

## Intubated Patients with Respiratory Failure under Mechanical Ventilation in Emergency Department

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### ABSTRACT

**Background:** Acute respiratory failure (ARF) is an important presentation in emergency department (ED). Intubation and mechanical ventilation (MV) are sometimes the ultimate decisions in such emergent situations. Many of these patients are unfortunately managed in an ED. This may endanger their outcome.

This study was aimed to compare the outcome of critically ill patients with ARF under MV admitted to ED with patients admitted to ICU.

**Methods:** All critically ill patients with ARF who were intubated and placed under MV were enrolled in this study. Cases were either admitted to ED or ICU. Demographic data, initial diagnosis, final diagnosis, length of hospital stay, one-month mortality rate, number of times patient was intubated and number of times patient was resuscitated were all recorded and compared between the 2 groups.

**Results:** Out of all 172 patients admitted to ED and ICU, 74 (43%) were females and 98 (57%) were males. Patients had a mean±SD age of 64.2±18.1 years. ICU patients (85 patients (49.4%)) had a significantly longer hospital stay ( $p=0.048$ ). ICU patients had significantly more resuscitation process ( $p=0.006$ ). Mortality rate in ICU was significantly higher than ED. In the meanwhile, more patients in ED finally survived ( $p=0.004$ ).

**Conclusion:** In the present study, ICU patients were admitted longer to the ward than ED patients. Overall, ED mortality rate was lower than ICU. More patients finally survived in ED in comparison to ICU.

Acute respiratory failure (ARF) is a sudden and dangerous respiratory dysfunction in gas exchange that can be manifested as acute, chronic or acute on chronic process [1]. Most of ARF cases finally need to be intubated, mechanically ventilated and cared at an intensive care unit (ICU). Treatment goals in this scenario are eliminating the underlying cause and preserving oxygen and carbon dioxide exchange [2].

ARF like many other medical conditions, has established volume-outcome relationship. The literature shows that in the United States, annually more than 300000 patients

with ARF undergo mechanical ventilation (MV) in ICUs and in hospital mortality rate reaches 50% [3-5]. ARF itself and moreover MV both have their own life-threatening complications [6]. The longer patient stays at the hospital the more irrecoverable complications and the more disease burden can happen [7]. Some studies reported a mortality rate of 30.7% in ICU in cases being treated under MV with a mean of 5.9 days. In this study, a survival rate of 69% was found in patients under MV longer than 12 hours [4].

Many of ARF cases refer to an emergency department (ED) as the first accessible place like many other

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critically ill patients. The outcome often depends on the time, resources, number of staffs and their level of expertise and knowledge. ED “boarding” of such patients (managing patients in a holding unit in an ED pending ICU bed availability) is nowadays a common term in many countries like in the United States [8]. ED boarding has now been introduced as a major health care system concern [9] with unclear special impacts on patient outcome [10-11].

In our hospital as a tertiary referral center, many critically ill patients are admitted and managed in ED especially in Coronavirus disease (COVID-19) pandemic. All required ICU cares are given to them by the busy ED staff in such a crowded environment. In this study, we decided to evaluate and compare the outcome (including 1-month mortality rate) of critically ill patients with ARF under MV admitted to ED with patients admitted to ICU.

## Methods

This was a retrospective cohort study, performed in ED of Dr Shariati hospital from June to Nov 2020 in Tehran, Iran. The study was approved in the Ethics Committee of Tehran University of Medical Sciences (IR.TUMS.MEDICINE.REC.1398.218). The privacy of data was maintained according to the Helsinki Declaration of biomedical ethics. Informed written consent was taken from patient’s guardian before enrolment. A predesigned checklist was fulfilled by patient data from his/her medical record documented in hospital files. Demographic data, initial probable diagnosis, final diagnosis, hospital length of stay, 1-month mortality rate, time span under MV, number of times cardiopulmonary resuscitation (CPR) performed, number of times intubation or extubating performed and cause of mortality were all registered and compared between the 2 groups.

## Participants

All critically ill patients with ARF, who were intubated and underwent MV, both in ED and ICU were enrolled in our study. The study time interval was

less than 6 months. In the first group, we evaluated patients admitted and managed in ED and in the second parallel group, we evaluated admitted and managed cases in ICU. Our exclusion criteria were cases not willing to participate in our study and referral patients being managed in other centers.

## Primary and secondary endpoints

Our primary outcome was comparing 1-month mortality rate between the 2 groups. Our secondary outcomes were comparing other mentioned study variables between the 2 groups.

## Statistical analysis and sample size calculation

Data were analyzed using SPSS V.23 software (IBM Corporation, Armonk, NY). We determined normality with the Kolmogorov–Smirnov test. The presented data are provided as mean  $\pm$  standard deviation (SD). We used chi-square test for qualitative variables and student’s t-test for parametric quantitative variables. The level of significance was  $<0.05$ . We enrolled all cases who met our inclusion criteria in less than 6 months in 2020.

