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Covid-19 deaths and their relation to mechanical ventilation

A research project submitted to the microbiology department,

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صدق الله العظيم

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Abstract:

Introduction: The latest coronavirus disease outbreak (2019 covid) is a worldwide emergency, as its rapid spread and high mortality rate have caused severe disruptions. To date, about 450 million people have been infected by COVID-19 and more than 6 million people have died worldwide. It caused several complications including ARDs that lead to the use of invasive ventilation.

Methodology: A cross-sectional study was conducted at Al-kindy teaching hospital. The data was collected by using a self-completed questionnaire that we used to collect information from the history-taking checklist. A 155 sample of covid 19 patients for 2020 was collected from a statistics department from 13 December 2022 to 9 February 2023. The sampling method used a convenience sample, which means collecting data from covid 19 patients who were isolated in the RCU ward or other isolated wards. The data collected was analyzed by using the program IBM spss Statistics version 26. Tables and figures were used to display the results.

Results: A total of 155 participants met the inclusion criteria and were included in the analysis with 83 males (53.5%) and 72 females (46.5%) aged from 18-90 years. All participants were infected with covid 19 and developed ARDs. the number of patients admitted to isolation wards was 135 (87.1%) and the number of patients admitted to the RCU ward and received ventilation was 20 (12.9%).And we noticed increased mortality rates among those using ventilation.

Conclusion: We found that there's a correlation between increased mortality rates among intubated covid-19 patients. there's no significant correlation
between gender and mortality rate. Respiratory failure was the common cause of death among covid patients.

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Introduction:

The latest coronavirus disease outbreak (2019 covid) is a worldwide emergency, as its rapid spread and high mortality rate have caused severe disruptions. To date, about **450 million** people have been infected by COVID-19 and more than **6 million people** have died worldwide.

In Iraq, an Iranian student reported the first patient with **COVID-19 on 24 February 2020**(1). The authorities have implemented effective public health strategies to contain the outbreak nationwide, however, the numbers have risen dramatically, according to WHO, the number of confirmed COVID-19 cases **reached 2 million with over 25 thousand deaths**. Most of the cases were recorded in Baghdad followed by Basra and Najaf. (2)

SARS2-COV-2 is a highly infectious novel coronavirus leading to an acute infectious disease with mild-to-severe clinical symptoms such as flu-like symptoms, fever, headache, dry cough, muscle pain, loss of smell and taste, increased shortness of breath, viral pneumonia, conjunctivitis, respiratory failure, cytokine release syndrome (CRS), sepsis, acute respiratory distress syndromes, and respiratory failure. (3-4)

ARDS was initially defined in 1968 with clinical symptoms including acute hypoxemia, non-cardiac pulmonary edema, low pulmonary compliance, and increased work of breathing. It is common among COVID-19 patients to develop acute respiratory distress syndrome (ARDS)(27-28-29-30-31), a life-threatening form of respiratory failure; many patients with ARDS require ICU admission as well as mechanical ventilation(27-28-29 30-31).

A mechanical ventilator is a machine that is used to assist with the work of breathing in cases that cause low oxygen or high carbon dioxide levels (COVID-19 ARDs related cases)(6-7-8-9).

Non-invasive ventilation (NIV) or invasive mechanical ventilation (MV) is frequently needed in patients with acute hypoxemic respiratory failure due to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection(10-11-12-13-14). While NIV can be delivered in hospital wards and non-intensive care environments, intubated patients require respiratory care unit (RCU) admission and support. Thus, the lack of RCU beds generated by the pandemic has often forced the use of NIV in severely hypoxemic patients treated outside the RCU.

Due to the high incidence of patients with COVID-19-related ARDS, there is an increasing number of patients admitted to RCU units who require a ventilator(15-16-17-18-19), adding to that increased mortality rate in those patients.

Research hypothesis: covid-19 patients who receive mechanical ventilation as measured by data collection from AL-kindey teaching hospital have an increased mortality rate than patients who don't.

The Aim: To find out the reasons for the increased mortality rate in ventilated patients, and clarify the secondary complications of using this invasive procedure in covid-19 patients.

OBJECTIVE:

- **Clarify the relationship between increased mortality rate and ventilated covid-19 patients.**

- **To assess the number of admissions of covid-19 patients during the pandemic 2020.**

- **To evaluate the mechanism of ventilated covid-19 deaths.**

Methodology:

A cross-sectional study was conducted at Al-kindy teaching hospital. The data was collected by using a self-completed questionnaire that we used to collect information from the history-taking checklist. A 155 sample of covid 19 patients for 2020 was collected from a statistics department from **13 December 2022 to 9 February 2023.**

The sampling method used a convenience sample, which means collecting data from covid 19 patients who were isolated in the RCU ward or other isolated wards. The data collected was analyzed by using the program **IBM spss Statistics version 26**. Tables and figures were used to display the results.

