

The Impact of COVID-19 Vaccine on Rate of Hospitalization and Outcome of COVID-19 Infection in a Single Center in the Eastern Province of Saudi Arabia

Dania M. Alkhafaji

King Fahad University Hospital

Reem J. Al Argan

King Fahad University Hospital

Abrar J. Alwaheed

King Fahad University Hospital

Safi Ghazi Alqatari

King Fahad University Hospital

Abdulmohsen Alelq

King Fahad University Hospital

Waleed Albaker

King Fahad University Hospital

Huda Bukhari

King Fahad University Hospital

Marwan Alwezzah

King Fahad University Hospital

Sarah Alwarthan

King Fahad University Hospital

Amal S. AlSulaiman (✉ 2150000632@iau.edu.sa)

King Fahad University Hospital

Reem S. AlSulaiman

Imam Abdulrahman Bin Faisal University

Hussain M. Almadan

Imam Abdulrahman Bin Faisal University

Ali A. Alhammad

Imam Abdulrahman Bin Faisal University

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Abstract

Background: Coronavirus 2019 (COVID-19) is an emerging and quickly disseminating disease that causes deleterious complications. Vaccines have the potential to improve population immunity and avoid serious disease and deaths.

Methodology: A retrospective cohort study was conducted on 331 hospitalized patients with Covid 19 infections between April 2021 and July 2021 at King Fahad University Hospital. Data was collected from the medical records stored in the electronic health system of the hospital.

Results: 27.7% of the participants required ICU admission, and 10.5% required mechanical ventilation. The mortality rate was around 7.23% of the infected cases. Two thirds of the study participants (64.05%) did not receive any vaccine, and it can be noted that only 16.8% had received 2 doses. The results suggest that the status of receiving a vaccine has significantly influenced the length of hospital stay, decreasing it by 19.7%. In addition, the date of receiving the vaccine was statistically significant in decreasing the incidence of ICU admission, as those who have received a vaccine for longer than 14 days needed ICU admission 82% less compared with their counterparts. The type of vaccine did not impact on any of the reported outcomes in the form of hospitalization rate, ICU admission and death.

Conclusion: The majority of the study participants didn't receive any vaccines before their admission with COVID 19, which in turn prolonged their hospital stay. This necessitates that the public require more awareness regarding the importance of receiving the vaccine.

Introduction

Coronavirus disease 2019 (COVID-19) is an emerging and quickly disseminating disease that causes various deleterious complications. It's caused by SARS-CoV-2, a member of the Coronavirus family. It was first discovered in Wuhan, China, in November 2019, and the first case was reported to the World Health Organization (WHO) on December 31st, 2019.[1] On March 11, 2020, the WHO labelled COVID-19 as a global pandemic. Despite the government efforts to reduce transmission, the number of cases continued to escalate rapidly, posing a public health compromise. [2]

By June 25,2021, a total of 179,686,071 positive cases were registered worldwide, including 3,899,172 deaths. [2] As the pandemic progresses, it will have a significant influence on mortality, particularly among those with pre-existing comorbidities. [3]

Vaccines have the potential to improve the population's immunity and avoid serious disease and death. At the time of writing, six vaccines (Pfizer BioNTech – Conirnaty, Moderna – mRNA-1273, AstraZeneca – Vaxzevria, Janssen – Ad26.COV 2-S, Beijing CNBG – BBIBP-CorV, Sinovac – CoronaVac) have received WHO Emergency Use Listing – EUL, with efficacy in phase 3 studies reaching 95%. [2] Up to date 17,341,114 vaccine doses have been given in Saudi Arabia, 15,894,908 of them are first doses, while 1,446,237 of them are second doses. [4]

To quantify the efficiency of these vaccinations at the level of the population and in real-world settings in terms of reducing the rate of hospitalizations and deaths from COVID 19 infection, we need large post-licensure epidemiological studies to supplement the results of pre-licensure trials. [4]

Methodology

A retrospective cohort study of 784 hospitalized patients with Covid 19 infection at King Fahad University Hospital (KFUH) between April 2021 and July 2021 was conducted.

