Evaluation of End Tidal Carbon Dioxide Values in Intubated Patients with COVID-19

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Abstract. *Background*: The aim of this study is to establish the value of P_{ETCO2} in COVID-19 patients intubated in emergency department, and its effects on mortality. *Objectives*: Between May 15, 2020 and January 15, 2021, The patients aged ≥18 years and diagnosed COVID-19, scheduled for urgent intubation in the emergency department were included. *Method*: Single-center, prospective and observational study. Age, gender, vital signs, laboratory findings are recorded. Immediately after intubation as measured by the capnography, the initial P_{ETCO2_1} and at post-ventilation 15 min, P_{ETCO2_2} and first, second arterial blood gas analysis are recorded. *Results*: The mean age of the 48 patients was 74 years. The P_{ETCO2_1} and P_{ETCO2_2} measurements were statistically significantly different between the patients who survived and those who died (p=0.014, p=0.015). The patients with a high first P_{ETCO2_1} value and a decrease to the normal level survived, but those with a low P_{ETCO2_1} value that could not increase to a normal value died (p=0.038, p=0.031). Increased levels of SpO_2, P_{ETCO2_1}, P_{ETCO2_2} and $PaCO_{2\_2}$ decreased the risk of mortality, while an increased level of PaO_{2_2} increased the risk of mortality. *Conclusion*: Capnography is non-invasive and provides continuous measurement. Assessment of changes in PETCO2 value would contribute to patient survival. (www.actabiomedica.it)

Keywords: capnography, COVID-19, emergency, intubation.

Introduction

Capnography refers to the measurement of the partial CO_2 pressure (P_{ETCO2}) in the respiratory gases of mechanically ventilated patients and is used routinely for the monitoring of endotracheal tube position, for the assessment of the effectiveness of cardiopulmonary resuscitation (CPR), for the monitoring of ventilation during interventional sedation and analgesia, for the ventilation monitoring of unconscious patients and for the assessment of respiratory diseases (1-3). P_{ETCO2} represents the partial pressure or maximal concentration of carbon dioxide at the end of exhalation (4, 5). As

such, the P_{ETCO2} measured immediately after the intubation of the patient allows the ventilation status of the patient to be ascertained.

COVID-19 is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which is an encapsulated virus containing ribonucleic acid (6-8). According to case reports, more than 80% of patients with the disease present with mild fever, while 14–17% develop acute respiratory distress syndrome (ARDS), leading to severe respiratory distress (9, 10). Furthermore, 5% of patients experience septic shock and multiple organ dysfunction syndrome (MODS), and 2–3% require tracheal intubation (10, 11). Mortal-

ity among critical patients is in the 16.7–61.5% range (6). COVID-19, which has been declared a pandemic by the World Health Organization (WHO), had been reported to have affected more than 175,000,000 confirmed cases including 3.792.777 deaths (12).

Turkey experienced the second peak of the outbreak in November 2020 (13). In this period, all hospitals were designated as COVID-19 referral hospitals, and our hospital also provided intensive care services to COVID-19 patients in most of the emergency department.

The objective of the present study is to establish the value of P_{ETCO2} measured by capnography in confirmed COVID-19 patients intubated in emergency department, and to determine its effects on mortality.

Materials and Methods

Study design and setting

This is single-center, prospective and observational study. Our institution is a tertiary-care university hospital that has been assigned as a pandemic hospital, where patients with confirmed or suspected COVID-19 are assessed by emergency medicine specialists in the emergency department, while initial interventions and nasopharyngeal swab sample collections for polymerase chain reaction (PCR) test (Bio-speedy® COVID-19 RT-qPCR test), tests are made in an area set aside for COVID-19. Critical COVID-19 patients are transferred to a separate area where the necessary initial interventions are performed; follow-ups are performed in the clean red area for cases in which COVID-19 has been ruled out, and in the pandemic area for those who cannot be ruled out. Approximately 4,000 patients with suspected COVID-19 are examined at the emergency department every month.