The questionnaire consisted of questions about age, sex, what ward the patients were isolated in, whether there is a relation between oxygen saturation and CBC level to their admission to RCU, and if the patient outcome is dead or discharged alive. Depending on the questions, the collected data was divided into gender(the male was given a value of 1, the female was given a value of 2), ward (RCU was given a value of 1, other isolation wards were given a value 2), outcome (dead was given a value 1, discharged alive was given value 2). This method was adopted only in the **Al_kindy teaching hospital.**

Results:

A total of 155 participants met the inclusion criteria and were included in the analysis with **83 males (53.5%) and 72 females (46.5%)**, Figure-1.

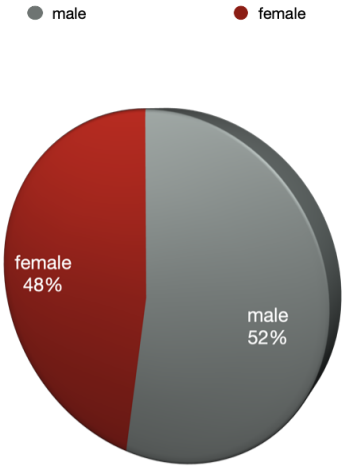

Figure-1: gender participation

Participants, aged from 18-90 years were categorised as (young = 18-35, adult=36-45, old=46-60, elderly=61,75, very elderly=72-90), as shown in Table-1.

		Count	%
Age category	Young	16	10.4%
	Adult	23	14.9%
	Old	51	33.1%
	Elderly	50	32.5%
	Very elderly	14	9.1%
Total		155	100%

Table-1: Age category

All participants were infected with covid 19 and developed ARDs. number of patients admitted to isolation wards was 135 (87.1%) and the number of patients admitted to the RCU ward and received ventilation was 20 (12.9%), as shown in Figure-2. All deaths were due to respiratory failure as shown in Figure-4

Figure-4: cause of death

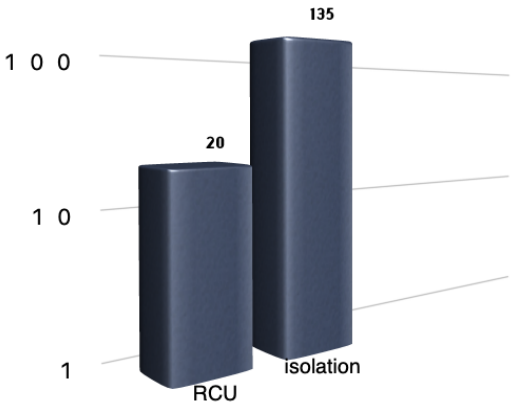

Figure-2: Admissions

Total deaths were **85 (54.8%)** while patients who were discharged alive were **70 (45.2%)**. Patients who were admitted to RCU and used mechanical ventilation were **20(12.9%)** with **16 dead (80%) and 4 discharged alive (20%)** with a **p value=0.015** however, the number of death among patients admitted to the isolation wards was **69 (51.1%) with 66 (48.9%) which discharge alive. there was a significant association between covid-19 deaths and mechanical ventilation admission,** As shown in Table-2.

Outcome					
Ward		Death		Discharge alive	
		Count	%	Count	%
	RCU	16	80.0%	4	20.0%
	Isolation	69	51.1%	66	48.9%

Table-2: shows the differences between RCU and isolation wards' death numbers

The table below shows the number of deaths regarding the gender of the participant with a **p-value of (2.136)** , **so there is no association between gender and the mortality rate.** As shown in Table-3.

Outcome					
Gender		Death		Discharge alive	
		Count	%	Count	%
	Male	41	48.2%	42	60.0%
	Female	44	51.8%	28	40.0%
Total		85		70	

Table-3: show the relation between gender and outcome.

Discussion:

This cross-sectional study aimed to find if mechanical ventilation contributes to increasing the mortality rate among covid 19 deaths. A total of **(n=155)** participants in this study met the inclusion criteria and were included in the analysis with **83 males (53.5%)** and **72 females (46.5%)** So higher participation from males is to be expected, as shown in Figure-1.

According to the results of our study, there is a significant difference between the percentage of mortality rate in RCU and other isolation wards, as shown in Figure-3.

The percentage of deaths in RCU was **80%** which is greater than the percentage in the isolation wards which was equal to **51.1%** So we can notice that the mortality rate increased after intubation. Those patients who were intubated by invasive mechanical ventilation had developed an **acute respiratory distress syndrome** in a certain way before getting intubated.

