

Management of a COVID-19 cluster of cases in a closed nursing healthcare facility after the start of the vaccination program – The role of COVID-19 vaccination

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Abstract

Background: COVID-19 disease has been occupying the scientific community for 20 months with a wealth of data emerging daily on the effectiveness and safety of the various interventions proposed. Vaccination probably represents the most promising intervention.

Methods: A retrospective study was conducted in 45 patients and 59 staff members of a rehabilitation center during an epidemic outbreak. Data from the center's medical records were used to determine vaccination status, positivity for COVID-19 and disease characteristics. Furthermore, the presence of a statistically significant relationship between vaccination status and incidence of the disease as well as of disease characteristics including viral load was examined. The statistical package SPSS v24 was used for the descriptive and statistical analysis.

Results: The mean values of CRP, WBC and lymphocytes at diagnosis were 1.9 mg/dl, 6425/μl and 1303/μl, respectively. Age was statistically significantly related to the severity of the disease. High viral load (CT- cycle threshold <25) was associated with about a 50-time higher death risk ($p < 0.05$). A person fully vaccinated is 19 times more likely not to be infected ($p < 0.001$, vaccination effectiveness of 95%). Furthermore, a negative correlation between vaccination and the presence of infection symptoms ($p = 0.035$) was observed.

Conclusion: Complete vaccination is more likely to protect against the possibility of infection or severe disease. It is important, however, to complete the second dose of the vaccine. On the other hand, measuring antibodies following vaccination does not seem to guarantee immunity and may predispose to dangerous behavior.

Key words: *Vaccine; COVID; viral load; CT (cycle threshold)*

INTRODUCTION

COVID-19 has been proved a major threat to public health provoking worldwide political and economic reactions and is now recognized as one of the 10 largest

pandemics in history. It is currently 6th in deaths (0.07% of the population) and the small percentage is related to the large increase in population in recent decades [1]. Currently, more than 254 million cases have been described with 5 million deaths.

This is a new disease that is being monitored very closely and all information must be published as scientifically as possible so that conclusions can be drawn

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quickly and clearly. Information disclosure (not misinformation) may change the course of this pandemic. More than 200,000 papers have been published since 2020 regarding COVID-19 and more than 17,000 regarding COVID-19 vaccination according to Scopus and PubMed databases.

Various therapeutic interventions have emerged [2,3], but the most promising so far seems to be primary prevention through vaccination of the population [4]. Vaccination is now widespread in Greece, starting from the beginning of 2021. However, there was a lot of skepticism against vaccines, even among medical staff [5,6].

The purpose of this study was to investigate the outbreak of COVID-19 cases in a rehabilitation center and to examine evidence on the preventive effect of vaccination. Furthermore, associations between viral load and severity of the disease were assessed.

METHODS

This is a retrospective study regarding a cluster of cases between March 16 and 30 April 2021. The study population consists of 45 patients and 59 medical, paramedical and other staff of a rehabilitation center in an area with an epidemic outbreak. In this context, the measures taken before the first case are reported and compared to the measures taken after the outbreak of cases. Vaccination status was defined by the relevant certificate, while testing for COVID-19 was based either on rapid Ag tests or PCR test, with all positive Ag tests being confirmed by PCR. Biochemical and clinical parameters of infected individuals were collected from the center's medical files. Viral load was determined by cycle

threshold (CT) in the PCR. We examined all associations between vaccination and the incidence of COVID-19, as well as the outcome and course of the disease. Furthermore, correlation between viral load and disease outcome was examined. The statistical package SPSS v24 was used for the descriptive and statistical analysis.

RESULTS

The study population included a total of 104 people, 45 hospitalized patients (55.6% women, mean age 73.3 years) and 59 staff personnel or attendants (69.5% women, mean age 39.8 years). Participants' characteristics are shown in Table 1.

