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Original article

Prone position protocol in awake COVID-19 patients: A prospective study in the emergency department



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ABSTRACT

Background: Limited effective interventions exist in the emergency department (ED) for COVID-19 patients with respiratory failure. One of the promising interventions is the prone position, which has been proven to improve oxygenation in ICU settings. Here, we aimed to describe and assess the utility of the prone position in awake non-intubated adult patients in EDs during the COVID-19 pandemic.

Methods: We conducted a prospective cohort study of hypoxic COVID-19 adult patients who presented to our emergency department. We collected the data from June to the end of August 2020, including vital signs and physiological and clinical parameters before and after completing the four-hour prone position protocol. The main outcomes assessed were improvement in oxygenation, respiratory rate, respiratory distress score, ICU admission, and intubation. Oxygenation was calculated based on the standard pulse oximeter saturation [SpO₂]/fractional concentration of oxygen in inspired air (FiO₂).

Results: The study included 49 patients (81.63% men; mean age, 53.37 ± 11 years). The mean oxygen saturation during the triage was 84.49% ± 7.98 on room air. After completing of the four-hour prone protocol, the mean SpO₂/FiO₂ ratio increased from 1.62 ± 0.78–1.99 ± 0.75 ($p < 0.0001$). The respiratory rate decreased from 32.45 ± 5.24–26.29 ± 5.40 ($p < 0.0001$). Respiratory distress scores decreased after changing patients' positions ($p < 0.0001$). Twenty-four patients (48.9%) were admitted to the ICU, 6 patients were intubated (12.2%), and 7 (14.3%) died in the hospital.

Conclusion: After applying the prone position in the ED, significant and immediate improvement was observed in oxygenation, respiratory rate, respiratory distress, and carbon dioxide levels. A linear relationship between the level of improvement in oxygenation and reduction in ICU admission was observed. However, further studies recommended to assess the advantage of the procedure in terms of ICU admission, intubation, or mortality.

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Introduction

The novel coronavirus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), also known as coronavirus disease 2019

(COVID-19), originated in December 2019 in Wuhan, China. It has ever since rapidly spread worldwide, causing morbidity and mortality in its way. In March 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a Pandemic [1]. The high virulence profile of the virus led to a large number of emergency departments (EDs) visits in a short period of time. This has directly put an unprecedented burden on healthcare workers often overwhelming health organizations across the globe and sometimes causing a collapse of some healthcare systems. Furthermore, the contagious nature of the disease remains a huge challenge for healthcare systems due to the isolation requirements which often

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required bed capacity optimization in order to decrease the spread of the virus within hospitals. Based on these considerations, the reported mortality rates are up to 11% in some areas and can went up to 40.8% in patients requiring invasive mechanical ventilation [2,3].

Intubation of severe COVID-19 patients in the emergency room is a stressful procedure, especially when hit with a disastrous influx of sick hypoxic patients, the ability to delay intubation for several hours in a more controlled setting in the ICU or even being able to abandon the need for intubation would be beneficial. Scientific societies around the world have started to investigate some traditional respiratory management techniques for COVID-19 cases, especially after they faced a sudden reduction in the supply of mechanical ventilators and oxygen cylinders. One of the techniques is positioning COVID-19 patients in a prone position, a promising technique that not only might improves oxygenation but also provide the practitioners the much needed time for receiving support and supplies. In the prone position, the dorsal aspect of the lungs has lower recruitment, meaning that theoretically, it poses less fluid, viral load, and other inflammatory secretions. In addition, changing a patient's position might improve atelectasis on the dorsal side as well as improve ventilation. Therefore, the prone position is recommended in the management protocol of Acute respiratory distress syndrome (ARDS) patients as it can improve oxygenation and decrease mortality rates [4]. Hence, the prone position is believed to be a promising intervention for severe COVID-19 pneumonia that can be initiated early in the ED.