Inclusion criteria:

- All adult patients admitted due to COVID-19 infection in KFUH with no prior history of COVID-19 infection regardless of their vaccination status.

Exclusion criteria:

- Pregnant women and children < 18 years old.
- Patients who tested positive for COVID 19 prior to April 2021.
- Patients who were admitted to the hospital for another reason and had an incidental finding of a positive COVID 19 test.

After applying the exclusion criteria to 784 patients and eliminating duplicated cases. 331 individuals were eligible for their data to be utilized in this study.

Data was collected from the medical records stored in the electronic health system at KFUH. A data collection form was utilized to segregate data into different sections. The form included five sections. The first section was concerned with demographic data, including the patient's sex, date of birth, age, and nationality. The second section included the patient's laboratory tests like Complete Blood Count (CBC), Renal Function Test (RFT), lactate dehydrogenase (LDH), inflammatory markers, and D-dimer. The third section was about COVID-19 Severity Data, including the severity of the infection, any complications such as Cytokine Storm, sepsis, Acute Respiratory Distress Syndrome (ARDS), and multi-organ failure. The fourth section was about the outcome of COVID-19 infection, such as hospital admission duration, any need for Intensive care unit (ICU) admission, or ventilation, and any related mortality. The final section was about vaccination information such as the type of the vaccine, number of doses, and the date of the last dose.

Data analysis:

- Data was transferred to an excel sheet and then analysed using the SPSS 26 version.
- Descriptive statistics were performed on both variables, and average was reported for quantitative variables or frequency for qualitative variables.
- Chi square for independent test was used to assess the association between categorical variables.
- The level of statistical significance was set at ($p < 0.05$).

Results

A total of 331 participants were included in the study. (Table 1) presents the Socio- demographic characteristics of these patients. The results showed that 70% of the study participants were aged between 41 and 80 years old. The least aged groups were those less than 20 years old, followed by those who were more than 80 years old. Furthermore, the majority of the study participants were males (58.91%) and (41.09%) were females. Regarding nationality, it can be noted that 62.84% of the study participants were Saudi citizens, whilst 37.16% of the respondents were non-Saudi. In terms of marital status, the majority of the participants were married (58.91%) compared to (39.58%) who were single. The least proportion were the widows constituting 1.51%.

The results of the complete blood count revealed that the percentage of abnormal WBC increased by 16% at the peak time compared to the admission. This was also associated with an increase in the WBC level from admission of 7.62 to the peak of 12.79. Moreover, 81.87% of the study participants showed a normal platelet count compared to 18.13% who had an abnormal level of platelets. Interestingly, two thirds of the study participants had normal levels of neutrophils, 63.85%, and this normal result was seen in the proportion of participants who had normal lymphocyte count 82.17%. This was also associated with normal neutrophil and lymphocyte levels of 1.24 and 1.94, respectively. (Table 2) summarizes the results of the complete blood count.

The results of renal function tests demonstrated that the majority of the study participants had normal blood urea nitrogen levels as 76.73% were allocated within the normal range with an average level of 7.62. It is noted that around half of the study participants had normal creatinine levels of 12.79. Regarding the electrolyte levels, the proportion of patients with normal sodium and potassium levels was identical with a percentage of 75.22% and an average level of 19.05 for sodium and 1.45 for potassium. Similarly, around 65% of the study participants had normal chloride levels with an average CO₂ of 1.13, as reported in (Table 3).

The results of LDH showed that the majority of the study participants (83.98%) had abnormal levels with an average of 451.36. Also, this is associated with abnormal Erythrocyte Sedimentation Rate (ESR) as 79.75% had abnormal levels with an average level of 683.18. In terms of C-Reactive Protein (CRP), 67% of the study participants showed an abnormal range with an average of 53.41. This is also noted in the number of participants who have an abnormal D-dimer of 66.77%, with an average of 67.10. Likewise, ferritin was abnormal in 80.7% of the study participants, with levels of 12.30, as described in (Table 4).