Study population

The study included patients aged 18 years and above who had been diagnosed COVID-19 after examinations and tests performed in the emergency department, who were scheduled for urgent intubation and who provided consent between May 15, 2020 and January 15, 2021. Patients with trauma or with cardiopulmonary arrest prior to intubation, and those who were pregnant were excluded from the study.

Study protocol and data collections

COVID-19 patients with the need for intubation as determined by examinations and tests are transferred to a separate area in which a physician, a senior resident, a nurse and a member of hospital staff are in attendance. All personnel use Level 3 personnel protective equipment (PPE). A video laryngoscope (Medan®) and intubation cabinet are used, and three sizes of endotracheal tube, as well as the stylets and medications required for anesthesia induction and resuscitation are kept available.

The demographic characteristics of the patients, such as age and gender, as well as any comorbidities, are recorded. Fever, heart rate, respiration rate, arterial blood pressure, thoracic tomography findings and laboratory findings are recorded. The thoracic tomography scans of the patients are classified as Type 1: typical appearance of COVID-19 pneumonia, Type 2: indeterminate features of COVID-19 pneumonia, Type 3: presence of pneumonia, but absence of COVID-19 features, and Type 4: absence of pneumonia in accordance with the system proposed by the Radiology Society of North America (RSNA) (14). The results of arterial blood gas analyses obtained at admission and 15 min after intubation (pH, lactate, bicarbonate (HCO_3), partial pressure of arterial blood oxygen and carbon dioxide) are recorded.

The intubation of patients is performed in accordance with the infection prevention protocol (7, 8, 15, 11). Accordingly, pre oxygenation is performed using nasal oxygen for 3–5 min, after which, induction is achieved using the midazolam, ketamine or propofol available in the area in a full dose appropriate for the vital signs and patient weight, and a full dose of vecuronium citrate, a neuromuscular blocker, is administered, again in accordance with the protocol. No manual ventilation is performed to avoid aerosol transmission. After the tracheal tube is clamped and seen to pass the vocal cords on the video laryngoscope, a heat and moisture exchanger (HME) filter, a mainstream capnography and a mechanical ventilator are connected.

The clamp is then released and the patient is mechanically ventilated with a Galileo® mechanical ventilator in continuous mandatory ventilation (CMV) mode, with tidal volume (TV) set to 5-6 ml/kg, positive end-expiratory pressure (PEEP) to 4-6 cmH$_2$O, and minute ventilation (MV) to 6-8 lt/min. The initial P$_{ETCO2\_1}$ and P$_{ETCO2\_2}$ at post-ventilation 15 min, as measured by the capnography, are recorded. Arterial blood gases are sampled at the time of the second measurement, and the results are recorded. All patients are then admitted to the intensive care units prepared for the pandemic, and monitored for mortality for one month.

Statistical method

The study data was assessed using the IBM SPSS Statistics 25.0 (IBM Corp., Armonk, New York, USA) software package. Descriptive statistics were presented as unit number (*n*), percentage (%), mean ± standard deviation (), median, and 25th (*Q$_1$*) and 75th percentile (*Q$_3$*); while qualitative variables were expressed as frequency and percentages. The normality of the quantitative data was assessed for normality with a Kolmogorov-Smirnov test. The homogeneity of variances was evaluated using Levene's test. Mortality comparisons were evaluated using an Independent Samples *t*-test. Spearman's correlation analysis was used to identify the association between P$_{ETCO2\_1}$ and PaCO$_{2\_1}$, and P$_{ETCO2\_2}$ and PaCO$_{2\_2}$. A univariate binary logistic regression analysis was carried out to identify the factors with an impact on mortality. Variables with p<0.10 in the univariate model were included in the multivariate model, for which the Backward Wald method was used. A *p* value of <0.05 was considered statistically significant.