A study conducted on COVID-19 patients that received non-invasive ventilation and prone position (PP) interventions showed clinical improvements in their respiratory and oxygenation rates [5]. Although the clinical situations of these patients were mandating the utilization of non-invasive ventilation, physicians refrained from using such interventions and decided to follow infection control recommendations that discourage using the above-mentioned interventions due to the risk of infection spread. Another pilot study was conducted in a single-center ED in New York City to assess the early use of the prone position for awake COVID-19 patients with hypoxemia, which showed marked improvement in saturation of peripheral Oxygen levels (SpO₂%) and helped in delaying some intubation decisions [6]. Additionally, a retrospective study from Italy was conducted to assess the efficiency of utilizing the prone position as a management technique to treat COVID-19 cases and it showed favorable outcomes in terms of oxygenation and in reductions in the workloads of critical care staff [7]. In the Middle East, a study conducted in Tehran showed marked improvement in COVID-19 patients who were admitted to the ICU in a prone position, a position implemented early on in the course of their illness. In addition, mortality rates have been declining for these patients as well [8]. Nevertheless, there are still insufficient studies assessing the utility of the prone position in EDs. Therefore, we aimed to assess the effectiveness of the prone position in adult COVID-19 patients being managed in EDs.

Material and methods

Study design

This was a single-center prospective cohort observational study conducted in the (concealed text) Saudi Arabia, between June and August 2020. The (concealed text) is a large public referral hospital and a level 1 trauma center in Riyadh, Saudi Arabia; it is considered one of the largest tertiary care centers in the country, with an ICU capacity of more than 220 ICU beds. In this study, we hypothesized that prone positioning has a significant effect on improving oxygenation and the clinical symptoms of patients with suspected COVID-19.

Patient population

During the study period, all adult (> 18 years) patients presenting to the ED with suspected coronavirus disease 2019 (COVID-19), identified by specific signs and symptoms of the disease according to the Ministry of Health (MoH) guidelines, with severe presentation (oxygen saturation less than 94%, respiratory rate > 30, accessory muscle usage) were included in the study. All mechanically ventilated patients (in a pre-hospital setting or upon arrival to the ED), pregnant women, pediatric age groups (< 18years), those that received recent surgeries (last 14 days), non-complaint (obese, uncooperative, or fearful) cases, or those unable to comprehend the study protocol (language barrier or mental illness) were excluded. The primary outcome of the study was the improvement of oxygenation, which was calculated based on the standard pulse oximeter saturation [SpO₂]/fractional concentration of oxygen in inspired air (FiO₂). FiO₂ was calculated based on the oxygen requirement of the liter (L) and oxygenation device used [9]. Secondary outcomes included: (1) reduction in respiratory rate; (2) decreased oxygen supplementation; (3) respiratory distress score; (4) changes in partial pressure of carbon dioxide (PCO₂) levels in venous blood gases; (5) ICU admission; (6) the need for mechanical ventilation; and (7) mortalities. The respiratory distress score was measured using the Likert scale questionnaire filled in by the patient, where 0 indicated that the patient felt very comfortable and 5 represented maximum respiratory discomfort. In addition, we aimed to analyze the predictors of responses to the prone position. Responsive patients were defined as patients with increased SpO₂/ FiO₂ ratios after completing the prone protocol.

Data collection

After explaining the study protocol for the patients, all enrolled subjects were monitored in a prospective real-time manner for 4 h; paired data pre-and post-intervention were recorded for each subject for the desired study outcomes by using vital sign monitoring and a visual Likert 5 points scale.

All cases were provided with the required oxygen supplements for 10 min before starting the prone protocol. This step was crucial to record a baseline reference for oxygen requirements, vital signs, and respiratory efforts before starting the intervention. Oxygen supplementation was fixed throughout the observation period to minimize the confounding effect of titrating oxygen delivery. After 10 min, all subjects were positioned in a (1) prone position for 90 min, followed by (2) 30 min on the right side, (3) 90 min prone, and finally (4) 30 min on the left side. After completion of this cycle, data of interest according to the outcomes of the study were recorded and compared to the pre-intervention records. At this point, any subject requiring mechanical ventilation before the completion of the cycle was excluded from the calculations; however, these subjects were included in the subject count of this study. Those requiring mechanical ventilation at any time after the completion of this cycle until leaving the hospital were counted as an outcome of the study (mechanical ventilation requirement). All patients were followed throughout their hospital stay to identify the final outcomes of the cases (recovery, mechanical ventilation, ICU admission, or death). We included demographic variables, comorbidities, vital signs, relevant laboratory investigations, important aspects of the intervention, and final outcomes in our data collection sheet. Data were collected by four trained healthcare providers and filled into an electronic sheet during study enrollment or through a follow-up of patient health records, and any discrepancies were crosschecked and resolved by the primary investigator. Data privacy was maintained by secure passwords (two-step authentication), and access was restricted to the primary investigator and data collectors after signing non-disclosure agreements.