The results obtained from the preliminary analysis of COVID 19 severity data suggested that 78.85% of the study participants had evidence of pneumonia in the chest x ray. Regarding the symptom severity criteria, 36.85% of the participants revealed oxygen saturation less than 93%, while 26% of patients showed lung infiltrates > 50% of the lung field within 24–48 hours of admission. However, Only 6% of the recorded cases had a PaO₂/FiO₂ < 300. Similarly, the results of critical symptom surveillance revealed that 45.71 percent of participants were at high risk of developing cytokine storm due to abnormal ferritin > 600, LDH > 250, or D-dimer > 1, as shown in (Table 5).

It is apparent from this table that the average length of hospital stay is around 10.26 days. The results also highlighted that 27.71% of the study participants needed ICU admission and 10.54% required a mechanical ventilator. The mortality rate was around 7.23% of infected cases, as illustrated in (Table 6).

The findings presented in (Table 7) revealed that two thirds (64.05%) of the study participants did not receive any vaccines. It can also be noted that only 16.8% of the vaccinated individuals received the second dose. Pfizer was the most frequent vaccine type given to the study participants in both the first and second dose. Furthermore, 80% of the study participants received the vaccine more than 14 days before their admission.

The results of comparison between the vaccine information and the COVID 19 outcome suggest that the status of receiving a vaccine has significantly influenced the length of hospital stay as the study participants who did not receive the vaccine reported longer hospital stay (CI 95%, P:0.02). Receiving the vaccine reduced the length of hospitalization by 19.7%. The date of receiving the vaccine was also statistically significant in relation to the incidence of required ICU admission, as those who have received a vaccine for longer than 14 days had fewer ICU admissions compared with their counterparts (CI 95%, P:0.03). The vaccine reduced the mortality rate by 50%, but it was not statistically significant (CI 95%, P:0.16).

The type of vaccine and number of doses did not impact on any of the reported outcomes in the form of need for ICU admission, mechanical ventilator, death, or length of stay as reported in (Table 8)

Discussion

In regards to the demographic factors, the majority of the study participants were males (58.91%), and (41.09%) were females. Likewise, in an observational study of Covid-19 patients hospitalized in Bergamo, Italy, out of 431 adult patients admitted, males constituted the majority of the participants, with a percentage of 72.4%, whereas females constituted 27.6%. [5]

In respect to age, the majority of the study participants were aged between 41 and 80 years old. This was consistent with a cohort done in metropolitan Atlanta and Georgia with 305 hospitalized COVID 19 patients where the median age was 60 years old with an interquartile range between 46–69 years old showing greater propensity for this age group. [6]

In terms of marital status, the majority of the participants were married (58.91%) compared to 39.58% who were single and 1.5% were widows. In contrast, a cross-sectional study was done in Ecuador. It included 9486 participants and showed that in terms of civil status, 39.3% of the participants were single, 38% were married, 13% were cohabitants with their partners, 5.4% were divorced, and 1.3% were widows. [7]

Patients infected with COVID-19 have variations in the symptoms, ranging from asymptomatic status to severe manifestations. Those with a mild type of the disease could have a fever, in addition to sore throat, cough, arthralgia, fatigability, vomiting, and diarrhea. The severe form has a wide range of symptoms, including a respiratory rate of more than 30 breaths per minute, oxygen saturation of 93% in room air, PaO₂/FiO₂ of 300, and lung infiltrates in more than 50% of the lung field. The critical type comprises acute respiratory distress syndrome (ARDS), sepsis, cytokine storm and multi-organ failure. [8]

78.8% of the study participants had evidence of pneumonia in their chest X-ray, 36.8% had o₂ saturation less than 93% in room air, 10.7% had ARDS, 3.5% had sepsis, and 45.7% met the criteria for cytokine storm. In comparison, a meta-analysis of 21 studies with a total of 47,344 patients looking for symptoms and complications of COVID 19 discovered that ARDS risk was 9.4%, kidney injury was 2.1%, and shock was 4.7%. [9]

Another retrospective study was conducted in China to evaluate the severity of symptoms on admission, complications, and outcome in COVID 19 patients. 548 patients were enrolled. The study identified that 49.1% of patients had severe presentations upon admission. Older age, underlying hypertension, high cytokine levels, and high LDH levels were significantly associated with severe COVID-19 on admission. According to the survival analysis, male sex, older age, leucocytosis, high LDH levels, and high-dose corticosteroid use were all associated with death in patients with severe COVID-19. [10]