Ethics statement

The present study protocol was reviewed and approved by zmir Katip Çelebi University Ethics Comitee (approval date: 12.05.2020, No: 703) and by The Ministry of Health Republic of Turkey (approval date: 09.05.2020, No: 2020-05-06T21_01_42). Written informed consent was obtained from each patient and / or heir at law, included in the study. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institution's human Research committee.

Results

During the study period, 108 patients were intubated in accordance with the RSI protocol in our emergency department and 86 patients were found to be positive for COVID-19. Forty-eight patients who presented during the shifts of the researchers and were intervened by the researchers, who met the inclusion criteria and who submitted their consent were included in the study.

The mean age of the 48 study patients was 74 (59.50-80.50) years. Of the patients, 60.4% were male and 39.6% were female. The general characteristics of the patients (age, gender and comorbidities) and vital signs at admission (BP, heart rate, respiratory rate, saturation and fever) are presented in Table 1.

The mean duration of intubation was 2.32 min±12 sec. The patients' laboratory findings (complete blood count, kidney and liver function tests, electrolytes), first blood gas analysis results (pH$_{\_1}$, PaO$_{2\_1}$, PaCO$_{2\_1}$,

Table 1. Descriptive statistics of patients' characteristics and admission vital signs(n=48)

variables	*Median(Q$_1$-Q$_3$)*	*Min-Max*
Age/ year	74 (59,50-80,50)	37-95
gender	*n*	(%)
female	29	(60,4)
male	19	(39,6)
Vital signs	*Median(Q$_1$-Q$_3$)*	*Min-Max*
Systolic BP/ mmHg	94,50 (83-118,5)	50-250
Diastolic BP/ mmHg	65 (56-78,5)	35-135
Pulse/min	110 (83,5-120-5)	25-170
Respiration rate/min	27,5 (18,5-32)	10-50
SpO$_2$/%	81 (72-88,5)	40-98
Fever /°C	37,9 (37,2-38,7)	36,5-39
Comorbid disease	n	%
none	9	(18,7)
1	20	(41,7)
2	8	(16,7)
3 and more	11	(22,9)

BP: blood pressure, SpO$_2$: oxygen saturation.

HCO_{3_1} and $Lactate_{\_1}$), second blood gas analysis results ($pH_{\_2}$, PaO_{2_2}, $PaCO_{2\_2}$, HCO_{3_2} and $Lactate_{\_2}$) and the results of the first and second P_{ETCO2} measurements and CT results were classified in accordance with the RSNA at are presented in Table 2.

An examination was made of the association between the first and second P_{ETCO2} measurements, and the first and second of $PaCO_2$ measurements. No statistically significant correlation was noted between the first measurements of P_{ETCO2_1} and $PaCO_{2\_1}$ ($r=0.185$; $p=0.318$), while a statistically significant strong positive correlation was noted between the measurements of P_{ETCO2_2} and $PaCO_{2\_2}$ ($r=0.769$; $p<0.001$).

Table 3 presents the results of the comparisons of the first and second P_{ETCO2} measurements based on the clinical outcome of the patients. The P_{ETCO2_1} measurements were statistically significantly different between the patients who survived and those who died ($p<0.014$). Likewise, the P_{ETCO2_2} measurements were statistically significantly different between the patients who survived and those who died ($p<0.015$). We found that patients with a high first P_{ETCO2_1} value and a decrease to the normal level survived ($p<0.038$), but those with a low first P_{ETCO2_2} value that could not increase to a normal value died ($p<0.031$) (Table 3).

The results of the logistic regression analysis of factors with an impact on mortality. Increased levels of $SpO2$, P_{ETCO2_1}, P_{ETCO2_2} and $PaCO_{2\_2}$ decreased the risk of mortality, while an increased level of PaO_{2_2} increased the risk of mortality (Table 4).

The table 5 presents a ROC analysis to test the sensitivity and specificity of $ETCO_2\_1$, $ETCO_2\_2$, PaO_2_2 and $PaCO_2\_2$ in predicting mortality (Table 5) (Figure 1).