Ethical approval

The (Concealed text) Institutional Review Board approved the study proposal and waived the need for written consent from the participants as part of an adjunct intervention that can be started in an emergency for severe COVID-19 patient according to the Ministry of Health protocols [10]. The study project was approved on July 1st, 2020, with reference number H1R1–28-June20–01.

Statistical analysis

Descriptive statistics, such as means, standard deviations, frequencies, and percentages, were used to present the patients' baseline characteristics. To examine the differences in respiratory rate (RR), SpO₂/FiO₂ ratio, pH, O₂ requirement in liters, distress score, SpO₂, respiratory alkalosis (PCO₂ < 35), and respiratory acidosis (PCO₂ > 45) between the supine and prone positions, paired *t*-tests were used. Simple logistic regressions were conducted to examine the impact of any increase, ≥ 10% increase, and ≥ 20% increase in the SPO₂/FiO₂ ratio on the risk of intensive care unit (ICU) admission. All statistical analyses were conducted using SAS® version 9.4 (SAS Institute, Cary, NC, United States).

Results

Of the 78 patients, the study analyzed 49 COVID-19 patients who were eligible and completed the prone position protocol in the emergency department (ED), as shown in Fig. 1. Most of the patients were men (81.63%) with a mean age of 53.37 ± 11 years. About 24% of the patients had diabetes and 16.32% had hypertension. The baseline characteristics of the patients are shown in Table 1. All of the patients were hypoxic during the ED triage, with a mean oxygen saturation of 84.49% ± 7.98% in room air. All other vital signs, such as heart rate, temperature, and blood pressure, were within the normal range. Twenty-four patients (48.98%) were admitted to intensive care units (ICUs), and 6 (12.24%) required intubation. The mean length of stay (LOS) was approximately 10 days, and seven patients (14.29%) died during hospitalization.

The mean respiratory rate decreased from 32.45 ± 5.24–26.29 ± 5.40 [−6.16 (95% CI: −8.17 to 4.16); *p* < 0.0001] after applying the prone position protocol. Additionally, the mean O₂ requirement was decreased from 8.49 L/min ± 3.39–6.49 L/min ± 3.41 after changing the patient's position [*p* < 0.0001]. The respiratory distress score was 3.91 ± 1.62 before the prone protocol and 2.26 ± 0.69 after; [CI −1.65 (−2.26 to −1.05)]. The SpO₂/FiO₂ ratio increased from 1.62 ± 0.78–1.99 ± 0.75, with a CI of 0.47 (0.28–0.65) and *p* < .0001. The percentage of patients with respiratory alkalosis (PCO₂ < 35) decreased significantly from 51.02% to 30.61% (Table 2).

Table 3 shows the simple logistic regression of the variant clinical and laboratory values related to improvements in oxygenation after changing the patient's position from the supine position to the prone position. We found that 28 patients (56%) responded positively via SPO₂/FiO₂ ratio improvements. Except for CRP, which could predict higher odds of responding in terms of improvements in SPO₂/FiO₂ ratios (OR = 4.50; 95% CI [1.326–15.27]; *p* = 0.016), no other variable could predict the response. Additionally, the data in Table 3 did not reveal an association between an increase in the SPO₂/FiO₂ ratio and ICU admission, intubation, or mortality. Although the data in Table 4 showed a trend where higher SPO₂/FiO₂ ratio cut-off values were associated with lower ICU admission, this trend was not statistically significant.

