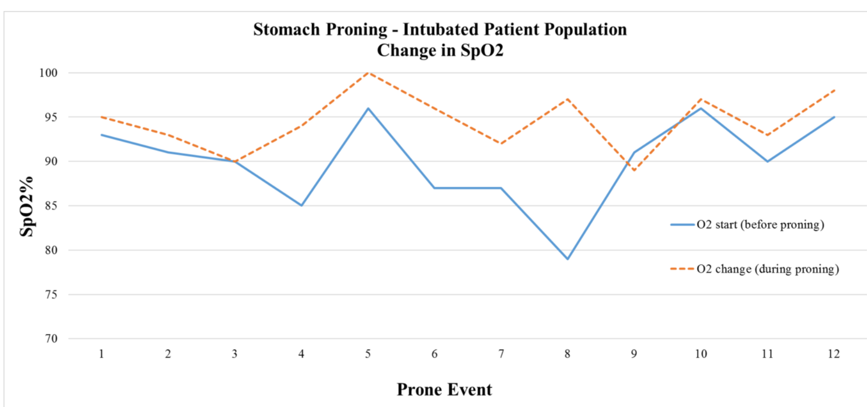


Figure 3. Nonintubated Patient Population (stomach and lateral). Changes in SpO2 are reflected in each graph before and during the proning event. *Upper graph* : Stomach proning (93 recorded SpO2 values) mean before proning 93% and during proning 95%. *Lower graph* : Lateral semi-proning (107 recorded SpO2 values) mean before proning 92% and during proning 93%.

Table 2. Self-Proning Patient Statistical Data

Self-Proning Statistical Data **Prone position**	*Nonintubated population (n=78)*	*Nonintubated population (n=78)*	*Intubated population (n=15)**	*Intubated population (n=15)**
	SpO2 (pre-proning)	**Change in SpO2 (during proning)**	**SpO2 (pre-proning)**	**Change in SpO2 (during proning)**
Stomach	*M* 93% *SD* 3.3 IQR 4 95% CI 92 - 94 Range 18 Skewness -0.5	*M* 95% *SD* 2.4 IQR 3 95% CI 95 - 96 Range 14 Skewness -0.9 R^2 <0.001 $t(170) =$ -5.22, p <0.001	*M* 90% *SD* 5.0 IQR 7 95% CI 87 - 93 Range 17 Skewness -0.8	*M* 95% *SD* 3.3 IQR 4 95% CI 92 - 97 Range 11 Skewness -0.1 R^2 0.028 $t(19) =$ -2.62, p 0.017
Lateral	*M* 92% *SD* 4.3 IQR 4 95% CI 92 - 93 Range 25 Skewness -1.4	*M* 93% *SD* 3.6 IQR 4 95% CI 93 – 94 Range 21 Skewness -1.8 R^2 <0.001 $t(205) =$ -1.92, p 0.055	*M* 92% *SD* 4.0 IQR 5 95% CI 90 - 93 Range 17 Skewness 0.004	*M* 95% *SD* 2.8 IQR 5 95% CI 94 - 96 Range 9 Skewness 0.1 R^2 0.011 $t(39) =$ -3.32, p 0.002

M = mean; *SD* = Standard deviation; IQR = Interquartile range; CI = Confidence interval; R^2 = Coefficient of determination; t = t-statistic; p = probability value. * SpO2 data for intubated patients were collected prior to intubation.



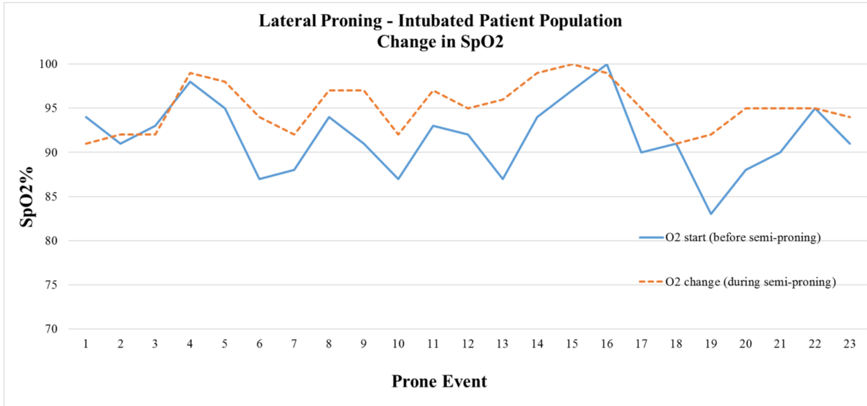


Figure 4. Intubated Patient Population (stomach and lateral). Changes in SpO2 are reflected in each graph before and during the proning event. *Upper graph* : Stomach proning (12 recorded SpO2 values) mean before proning 90% and during proning 95%. *Lower graph* : Lateral semi-proning (23 recorded SpO2 values) mean before proning 92% and during proning 95%.

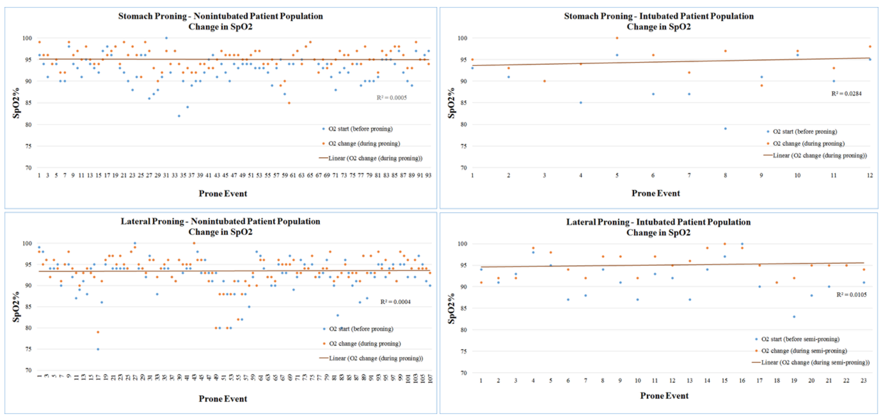


Figure 5. Linear Regression Models and R^2 . Illustrations of the relationship between proning and the changes in SpO2 for the patient populations. *Upper and lower left* : Nonintubated population - stomach R^2<0.001, lateral R^2 <0.001. *Upper and lower right* : Intubated population - stomach R^2 0.028, lateral R^2 0.011.