Discussion

The ongoing global COVID-19 outbreak has spread primarily through droplets. It usually results in severe pneumonia in individuals with underlying comorbidities and those of advanced age. As yet, no effective treatment has been identified (9, 15). Endotracheal intubation is recommended if there is no improvement in respiratory distress (patients with a respiratory rate >30/min) and if oxygenation remains

Table 2: Descriptive statistics of patients' laboratory values at the time of admission, first and second blood gas analysis and P_{ETCO2} values, Computed Tomography results ($n=48$).

Variables	Median (Q1-Q3)	Min-Max
pH_1	7,24 (7,01-7,32)	6,96-7,41
PaO_2_1 (*mmHg*)	60,8 (44,75-68)	27,9-99
$PaCO_2\_1$ (*mmHg*)	50,2 (42-71,5)	23,5-98,3
HCO_3_1(*mEq/L*)	19,7 (16,1-25)	8,4-39,6
Lactat_1 (*mmol/L*)	2,35 (1,25-7,1)	0,4-14,1
WBC (x10^3/μL)	13,65 (10,42-20,19)	6,10-26,15
HCT (*%*)	30,6 (23,09-39,8)	17,50-46,10
PLT (x10^3/μL)	258 (193-483)	31-714
Glucose (*mg/dl*)	171 (130-224)	56-665
BUN (*mg/dl*)	26 (18-61)	9-154
Cre (*mg/dl*)	1,34 (0,89-2,43)	0,29-8,78
AST (*U/L*)	34 (20-66)	8-913
ALT (*U/L*)	22 (15-40)	6-794
Na (*mEq/L*)	137 (133-140)	129-158
K (*mEq/L*)	4,40 (3,90-4,90)	2,90-9,30
Ca (*mEq/L*)	7,60 (7,10-8,30)	6,10-9,20
CRP (*mg/dl*)	92,15 (47,20-180,87)	0,28-331,69
pH_2	7,32 (7,2-7,41)	6,97-7,57
PaO_2_2 (*mmHg*)	122 (72,1-154,5)	37,8-324
$PaCO_2\_2$ (*mmHg*)	42 (31,5-48,1)	3,67-109
HCO_3_2 (*mEq/L*)	20,9 (17,2-24,3)	8-37,5
Lactat_2 (*mmol/L*)	2,1 (1,1-5,25)	0,6-11,8
P $_{ETCO2\_1}$ (*mmHg*)	34 (23-44,5)	14-82
P $_{ETCO2\_2}$ (*mmHg*)	37 (32-41,5)	20-68
Computed tomography	*n*	%
No Tomography	3	(6,2)
Type 1	8	(16,7)
Type 2	11	(22,9)
Type 3	5	(10,4)
Type 4	21	(43,8)

WBC: White blood cell, HCT: hematocrit, PLT: platelet, AST: Aspartate amino transferase, ALT: alanine amino transferase, CRP: C-reactive protein. BUN: blood urea nitrogene, cre: creatinine, Na: sodium, K: potassium, Ca: calcium, PaO_{2_1}: partial oxygen pressure of the first arterial blood, $PaCO_{2\_1}$: partial carbon dioxide pressure of the first arterial blood, HCO_{3_1}: first bicarbonate, PaO_{2_2}: partial oxygen pressure of the second arterial blood, $PaCO_{2\_2}$: partial carbon dioxide pressure of the second arterial blood, HCO_{3_2}: second bicarbonate, P_{ETCO2_1}: partial end tidal carbondioxide pressure immediately after intubation, P_{ETCO2_2}: partial end tidal carbondioxide pressure after 15 min ventilation.

Table 3: Comparison of $P_{ETCO2-1}$ and $P_{ETCO2-2}$ measurements according to patients survival status (n=48).