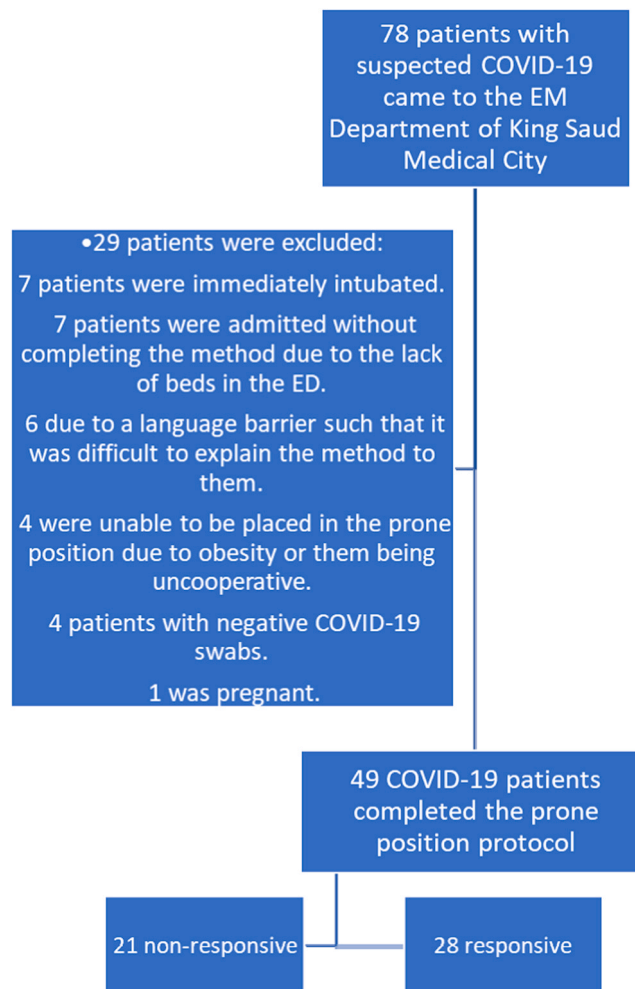


Fig. 1. Flowchart of the study sample.

Discussion

Our study focused on the potential benefits of prone positioning early upon patient arrival to the emergency room in terms of either improving respiration or improving patient-oriented outcomes, such as decreasing the need for ICU admission, intubation, or mortality. We found a substantial improvement in respiratory rate, oxygen saturation, SPO₂/FiO₂ ratio, CO₂ level, and comfort score after completing 4 h of the prone positioning protocol when compared to the pre-intervention data. In our sample, around 57% of the cases were positive responders in terms of oxygenation, and 40% of the cases had an SPO₂/FiO₂ ratio improvement ≥ 20%. Despite the 4 h duration in our protocol, the improvement after prone positioning was observed after only 30 min in most cases. Such rapid improvement was also observed in other studies conducted outside the ICU on awake COVID-19 cases, performed utilizing different prone positioning protocols [5,11,12].

In a similar context to our study, a study was published in *The Lancet* that described the utility of prone position protocols for severe cases of COVID-19-related pneumonia. They found that 50% of their patients responded positively to the prone protocol, displaying improved oxygenation, and the major predictor of improvement was the time lapse between ER presentation and initiation of the prone positioning [10]. The aforementioned study began their prone positioning protocol in the inpatient bed after admission from the ED, while we started the protocol in the emergency department. This can explain the slightly higher percentage of responders in our

Table 1
Baseline characteristics of the patients (N = 49).