The severity and mortality rates of COVID 19 vary across different studies. In our study, 27.7% of the participants required ICU admission, 10.5% required mechanical ventilators, with a 7.2% mortality rate. According to a meta-analysis from 37 articles, about one-third of the patients infected with Covid 19 were admitted to the ICU with severe disease features, with mortality exceeding 30% of the total number of patients admitted. [11]

Furthermore, it's speculated that the widespread availability of the vaccine to be associated with a decline in the number of cases admitted to the hospital and to the ICU. In accordance with that, our study displayed that taking the vaccine more than 14 days prior to hospitalization reduced ICU admissions by 82% and receiving a vaccine reduced hospital stay by 19.7%, which demonstrates that vaccines have a tangible influence in decreasing the length of hospitalizations and ICU admissions. A prospective cohort study was done in 2021 in Scotland to explore the association between the widespread distribution of first doses of COVID-19 vaccines and COVID-19 hospitalizations. A total of 1,331,993 individuals were vaccinated during the study duration. The average age of those who had been immunized was 65. The 1st dose of the Pfizer vaccine reduced COVID-19 admission to the hospital by 91% at 28 to 34 days after immunization. During the same period, the AstraZeneca vaccine reduced hospitalizations by 88%. When the study was limited to patients aged 80 and above, the combination of vaccine effects in reducing COVID 19 hospitalization was similar, reaching up to 83 percent at 2834 days post-vaccination. The widespread distribution of the 1st doses of both vaccines was linked to a significant decrease in the frequency of COVID-19-related hospitalization in Scotland, according to the forementioned findings. [12]

In 2021, A case-control study was conducted in England to determine the efficacy of the Pfizer (BNT162b2) vaccine and the AstraZeneca (ChAdOx1) vaccine against confirmed COVID-19 hospitalizations, and deaths in the real world. All individuals in England aged 70 and more were included in the study (over 7.5 million). cases who had received 1 dosage of Pfizer had a 43% lower chance of emergency hospitalization and a 51% lower risk of mortality. Cases who received 1 dose of AstraZeneca vaccine had a 37% lower probability of emergency hospitalization. Due to the vaccine's later introduction, there was insufficient follow-up to examine the AstraZeneca effect on mortality. When the effect against symptomatic illness was considered, one dose of either vaccines was around 80% effective to prevent hospitalization. According to the findings, vaccination with any of the two options was linked to a considerable decrease in symptomatic COVID-19 positive cases in the elderly population with better protection against severe disease. [13]

Conclusion

According to the available literature, there were no studies conducted on the Saudi population to assess the efficacy of vaccination in reducing hospitalization and deaths from COVID-19. Therefore, it is very important to assess the vaccine efficacy in Saudi Arabia to benefit the population in increasing awareness and in reducing severe diseases and deaths.

Limitations And Recommendations

The limitations of our study include the small sample size of eligible patients, which can affect the generalizability of the results. In addition, the study included a specific population of patients from one centre. We recommend multicentric studies in the future with patients from different regions in Saudi Arabia, including rural provisions where lack of immunization awareness may be present.

Abbreviations

Coronavirus disease 2019 (COVID-19), Complete Blood Count (CBC), lactate dehydrogenase (LDH), Blood Urea Nitrogen (BUN), Erythrocyte Sedimentation Rate (ESR), C-reactive protein (CRP), Renal Function Test (RFT), Intensive Care Unit (ICU), World Health Organization (WHO), Acute Respiratory Distress Syndrome (ARDS), King Fahad University Hospital (KFUH).

Declarations

Ethics approval and consent to participate:

Institutional Review Board Committee of Imam Abdulrahman Bin Faisal University approved the study. Confidentiality and anonymity were assured. Written informed consent was obtained from participants. The study protocol is performed in accordance with the relevant guidelines. The IRB number is IRB-2021-01-261. All methods were carried out in accordance with relevant guidelines and regulations. No experiments involving human participants were used in this study.