P_{ETCO2}	Patient's outcomes			Test statistics
	live	ex	Total	$p$value
1.Measurement ($P_{ETCO2-1}$)	41,29±18,92	29,88±10,95	35,58±16,35	F=4,895 *p<0.014
2. Measurement ($P_{ETCO2-2}$)	40,79±1064	34,25±7,12	35,94±9,52	F=0,678 *p<0.015
Test statistics P value	F=10,472 *P<0.038	F=2,288 *p<0.031		

T Independent Test was used; P_{ETCO2}: partial end tidal carbondioxide pressure

AUC: Area Under Curve, Sens: Sensitivity, Spec: Specificity, +LR: Positive Likelihood Ratio, –LR: Negative Likelihood Ratio, PPV: Positive Predictive Value, NPV: Negative Predictive Value, CI: Confidence Interval

Table 4. Logistic regression analysis of parameters that affect mortality.

Parameters	B	S.E.	Exp (B)	p
PaO_{2_1}	0,544	0,196	7,654	0.196
PaO_{2_2}	0,786	0,361	1,089	**0.034**
$PaCO_{2\_1}$	-0,196	0,119	4,341	0.076
$PaCO_{2\_2}$	-0,261	0,234	1.716	**0.048**
SpO_2	-0,625	0,294	1,165	**0.005**
P_{ETCO2_1}	-0,414	0,261	1,347	**0.008**
P_{ETCO2_2}	-0,297	0,327	1,107	**0.017**

PaO_{2_1}: partial oxygen pressure of the first arterial blood gas, $PaCO_{2\_1}$: partial carbon dioxide pressure of the first arterial blood gas, PaO_{2_2}: partial oxygen pressure of the second arterial blood gas, $PaCO_{2\_2}$: partial carbon dioxide pressure of the second arterial blood gas, P_{ETCO2_1}: partial end tidal carbondioxide pressure immediately after intubation, P_{ETCO2_2}: partial end tidal carbondioxide pressure after 15 min ventilation.

poor despite two hours of high-flow (HFNO) and/or non-invasive mechanical ventilation (NIMV) (PaO_2/FiO_2 ratio <150 mmHg) (15, 16). Rapid Sequence Intubation is an effective and safe approach to airway management in the emergency department (6, 17). The present study is the first to assess P_{ETCO2} in intubated COVID-19 patients in the emergency department.

Capnography measures expiratory PCO_2. The measured P_{ETCO2} is a parameter that is used to determine and monitor the ventilatory status of patients. An P_{ETCO2} of 35–45 mmHg indicates sufficient breathing in the patient (3, 4, 18). A high P_{ETCO2} indicates high alveolar PCO_2, while a low value indicates that alveolar PCO_2 is low (2, 4, 5). In the present study, we found that a cut-off value of 40 mmHg for P_{ETCO2_1}, measured immediately after the patient was intubated, was significant in predicting mortality, and that a cutoff value of 40 mmHg for P_{ETCO2_2}, measured after 15 minutes of mechanical ventilation, was also a significant indicator of mortality. A comparison of the effects of both values on mortality revealed that patients with a higher P_{ETCO2_1} and a near-normal second measurement (P_{ETCO2_2}) survived, while those with a lower P_{ETCO2_1} and a not near-normal second measurement died. In the present study, none of the patients were manually ventilated prior to intubation, the induction agents were administered at full dose and the intubation was performed by clamping the intubation tube.

Table 5: Determination of cut-off point, area under the curve, sensitivity, specificity, positive and negative predictive values of P_{ETCO2_1}, P_{ETCO2_2}, PAO_{2_2} ve $PACO_{2\_2}$ measurements.