Characteristic	Value
Age (years), mean ± SD	53.37 ± 11.32
Male sex, N (%)	40 (81.63%)
Female sex, N (%)	9 (18.37%)
Weight (kg), mean ± SD	74.53 ± 10.52
Temperature (°C), mean ± SD	37.56 ± 0.99
Temperature over 38 °C, N (%)	12 (24.49%)
Systolic blood pressure (SBP), mean ± SD	131.14 ± 21.57
SBP less than 90 mmHg, N (%)	None
White blood count (WBC) in 10 ⁹ /L, mean ± SD	10.15 ± 4.96
WBC > 11, N (%)	14 (28.57%)
Hemoglobin (HGB), mean ± SD	13.30 ± 2.08
HGB < 12, N (%)	12 (24.49%)
D-dimer, mean ± SD	2.15 ± 2.26
Lactate dehydrogenase (LDH), mean ± SD	499.63 ± 270.94
Heart rate (HR), mean ± SD	102.43 ± 16.85
Heart rate (HR) over 100, N (%)	27 (55.1%)
Triage room Air SPO ₂ (RA), mean ± SD	84.49 ± 7.98
Current smokers, N (%)	3 (6.12%)
Diabetes, N (%)	12 (24.49%)
Hypertension (HTN), N (%)	8 (16.32%)
Sickle cell anemia (SCA), N (%)	1 (2.04%)
Hypothyroidism, N (%)	1 (2.04%)
Bronchial asthma, N (%)	1 (2.04%)
Parkinson disease, N (%)	1 (2.04%)
Ischemic heart disease, N (%)	1 (2.04%)
Oxygenation device requirement, N (%)	
Face mask use	33 (67.3%)
Nasal cannula use	15 (30.6%)
Non-rebreathing mask use	1 (2.0%)
Length of stay (LOS) in days, mean ± SD	10.12 ± 5.33
ICU admittance, N (%)	24 (48.9%)
Intubation, N (%)	6 (12.2%)
In-hospital mortality, N (%)	7 (14.3%)

sample (57%) and points towards better outcomes as a result of earlier prone positioning.

In ICU settings, multiple studies have revealed the usefulness of prone positioning for ARDS cases due to COVID-19 infection or any other pathologies and was shown to be beneficial for some outcomes, including mortality [6,13–15]. Drawing conclusions from previous studies regarding the effectiveness of utilizing prone positions in emergency rooms for awake patients is quite difficult. Previous trials mainly targeted intubated patients and utilized a prolonged duration of the procedure, which is not possible in an emergency context; in addition, the populations considered were admitted due to pathologies other than COVID-19.

The mortality rate for intra-hospital deaths in both ICU- and non-ICU-admitted COVID-19 cases in our sample was comparable to other mortality rates reported in the literature from different areas, which ranged from 4.5% to 23% [11,12,16,17]. When comparing the responsive group to the non-responsive group, we observed a similar mortality rate. Consistently, another study found no difference in mortality rate between awake COVID-19 responders and non-responders after a minimum of 3 h of prone positioning [12].

Table 2
The differences in mean values of physiological and clinical parameters before and after prone positioning.

Parameter	Supine	Prone	Difference (95% CI)	p-value
Respiratory rate (RR)	32.45 ± 5.24	26.29 ± 5.40	-6.16 (-8.17 to -4.16)	< 0.0001 ^a
SpO ₂ /FiO ₂ ratio	1.62 ± 0.78	1.99 ± 0.75	0.47 (0.28–0.65)	< 0.0001 ^a
pH	7.43 ± 0.05	7.41 ± 0.04	-0.02 (-0.04 to -0.01)	0.002 ^a
O ₂ requirement (L/min)	8.49 ± 3.39	6.49 ± 3.41	-2.0 (-2.85 to -1.14)	< 0.0001 ^a
Respiratory distress score	3.91 ± 1.62	2.26 ± 0.69	-1.65 (-2.26 to -1.05)	< 0.0001 ^a
SpO _{2s}	94.69 ± 2.14	93.86 ± 2.71	-0.84 (-1.72 to 0.05)	0.064
Respiratory alkalosis (PCO ₂ < 35), N (%)	25 (51.02)	15 (30.61)	20.41%	0.012 ^a
Respiratory acidosis (PCO ₂ > 45), N (%)	4 (8.16)	3 (6.12)	2.04%	0.359

^a Indicates statistical significance.**Table 3**
Simple logistic regression of variant variables associated with a response to the prone positioning, defined as improvements in SPO₂/FiO₂ ratios (N = 28).