## Results

We enrolled 190 cases in this study. Eighteen patients were excluded based on the exclusion criteria. Finally, 172 critically ill patients with ARF under MV were evaluated (74 females (43%) and 98 males (57%)). They were either admitted in ED or ICU. Among all patients with ARF under MV, 85 cases (49.4%) were admitted in ICU and 87 cases (50.6%) in ED.

In this population of patients, generally, age had a mean $\pm$ SD of 64.2 $\pm$ 18.1 years, hospital length of stay was 14.1 $\pm$ 15.2 days, length of time being under MV was 9.7 $\pm$ 12.3 days. The most common initial and final diagnosis were COVID-19 and sepsis respectively. Most patients were intubated only once (158 cases (91.8%)). CPR was performed once on the majority of our patients (138 (80.2%)). The mortality rate was 124 cases (72.0%). Basic data in the general population is shown in (Table 1).

**Table 1- Basic data in the general population**

Variable		
Gender N (%)	Female	74 (43)
	Male	98 (57)
Age Year	64.2 $\pm$ 18.1	Min Max
mean $\pm$ SD		12 97
Hospital length of stay Day	14.1 $\pm$ 15.2	1 95
	mean $\pm$ SD	
length of time under mechanical ventilation Day	9.7 $\pm$ 12.3	1 81
	mean $\pm$ SD	
Admission ward N (%)	Intensive care unit	85 (49.4)
	Emergency department	87 (50.6)
Frequency of intubation and mechanical ventilation N (%)	1	158 (91.8)
	2	12 (7.0)
	3	1 (0.6)

	4	0 (0.0)
	5	1 (0.6)
Frequency of cardiopulmonary resuscitation N (%)	0	32 (18.6)
	1	138 (80.2)
	2	2 (1.2)
Outcome of cardiopulmonary resuscitation N (%)	No need to be resuscitated	32 (18.6)
	Alive	16 (9.4)
	Expired	124 (72.0)
Final diagnosis of expired cases N (%)	Cardiopulmonary condition	76 (61.2)
	Septic shock	28 (22.5)
	Multi organ failure	17 (13.9)
	Acute respiratory distress syndrome	3 (2.4)
Venous blood gas analysis before intubation mean±SD	Potential of hydrogen (PH)	7.30±0.13
	Carbon dioxide partial pressure (PCO2)	47.31±18.4
	Oxygen partial pressure (PO2)	48.84±36.91
	Bicarbonate (HCO3)	23.23±7.87
	Oxygen saturation (SPO2)	66.35±23.16
Venous blood gas analysis after intubation mean±SD	Potential of hydrogen (PH)	7.26±0.15
	Carbon dioxide partial pressure (PCO2)	48.47±20.09
	Oxygen partial pressure (PO2)	58.72±49.50
	Bicarbonate (HCO3)	22.44±9.42
	Oxygen saturation (SPO2)	69.27±22.90

Data analysis was continued to compare patients in ICU versus ED. Patients in ED happened to be significantly older than ICU cases ( $p=0.001$ ). Gender distribution had no significant difference between the 2 groups ( $p=0.629$ ). ICU patients were admitted significantly longer than cases in ED ( $p=0.048$ ). Length of time being under MV showed no significant difference between the 2 groups ( $p=0.339$ ). Number of times intubation and MV performed showed no significant difference between the

2 groups ( $p=0.346$ ). 21 patients in ED and 11 patients in ICU were not resuscitated at all and they were all finally discharged from hospital. In ED, 56 patients unfortunately expired but in ICU 68 patients finally expired. ICU patients had significantly higher CPR and mortality rates ( $p=0.006$  and  $0.004$  respectively). Data is shown in (Table 2). Patients in ED suffered more acute metabolic acidosis both before and after intubation ( $p<0.5$ ).

**Table 2- Comparison of study variables between the 2 groups**

Variable		Intensive care unit	Emergency department	P value
Gender N (%)	Female	35 (20.3)	39 (22.7)	0.629
	Male	50 (29.0)	48 (28.0)	
Age Year mean±SD		60.46±17.09	69.90±17.85	0.001
Hospital length of stay Day mean±SD		16.41±15.88	11.83±14.32	0.048
length of time under mechanical ventilation Day mean±SD		8.83±9.95	10.63±14.19	0.339
Frequency of intubation and mechanical ventilation N (%)	1	79 (45.9)	79 (45.9)	0.346
	2	4 (2.3)	8 (4.7)	
	3	1 (0.6)	0 (0.0)	
	4	0 (0.0)	0 (0.0)	
	5	1 (0.6)	0 (0.0)	
Frequency of cardiopulmonary resuscitation N (%)	0	11 (6.3)	21 (12.3)	0.006
	1	77 (44.7)	61 (35.5)	
	2	0	2 (1.2)	
Outcome of cardiopulmonary resuscitation N (%)	No need to be resuscitated	11 (6.3)	21 (12.3)	0.004
	Alive	6 (3.6)	10 (5.8)	
	Expired	68 (39.5)	56 (32.5)	