	Cut-off value	AUC	Sens % (95 % CI)	Spec % (95 % CI)	+LR (95 % CI)	-LR (95 % CI)	PPV % (95 % CI)	NPV % (95 % CI)
$ETCO_{2\_1}$	40	0,845	83 (60,9-95,3)	79,3 (47,7-95,4)	4,21 (1,64-12,03)	0,22 (0,08-0,45)	88,4 (74,0-94,7)	73 (53,1-83,6)
$ETCO_{2\_2}$	40	0,765	86 (62,1-97,4)	55,85 (23,4-83,3)	1,892 (1,09-3,22)	0,28 (0,11-0,84)	79,1 (66,7-86,1)	67,1 (40,9-85,3)
PAO_{2_2}	118	0,785	66 (36,1-81,7)	100 (71,4-100)	0 (0-0,47)	2,58 (1,53-2,66)	59,7 (45,8-58,3)	100 (79,6-100)
$PACO_{2\_2}$	41,8	0,781	76,1 (51,3-90,7)	75,7 (39-94)	2,83 (1,27-7,38)	0,35 (0,15-0,79)	83,8 (67-94)	62,7 (40,6-73,8)
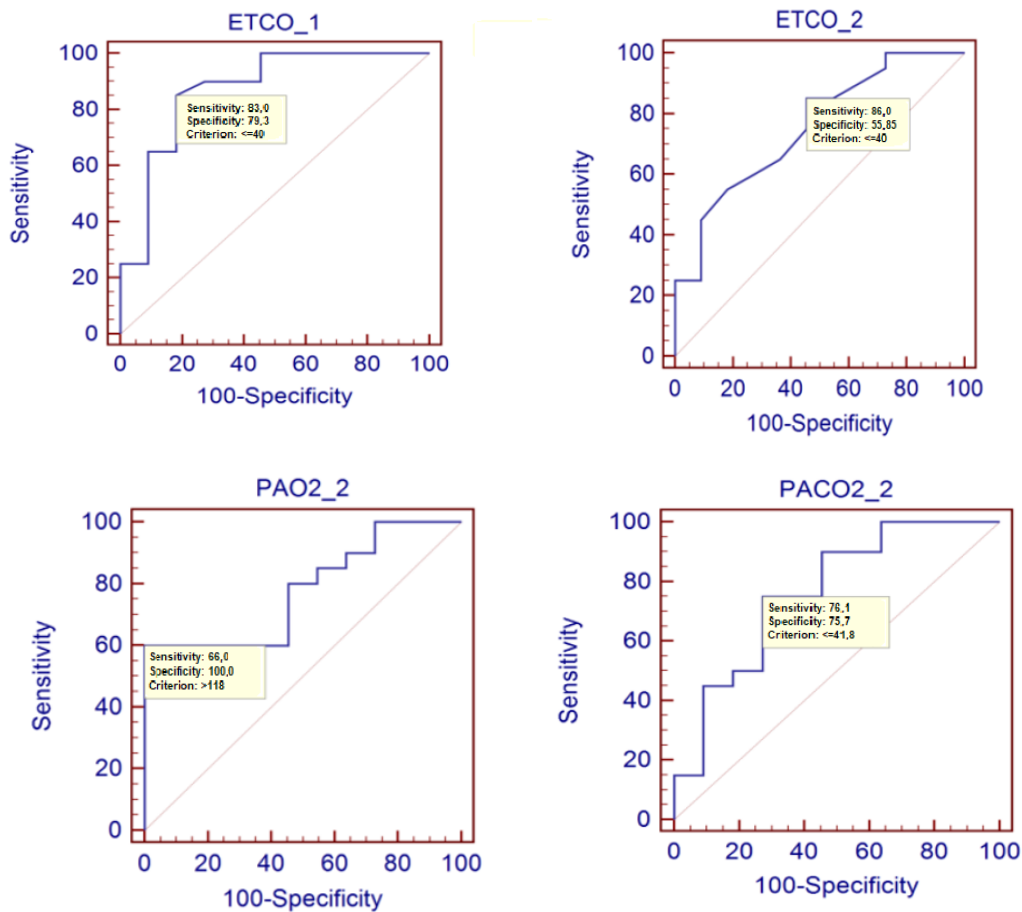
Figure 1. ROC analysis of P_{ETCO2_1}, P_{ETCO2_2}, PaO_{2_2} and $PaCO_{2\_2}$ to predicting mortality.