Variable	Odds ratio (OR)	95% CIs	p-value
Age	0.998	0.948–1.050	0.935
Age > 60 years	1.11	0.337–3.659	0.862
Number of comorbidities	0.779	0.406–1.493	0.451
Diabetes	0.833	0.233–2.985	0.779
HTN	0.327	0.054–1.986	0.225
Temperature (> 38 °C)	0.682	0.184–2.522	0.566
Platelet count (> 450,000 platelets)	0.731	0.094–5.661	0.764
HGB (< 12.8 gm/dL)	0.30	0.086–1.041	0.057
D-dimer (≥ 0.9 µg/mL)	1.875	0.592–5.934	0.285
LDH (> 449.7 U/L)	0.863	0.273–2.724	0.801
Sex (female)	0.533	0.124–2.94	0.398
Ferritin (> 400 ng/mL)	1.583	0.490–5.117	0.443
Creatinine (> 115 µmol/L)	0.533	0.124–2.294	0.398
C-reactive protein (CRP) (> 10 mg/DL)	4.50	1.326–15.27	0.016 ^a
ESR (> 100 mm/hr)	3.167	0.585–17.154	0.181
WBC (> 10 10 ⁹ /L)	1.051	0.329–3.362	0.932
ICU admission	0.788	0.237–2.621	0.697
Length of stay in days (LOS)	0.985	0.882–1.10	0.785
Mortality	1.000	0.194–5.154	1.0000
Intubation required	0.750	0.135–4.159	0.742

^a Indicates statistical significance.

In our institute, during pandemic waves, we utilized strict criteria with a higher threshold than on regular days in order to admit patients to ICU beds; this was done in an effort to spare ICU beds for the subpopulation that is in real need of advanced ICU settings (e.g., intubated, requiring ECMO, and so on). Despite the statistical insignificance, utilizing prone positioning in the emergency room slightly reduced the number of admissions to ICU beds within the COVID-19 population, especially after rapid and dramatic improvements in hypoxemia levels. Regression analysis revealed a linear relationship between the degree of SPO₂/FiO₂ improvement and the need for ICU admission. Further trials enrolling different complexity levels and directly comparing intervention vs. control groups are required to evaluate the effectiveness of prone positioning in ER rooms as a method to decrease ICU admission. Saving ICU beds was a strategic priority during the pandemic in different places around the globe, where multiple interventions have been attempted and succeeded, including prone positions outside ICU settings [18].

COVID-19 cases who approached our emergency room during the first and second waves were hypoxic and in severe respiratory distress, and every individual of those populations was a possible candidate for endotracheal intubation. We observed that early prone positioning might lead to a decrease in the need for immediate intubation in the ER. The intubation rate was 12% in our sample, which was lower than the intubation rates reported in the literature [16,19]. Consistently, prone positioning for awake patients diagnosed with COVID-19 helped to avoid intubation, with a number needed to treat (NNT) of 14 [11]. In contrast, Fernando et al. did not note any reductions in intubation rates after utilizing prone positioning for

Table 4

Simple logistic regression (with different cut-off values) of the impact of improvements in SPO₂/FIO₂ ratios after applying the prone position protocol on the risk of intensive care unit (ICU) admission.

Variable	Odds ratio (OR)	95% CIs	p-value
Any increase in the SPO ₂ /FIO ₂ ratio (N = 28)	0.788	0.237–2.621	0.6975
≥ 10% increase in the SPO ₂ /FIO ₂ ratio based on the mean baseline SPO ₂ /FIO ₂ ratio (N = 24)	0.400	0.118–1.352	0.1403
≥ 20% increase in the SPO ₂ /FIO ₂ ratio based on the mean baseline SPO ₂ /FIO ₂ ratio (N = 22)	0.333	0.097–1.144	0.0808

awake COVID-19 cases. Some differences in the methodology and sample characteristics between our study and their trials could explain this inconsistency. First, they started prone positioning after admission, not in ER rooms, with an average time lapse between 7 and 11 h. Second, they included only the cases that required high-flow nasal oxygen, which was a subgroup in our population. In addition, a high-flow nasal cannula might be a confounder that led to decreased intubation rates in both the control and intervention groups. A similar complexity level based on hypoxia levels and PO₂/FIO₂ ratios was observed in an observational study that showed an intubation rate of 9% [16]. Further controlled trials are required to reach a scientific conclusion regarding the use of prone positioning for awake COVID-19 cases in ER settings as a method to reduce intubation rates.