Venous blood gas analysis before intubation mean±SD	Potential of hydrogen (PH)	7.34±0.10	7.25±0.14	0.000
	Carbon dioxide partial pressure (PCO <sub>2</sub> )	46.42±16.20	48.15±20.35	0.549
	Oxygen partial pressure (PO <sub>2</sub> )	51.02±43.49	46.74±29.31	0.458
	Bicarbonate (HCO <sub>3</sub> )	25.13±7.37	24.15±8.38	0.387
	Oxygen saturation (SPO <sub>2</sub> )	69.02±23.26	63.76±22.89	0.145
Venous blood gas analysis after intubation mean±SD	Potential of hydrogen (PH)	7.29±0.13	7.23±0.16	0.015
	Carbon dioxide partial pressure (PCO <sub>2</sub> )	50.53±18.95	46.50±21.03	0.199
	Oxygen partial pressure (PO <sub>2</sub> )	54.27±56.32	62.96±41.90	0.262
	Bicarbonate (HCO <sub>3</sub> )	24.43±8.01	20.55±10.28	0.008
	Oxygen saturation (SPO <sub>2</sub> )	68.97±20.85	69.56±24.81	0.869

## Discussion

This study was designed with the aim of outcome assessment of critically ill patients who underwent intubation and MV in ED and ICU. Overall, the 1-month mortality rate in our study (both in ED and ICU) was undeniably higher than some similar studies in the past. The most important reason might be the existence of COVID-19 pandemic and the serious crisis we had faced.

Our single center observational study revealed higher mortality rate in ICU patients (39.5%) rather than ED (32.5%). More patients finally survived in ED (5.8%) in comparison to ICU (3.6%). These findings were not in agreement with Engebreston's et al study [12]. They reported a total percentage of 16.8% mortality rate (12.5% in ICU vs. 22.4% in non-ICU cases). Moreover, hospital length of stay was significantly higher in patients hospitalized in ICU (16.41±15.88 days) in comparison to ED (11.83±14.32 days). This finding was similar to Engebresten et al's [12].

Bauer et al in 2017, evaluated the association between the timing of intubation and outcome in critically ill patients and they found that ICU mortality rate was 18.2% vs. hospital mortality rate of 23.4% [13]. In their study, hospital length of stay was significantly higher than ICU length of stay.

Esteban et al in 2002, studied outcome of adult patients under MV and they concluded that the mean±SD days receiving MV was 5.9±7.2 days. ICU mean±SD length of stay was calculated to be 11.2±13.7 days. They also estimated an overall ICU mortality rate to be 30.7% [4].

One of the important factors that was evaluated in this study was the initial diagnosis of the patients who entered

the study. Although patients had a wide range of initial diagnoses, the most common diagnoses were Covid 19 (29.7%) and pneumonia (25.6%). This finding is important because this study was conducted in a 6-month period in 2021 at Shariati Hospital, which coincided with the occurrence of third waves of Covid pandemic in Iran. This may explain the high prevalence of respiratory diseases in the present study. The final diagnosis of patients in this study were sepsis (73.3%) and pneumonia (7.6%). Engebresten et al reported cardiopulmonary conditions and poisoning as the most common initial diagnosis [12].

Hsiao et al in 2020 showed that ICU and general ward had higher mortality rate and cardiopulmonary collapse after intubation in comparison to ED intubated cases [14]. This report was similar to our study result. Of course, many factors are involved in ED management of critically ill patients under intubation and MV. In our study we found out that most COVID-19 cases were intubated and managed in ICU rather than ED. This might play a major role in the observed difference.

To our best knowledge, there are few studies in the literature comparing the ultimate outcomes of critically ill patients being intubated and managed under MV in ICU in comparison to ED. Further studies with larger sample size are necessary to be performed in this field. We also need more studies including evaluation of the final outcomes in COVID-19 being managed in ICU vs. ED.

### Limitations of the study

Because of limitations of an observational study and small sample size, these findings cannot be extrapolated

to all ICU and ED patients. In our research, we did not assess severity of disease and other factors that may affect mortality rate in critically ill patients. In this regard, due to the COVID-19 crisis, the existing reports are very different and contradictory. Therefore, for a more accurate evaluation in this field, it is recommended to conduct similar research in other hospitals during COVID-19 pandemic.

## Conclusion

Our single center observational study showed higher mortality rate in critically ill patients under MV in ICU rather than ED. ICU cases had longer hospital length of stay.

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