The P_{ETCO2} level measured once the patient was intubated reflects the P_{ETCO2} level during the apneic state of patients. A low P_{ETCO2} level is an indicator of increased alveolar dead space and hypoventilation. This indicates increased intrapulmonary shunt and ARDS (2, 19). The COVID-19 pneumonia is known to cause ARDS (6, 20). Normalization of carbon dioxide pressure is recommended for the patients intubated for ARDS management (21, 22). These findings of our study show decreased mortality in patients with near-normal P_{ETCO2} values. In our study, the second measurements were made 15 minutes after intubation. The study by Deakin et al. on trauma patients who were intubated using RSI reported that the P_{ETCO2} value measured at 20 minutes after intubation predicted the survival of the patient. The lack of association between the P_{ETCO2} value measured immediately after intubation and survival was attributed to inadequate alveolar ventilation. The authors stated that the patients survived if effective ventilation was achieved after the patient was placed on the ventilator and ventilated for 20 minutes (23). Similarly, Grmec et al. indicated that utilization of a capnography is an effective method in the follow-up of patients intubated outside the hospital. Patients with a P_{ETCO2} value of ≥ 30 mmHg were reported to have an increased chance of survival (24). Our findings are consistent with these studies. In addition, we established that a cut-off value of 40 mmHg at first and second P_{ETCO2} measurements had a negative relationship with mortality in our study. Normal value of P_{ETCO2} is 35–45 mmHg (1, 3, 4). In this case, normalization of P_{ETCO2} value by adjusting the ventilator settings according to the first P_{ETCO2} measurement in intubated COVID-19 patients would increase the survival.

In patients with normal lung function, the $P_{(alveolar-intubation\ tube)CO_2}$ gradient is narrow. Thus, the P_{ETCO_2} measurement accurately reflects $PaCO_2$. In respiratory disorders due to pulmonary diseases, this gradient widens and the P_{ETCO_2} value measured from the intubation tube decreases, while the blood level of $PaCO_2$ increases due to the inability to clear carbon dioxide. This, which is a situation of a broken-down correlation between the P_{ETCO_2} and $PaCO_2$ levels, is a result of dead space ventilation (2, 4, 5, 25). In our study, we found no correlation between the $PaCO_2$ at admission blood gas analysis and P_{ETCO_2} values measured immediately after the patient was intubated. We established a correlation between the second P_{ETCO_2} and $PaCO_2$ values measured after the patients were ventilated for 15 minutes. These findings show that patients with alveolar dead space ventilation initially were effectively ventilated after intubation. In support of our findings, the study by Krauss et al. suggested that a greater difference between P_{ETCO_2} and $PaCO_2$ indicates poor ventilation, while a decreased difference indicates improved ventilation (2).

Also in the present study, we found a cutoff value of 41.8 for post-intubation $PaCO_{2\_2}$ to be associated with mortality. Similar to our study, Zhang et al. compared the pre- and post-intubation blood gas, oxygen saturation, pH, PaO_2, lactate and $PaCO_2$ levels of COVID-19 patients who survived and died. The authors found higher lactate and $PaCO_2$ levels before and after intubation among the patients who died than in those who survived, with a $PaCO_2$ value of 54.28 ± 22.92 mmHg in the patients who died after intubation, compared to 42.33 ± 10.2 mmHg in those who survived (16). In this regard, the findings of Zhang et al. are consistent with those recorded in the present study. $PaCO_{2\_2}$ is a guiding parameter when monitoring the ventilatory status of patients after intubation. $PaCO_2$ is calculated from arterial blood gas, and so requires arterial interventions and the appropriate equipment. Based on the correlation established in our study, we can recommend the use of P_{ETCO_2} for patient follow-up, given its ability to be measured non-invasively and to provide instantaneous and simultaneous information.

The study by Zhang et al. found oxygen saturation and pH in the blood gas analysis to be lower in patients who died than in those who survived (16).