Although there was no clear evidence of mortality benefit, prone positioning is easy to apply in emergency settings without any added costs, monitoring, or equipment, resulting in rapid improvement in both objective and subjective measures, which might lead to delayed intubation or even omit the need for intubation entirely. We encourage all emergency physicians to utilize prone positioning for hypoxic patients presenting with signs and symptoms of severe COVID-19. In disaster situations where all isolation emergency rooms are occupied and patients keep coming to emergency rooms and waiting in triage areas, we recommend using prone positioning in the triage areas to achieve rapid improvement and to buy time until emergency rooms are ready to accept the next cases. Furthermore, we recommend adding improvements to SPO₂/FIO₂ ratios to the criteria for ICU admission in disaster situations, with an improvement threshold of 20% or greater after prone positioning.

Positioning awake respiratory distress patients to prone might not be an easy task in the ED. The most difficult challenge we faced was how to explain the procedure for the patients, especially if there was a language barrier. However, utilizing written protocol with a visual illustration of the positions was a very helpful tool to increase the understanding of protocol for both the patients and the bedside nurses. The second challenge was how to monitor the patients and keep all the lines functioning, which was solved by educating the nurse to anticipate the possibility and preparing the patient first and checking the lines frequently. We believe that reassuring and communicating with the patient before and after initiating the protocol will increase the compliance and the success of the procedure.

Our study had a few limitations. First, the sample size was considered relatively small compared to trials measuring the effectiveness of prone positions in ICU settings. Second, the lack of a control group made the causation effect of the intervention difficult to conclude. Additionally, the study being conducted in a single center makes generalization of the results questionable. We only studied short-term outcomes such as oxygenation, respiratory rate, and comfort, which were measured immediately after the patients underwent the prone position. Lastly, because the patients were awake and non-intubated, we could not measure their FIO₂ accurately; these values were estimated based on each patient's oxygen requirement by liter and the provided device.

Conclusions

After completing the prone position in the ED, we observed a significant and immediate improvement in oxygenation, respiratory rate, respiratory distress score, and carbon dioxide levels. The reduction in the number of ICU admissions was statistically inconclusive in our sample, despite the linear trend toward an association between oxygenation improvement and reductions in ICU admissions. Nevertheless, a larger randomized studies are recommended to evaluate the efficacy of the ED-prone protocol in reducing ICU admission rates, intubation rates, and mortality. If the only benefit of prone positioning is a rapid improvement in hypoxia level and delayed intubation in the ED setting, this still allows for more time for better resource utilization; the protocol is therefore worth applying in ED patients, especially in disaster situations.

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Conflict of interest

None.

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References

- [1] Koritala T, Hussain A, Pleshkova Y, et al. A narrative review of emergency use authorization versus full FDA approval and its effect on COVID-19 vaccination hesitancy. *Infect Med* 2021;29:3. <https://doi.org/10.53854/liim-2903-4>
- [2] Xu Q, Wang T, Qin X, Jie Y, Zha L, Lu W. Early awake prone position combined with high-flow nasal oxygen therapy in severe COVID-19: a case series. *Crit Care* 2020;24(1):250. <https://doi.org/10.1186/s13054-020-02991-7>
- [3] Domecq JP, Lal A, Sheldrick CR, et al. Outcomes of patients with coronavirus disease 2019 receiving organ support therapies: the International Viral Infection and Respiratory Illness Universal Study Registry. *Crit Care Med* 2021;49:437–48. <https://doi.org/10.1097/CCM.0000000000004879>
- [4] Kallet RH. A comprehensive review of prone position in ARDS. *Respir Care* 2015;60(11):1660–87. <https://doi.org/10.4187/respcare.04271>
- [5] Sartini C, Tresoldi M, Scarpellini P, Tettamanti A, Carcò F, Landoni G, et al. Respiratory parameters in patients with COVID-19 after using noninvasive ventilation in the prone position outside the Intensive Care Unit. *JAMA* 2020;323(22):2338–40. <https://doi.org/10.1001/jama.2020.7861>
- [6] Caputo ND, Strayer RJ, Levitan R. Early self-proning in awake, non-intubated patients in the emergency department: A Single ED's Experience During the COVID-19 Pandemic. *Acad Emerg Med Single A*, editor 2020; 27(5):375–8. <https://doi.org/10.1111/acem.13994>
- [7] Carsetti A, Damia PA, Marini B, Pantanetti S, Adrario E, Donati A. Prolonged prone position ventilation for SARS-CoV-2 patients is feasible and effective. *Crit Care* 2020;24(1):225. <https://doi.org/10.1186/s13054-020-02956-w>
- [8] Ghelichkhani P, Esmaeili M. Prone position in management of COVID-19 patients: a commentary. *Arch Acad Emerg Med* 2020;8(1):e48.
- [9] Tintinalli JE, Ma JO, Yealy DM, Meckler GD, Stapczynsk JS, Cline DM, editors. *Tintinalli's Emergency Medicine: a Comprehensive Study Guide*. New York: McGraw-Hill Education; 2016.