Covid-19 has an S protein in its structure, the mature virion consists of two non-covalently associated subunits (S1, S2).S1 binds to ACE2 receptors which are predominantly found in the respiratory region while S2 anchors the S protein to the membrane of the virus. When the S1 protein binds to ACE2 receptors they cause membrane effusion. As the virus enters the cell, it releases inflammatory mediators that recruit macrophages which further release cytokines (IL-1, IL-6, TNF-a) which in turn cause vasodilation leading to increase vascular permeability, accumulation of fluid in the area that surrounds the alveoli that will compress the alveoli and prevent gas exchange result in hypoxemia. (26)

The aim of ventilation during covid-19 is to provide an adequate gas exchange for those patients who progressed to **acute respiratory distress syndrome**

while avoiding ventilator-induced lung injury(20). But a long period of intubation results in multiple side effects that may lead to death(21). Figure-3 shows that all the covid-19 patients whether they were ventilated or not died of respiratory failure due to lung injury.

This injury depends on ventilator settings, If ventilation is set at low lung volume can cause **atelectrauma**, whereas ventilation set at high lung volume can lead to **over-distention and barotrauma**. Under decreasing pressure and expanding volume, the alveoli will rupture along with their surrounding blood vessels. The alveoli will be flooded with blood and debris and will collapse. Alveoli are located centrally and peripherally. Depending on the location of the ruptured collapsed alveoli, air will leak out. Generally, air travels to five areas in the body. It can move centrally to the mediastinum, causing pneumomediastinum, pneumopericardium, and then towards the head and neck, manifesting as subcutaneous emphysema, or track along the esophagus and causing pneumoperitoneum. It can travel peripherally to the pleural spaces causing pneumothorax or tension pneumothorax(22). Alveolar air can enter the capillary vessels, pulmonary veins, and central circulation, forming air gas embolism, a severe life-threatening event. And mechanical ventilation can cause secondary bacterial infections that may result in severe complications for the patients. This high incidence of secondary infection could be partially justified by an altered T lymphocyte immune response in COVID-19 patients. Preliminary flow cytometry determination of blood immune cells demonstrated a reduction in absolute numbers of total T lymphocytes (CD4+, CD8+, and regulatory T cells)(23) Sometimes, a person receiving breathing support via a ventilator may show signs of respiratory alkalosis. (24-25)

Respiratory alkalosis is a common complication in mechanically ventilated patients, particularly those with COVID-19. It occurs when low carbon dioxide

levels disrupt your blood's acid-base balance. It often occurs in people who experience rapid,

uncontrollable breathing (hyperventilation). While alkalosis can be a beneficial response to respiratory distress, it can also lead to adverse outcomes, such as increased morbidity and mortality rates.

This means that the ventilator provides too many breaths, or breaths that are too large, and the person breathes off extra carbon dioxide. This results in respiratory alkalosis.

Those studies reported that there is a correlation between mechanically ventilated covid 19 patients and increased mortality rates. On the other hand, we found a study that suggested there is no significant correlation between them.as shown in the Table above we divided the data according to age group, so we found that the age group from 51 to 65 years was more susceptible to getting infected by covid 19. So the older the age, the greater the chance of infection. Aging can cause numerous biological changes in the immune system that can influence the host's immune response and weaken the ability to fight respiratory infections. It can also be accompanied by a progressive decline in most physiological functions, increasing susceptibility to disease (32).

In Table (3) there's no correlation between gender and total death as mentioned in the previous results as the p-value was **p=0.108**. In other studies like(33)the mortality rate in males was twice higher than in females. It may be due to our small sample size in comparison with their huge sample size.

Limitations:

We have several limitations in our study, firstly the health status of the intubated patients was unknown, including chronic diseases, HIV, cardiac problems, and other diseases rather than covid-19 that may alter our findings.

Also, we weren't aware of how long the patients spent on mechanical ventilation because It wasn’t informed in the patient’s checklist in addition to other specific information that would have provided us better information about patient status, Including the cause of death was only reported as respiratory failure.

Conclusion:

- There's an obvious increase in the mortality rate among intubated covid-19 patients.
- Respiratory failure was the common cause of death in intubated covid-19 patients due to respiratory alkalosis, secondary infection, atelectrauma, and barotrauma.
- There's no correlation between gender and mortality rate.
- There's a significant correlation between age and increased mortality rate as the elderly have the largest proportion.

Recommendations:

The present study recommends that there should be several points to be consider,which include the following:

1. **The set of ventilator machines should be suitable for the patient's state.(Not too high that may result in lung injury, Not too low that won't be effective).**
2. **The duration of the ventilation process should be not too long to avoid complications such as respiratory alkalosis.**
3. **The ventilator should be highly sterilised to avoid secondary bacterial infections.**
4. **More beds should be available in the RCU.**

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