We also found oxygen saturation measured by pulse oximetry at admission to be associated with mortality, and our findings suggest that mortality risk decreases as oxygen saturation measured by pulse oximetry increases. This reveals the importance of oxygenation prior to intubation. There is a lack of consensus on the optimum pre oxygenation approach prior to intubation in COVID-19 patients with severe dyspnea and hypoxia. In the study by Wang et al., patients were pre oxygenated using NIMV prior to intubation, and in a comparison of the pre- and post-intubation SpO_2 levels of the patients, the SpO_2 was seen to increase from 77.44 ± 12.64 (%) to 94.78 ± 7.45 after intubation (p<0.000) (26). In contrast, the study by Whenlong et al. of COVID-19 patients intubated, reported pre oxygenation prior to intubation to be insufficient, stating further that the oxygenation of patients should be continued using HFNO or NIMV during intubation (6). Cook et al., in turn, suggested that HFNO and NIMV should be avoided due to the increased aerosol transmission (8). In the present study, patients were pre oxygenated using a mask or/and HFNO prior to intubation. Preventing hypoxia upon admission to the emergency department would improve the survival of patients. It is possible to continue oxygenation during intubation through methods that reduce aerosol transmission, although literature contains few studies that make intubation recommendations. Consequently, there is a need for studies involving larger patient groups.

We found PaO_{2_2} obtained from the blood gas after 15 minutes of mechanical ventilation to be associated with mortality. Mortality increases with increasing PaO_{2_2} levels, and we established in our study that PaO_{2_2} increased the risk of mortality by a factor of 1.089 times. In Page et al.'s evaluation of patients intubated in the emergency department, a higher mortality rate was noted among those with a mean PaO_2 of 189 mmHg (27). Likewise, in the study by Jouffroy et al. of patients intubated in the emergency department, PaO_2>150 mmHg was found to be associated with mortality (28). Our findings are consistent with these studies, with a cutoff value of ≥130 mmHg for PaO_{2_2} being associated with mortality, and a high pressure of oxygen noted to cause the release of free radicals at a tissue level. Furthermore, high pressure oxygen leads

to interstitial fibrosis, protein leakage and inflammation in the lungs, resulting in injury (29, 30). We found that PaO_{2_2} measured 15 minutes after intubation was associated with mortality. The recommended PaO_2 value in ARDS is 60–65 mmHg. After intubation, the FiO_2 is first set at 100% in the mechanical ventilator. While the patient is on ventilation, the FiO_2 can be reduced to below 60%, with a PaO_2 value of 60–65 (21, 31). We believe that the early determination of PaO_2 and the adjustment of mechanical ventilator settings based on PaO_2 will improve patient survival.

Regarding the mean age of the patients, in the study of Zhang et al. involving intubated COVID-19 patients, the mean age of the respondents was 71.2 years, and 90% of the patients were above the age of 60 years (16). In the study by Whenlong et al., 128 of the 202 study patients were above the age of 65 years (6). Whang et al., in turn, reported a mean age of 70.39±8.02 years in their study (26). The mean age of the patients requiring intubation is high due to the severe course of COVID-19 among the older population. In this regard, the mean age of our study group is consistent with that of other studies.

Conclusion

Pneumonia due to SARS-CoV-2 causes ARDS-like hypoxemic respiratory failure. The prognosis of these patients depends on early interventions in the emergency department. In ARDS patients, mechanical ventilation is not easy and is a treatment that should always be administered meticulously. Changes that may occur in the patient during the implementation and monitoring of lung protective ventilation should be identified and ventilator settings should be adjusted accordingly. Capnography is an important tool for clinicians in the monitoring of ventilation as it is non-invasive and provides continuous measurement and instant data acquisition. Assessment of changes in P_{ETCO2} value would contribute to patient survival. Studies in large patient groups are needed to more clearly demonstrate the role and significance of capnography in intubation, and monitoring of ventilation among COVID-19 patients.

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