- [10] Ministry of Health. Use of Prone Positioning in Adult with COVID-19 Respiratory Failure, 2020. Accessed 20 November 2021. (<https://www.moh.gov.sa/Ministry/MediaCenter/Publications/Documents/Prone-position-guidelines.pdf>) >
- [11] Ehrmann S, Li J, Ibarra-Estrada M, Perez Y, Pavlov I, McNicholas B, et al. Awake Prone Positioning Meta-Trial Group. Awake prone positioning for COVID-19 acute hypoxaemic respiratory failure: a randomised, controlled, multinational, open-label meta-trial. *Lancet Respir Med* 2021;21:S2213–600. [https://doi.org/10.1016/S2213-2600\(21\)00356-8](https://doi.org/10.1016/S2213-2600(21)00356-8)
- [12] Coppo A, Bellani G, Winterton D, Di Pierro M, Soria A, Faverio P, et al. Feasibility and physiological effects of prone positioning in non-intubated patients with acute respiratory failure due to COVID-19 (PRON-COVID): a prospective cohort study. *Lancet Respir Med* 2020;8(8):765–74. [https://doi.org/10.1016/S2213-2600\(20\)30268-X](https://doi.org/10.1016/S2213-2600(20)30268-X)
- [13] Guérin C, Albert RK, Beitler J, Gattinoni L, Jaber S, Marini JJ, et al. Prone position in ARDS patients: why, when, how and for whom. *Intensive Care Med* 2020;46(12):2385–96. <https://doi.org/10.1007/s00134-020-06306-w>
- [14] Jiang LG, LeBaron J, Bodnar D, Caputo ND, Chang BP, Chiricolo G, et al. Conscious proning: an introduction of a Proning protocol for nonintubated, awake, hypoxic emergency department COVID-19 patients. *Acad Emerg Med* 2020;27(7):566–9. <https://doi.org/10.1111/acem.14035>
- [15] Gattinoni L, Taccone P, Carlesso E, Marini JJ. Prone position in acute respiratory distress syndrome. Rationale, indications, and limits. *Am J Respir Crit Care Med* 2013;188(11):1286–93. <https://doi.org/10.1164/rccm.201308-1532CI>
- [16] Santus P, Radovanovic D, Sadler L, Marino P, Cogliati C, De Filippis G, et al. Severity of respiratory failure at admission and in-hospital mortality in patients with COVID-19: a prospective observational multicentre study. *BMJ Open* 2020;10(10):e043651. <https://doi.org/10.1136/bmjopen-2020-043651>
- [17] Liu Y, Mao B, Liang S, Yang JW, Lu HW, Chai YH, et al. Association between age and clinical characteristics and outcomes of COVID-19. *Eur Respir J* 2020;55(5):32312864. <https://doi.org/10.1183/13993003.01112-2020>
- [18] Ferrando C, Suarez-Sipmann F, Mellado-Artigas R, Hernández M, Gea A, Arruti E, et al. Clinical features, ventilatory management, and outcome of ARDS caused by COVID-19 are similar to other causes of ARDS. *Intensive Care Med* 2020;46(12):2200–11. <https://doi.org/10.1007/s00134-020-06192-2>
- [19] Hur K, Price CPE, Gray EL, Gulati RK, Maksimoski M, Racette SD, et al. Factors associated with intubation and prolonged intubation in hospitalized patients with COVID-19. *Otolaryngol Head Neck Surg* 2020;163(1):170–8. <https://doi.org/10.1177/0194599820929640>