Consent for publication:

Consent was obtained from Internal medicine department to publish this paper

Data Availability:

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request

Declaration of competing interest:

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Author Contribution:

- Development of Research proposal: Abrar Alwaheed, Danya alkhafaji, Amal Shehab. AISulaiman, Reem Shehab AISulaiman, Ali Alhammad, Hussain Almadan, Abdulmohsen Alelq
- Data collection: All Researchers
- Data entry and analysis: Safi Alqatari, Sarah Alwarthan, Reem Alarqan
- Manuscript preparation: Reem Shehab AISulaiman, Amal Shehab AISulaiman, Ali Alhammad, Hussain Almadan, Huda Bukhari
- Manuscript editing and review: Huda Bukhari, Marwan ALwezah, Sara Alwarthan, Waleed Albaker
- Write draft for Publication: Amal AISulaiman, Reem AISulaiman, Ali Alhammad, Hussain Almadan, Danya alkhafaji

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Author Information

Affiliation:

1. Endocrinology Consultant, Department of Internal Medicine, College of Medicine, King Fahad University Hospital, Khobar, Saudi Arabia

Dania Alkhafaji, Reem Al Argan, Abdulmohsen Alelq, Waleed Albaker,

2. Infectious Disease Consultant, Department of Internal Medicine, College of Medicine, King Fahad University Hospital, Khobar, Saudi Arabia

Huda Bukhari, Marwan Alwazzeah, Sarah Alwarthan

3. Hematology Consultant, Department of Internal Medicine, College of Medicine, King Fahad University Hospital, Khobar, Saudi Arabia

Abrar Alwaheed

4. Rheumatology Consultant, Department of Internal Medicine, College of Medicine, King Fahad University Hospital, Khobar, Saudi Arabia

Safi Alqatari

5. Internal Medicine Resident, Department of Internal Medicine, King Fahad University Hospital, Khobar, Saudi Arabia

Amal ALSulaiman

6. College of Medicine, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia

Reem ALSulaiman, Hussain Almadan, Ali Alhammad

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Tables

Table 1
Sociodemographic Characteristics of
Participants (n = 331)

Characteristics	Frequency	Percentage
Age		
< 20	2	0.60%
20–40	82	24.77%
41–60	140	42.30%
61–80	93	28.10%
> 80	14	4.23%
Gender		
Male	195	58.91%
Female	136	41.09%
Nationality		
Saudi	208	62.84%
Non-Saudi	123	37.16%
Marital Status		
Single	131	39.58%
Married	195	58.91%
Divorce	0	0.00%
Widow	5	1.51%

Table 2
The Results of Complete Blood Count

Test	Frequency	Percentage
WBC on Admission		
Normal	232	70.10%
Abnormal	99	29.90%
WBC on admission (Level)	7.62	4.35
WBC Peak		
Normal	179	54.07%
Abnormal	152	45.92%
WBC Peak (Level)	12.79	2.36
Platelets		
Normal	271	81.87%
Abnormal	60	18.13%
Platelets (Level)	239.0	108.26
Neutrophils		
Normal	212	63.85%
Abnormal	120	36.18%
Neutrophils (Level)	1.24	0.80
Lymphocyte		
Normal	272	82.17%
Abnormal	59	17.83%
Lymphocyte (Level)	1.94	0.95
WBC: White Blood Cell Count		

Table 3
The Results of Renal Function Test

Test	Frequency	Percentage
BUN		
Normal	254	76.73%
Abnormal	77	23.26%
BUN (Level)	7.62	4.35
Creatinine		
Normal	188	56.79%
Abnormal	143	43.20%
Creatinine (Level)	12.79	2.36
Sodium		
Normal	249	75.22%
Abnormal	82	24.78%
Sodium (Level)	19.05	19.36
Potassium		
Normal	249	75.22%
Abnormal	82	24.78%
Potassium (Level)	1.45	2.36
Chloride		
Normal	213	64.45%
Abnormal	118	35.55%
Chloride (Level)	135.44	9.16
CO2	1.13	0.37
BUN: Blood Urea Nitrogen		

Table 4
The Results of Other Laboratory Tests

Test	Frequency	Percentage
LDH		
Normal	63	16.01%
Abnormal	267	83.98%
LDH (Level)	451.36	358.37
ESR		
Normal	67	20.24%
Abnormal	265	79.75%
ESR (Level)	683.18	166.25
CRP		
Normal	109	32.93%
Abnormal	223	67.07%
CRP (Level)	53.41	32.82
D-dimer		
Normal	110	33.23%
Abnormal	222	66.77%
D-dimer (Level)	67.18	49.90
Ferritin		
Normal	65	19.63%
Abnormal	267	80.37%
Ferritin (Level)	12.30	15.95
ESR: Erythrocyte Sedimentation Rate CRP: C-reactive protein LDH: lactate dehydrogenase		

Table 5
The Results of COVID-19 Severity Data

Question	Frequency	Percentage
Is there any pneumonia in the CXR?		
Yes	261	78.85%
No	70	21.15%
What Severe COVID-19 Symptoms does the Patient has?		
Respiratory Rate \geq 30/minute	112	18.18%
Oxygen saturation \leq 93% in room air	227	36.85%
PaO ₂ /FiO ₂ < 300	38	6.17%
Lung infiltrates > 50% of the lung field within 24–48 hour	166	26.95%
No Severe Symptoms	73	11.85%
What Critical Symptoms does the Patient has?		
ARDS	45	10.71%
Sepsis	15	3.57%
Altered level of consciousness	29	6.90%
Multi-organ failure	15	3.57%
Cytokine Storm (one of the following: Ferritin > 600, LDH > 250 or D-dimer > 1)	192	45.71%
No Critical Symptoms	124	29.52%
ARDS: Acute respiratory syndrome PaO ₂ /FiO ₂ : the ratio of arterial oxygen partial pressure (PaO ₂ in mmHg) to fractional inspired oxygen		

Table 6
The Results of COVID-19 Disease Outcome Data

Question	Frequency	Percentage
Length of hospital stay	10.26 days	3.25
Need for ICU admission		
Yes	92	27.71%
No	240	72.29%
Need for mechanical ventilation		
Yes	35	10.54%
No	297	89.46%
Death		
Yes	24	7.23%
No	308	92.77%

Table 7
The Results of Vaccine Information

Question	Frequency	Percentage
Vaccine status		
Received	119	35.95%
Not received	212	64.05%
How many doses?		
First dose	99	83.19%
Second dose	20	16.81%
Type of vaccine first dose		
Pfizer	90	76.63%
AstraZeneca	29	24.37%
Others	0	0.00%
Type of vaccine second dose		
Pfizer	20	62.50%
AstraZeneca	1	3.13%
Others	11	34.38%
Date of last dose		
< 14 days	23	19.33%
> 14 days	96	80.67%

Table 8
Comparison Vaccine information in relation to the COVID-19 disease Outcome Data

Subscale	Need for ICU admission		χ^2	p	Need for mechanical ventilation		χ^2	p	Death		χ^2	P	Length of stay	t	p
	Y	N			Y	N			Y	N					
Vaccine status															
Received	27	92	2.4	0.29	11	108	0.24	0.88	8	111	0.16	0.91	9.08	-1.13	0.02
Not received	63	147			22	188			16	194			11.05		
Number of doses															
One	23	76	0.09	0.97	10	89	0.41	0.52	6	93	0.41	0.52	9.8	0.8	0.2
Two	4	16			1	19			2	18			9.4		
Type of first dose															
Pfizer	23	67	3.5	0.17	8	82	0.17	0.91	7	83	0.69	0.70	9.5	-0.66	0.51
AstraZeneca	4	25			3	29			1	27			10.5		
Type of second dose															
Pfizer	14	55	0.33	0.54	7	56	0.74	0.33	3	67	0.37	0.17	7.8	0.24	0.36
AstraZeneca	13	47			4	45			5	43			8.3		
Date of last dose															
< 14days	86	86	2.9	0.03	1	19	0.73	0.18	2	18	1.16	0.76	9.4	-0.25	0.8
> 14 days	4	4			32	276			0	277			11.02		