A total of 23 people were infected with the SARS-CoV-2 (17 patients, 5 staff members and 1 attendant), 7 men (30.4%) and 16 women (69.6%). The mean age of infected individuals was 65 years and that of uninfected individuals was 51.2 years. The descriptive characteristics of the infected group are shown in Table 2, while the original immunity status of the study group can be seen in figure 1.

Within the infected group, 3 (13%) were fully vaccinated (2 staff members and one patient). However, one patient had just been vaccinated with the second dose at the time of diagnosis, so he should be considered as incompletely vaccinated.

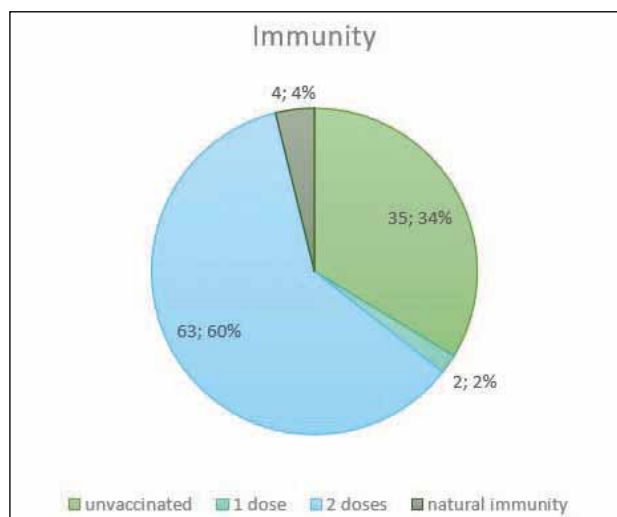
Among the fully vaccinated patients, only 3 (4.9%) tested positive and were all asymptomatic, despite daily exposure to the virus (Table 3). One of them had just been vaccinated with the second dose, in the second patient no antibodies were measured and the third had antibodies more than 150 times above the laboratory limit.

Table 1. Demographics of the study group.

Group	Men		Women		Total	
	No	Mean Age (SD)	No	Mean Age (SD)	No	Mean Age (SD)
Patients	20	68.2 (17.1)	25	77.4 (13.2)	45	73.3 (15.6)
Nursing personnel	13	35.8 (5.1)	22	36.3 (9.9)	35	36.1 (8.4)
Medical personnel	2	47.5 (7.7)	3	39.3 (19)	5	42.6 (14.7)
Kitchen personnel	1	43	5	46.6 (10.6)	6	46 (9.6)
Cleaning personnel	0	0.0	4	50.8 (6.5)	4	50.8 (6.5)
Reception	1	33	4	37.5 (7.8)	5	36.6 (7.1)
Relatives/caregivers	1	28	3	60 (5)	4	52 (16.5)
TOTAL	38	53.4 (20.5)	66	54.8 (21.7)	104	54.3 (21.2)

Table 2. Descriptive characteristics of the infected and non-infected individuals.

	Men		Women		Total	
	No	Mean Age (SD)	No	Mean Age (SD)	No	Mean Age (SD)
Infection	7	54.6 (16.7)	16	69.6 (19.6)	23	65 (19.7)
No Infection	31	53.1 (21.5)	50	50.1 (20.3)	81	51.2 (20.7)

**Figure 1.** Immunity characteristics of the study population (number of persons, percentage).

The total number of cases developed in 3 phases: In the first phase, there was no case isolation (incidents were referred to the hospital for admission) and their relatives could visit them - albeit for a limited time - applying all individual protection measures and hand washing. In the second phase, case-limiting measures were developed with periodic patient and staff testing. In the third phase, many new incident cases were discovered among new admissions from surrounding

hospitals, and thus they remained in isolation for 5 days.

At the beginning of the study period, 5 patients and 1 attendant were found positive. The subsequent follow-up examinations revealed 4 additional patients and 2 staff members. All 12 were unvaccinated. Afterwards, when the measures were fully implemented, 11 more people were found positive, all of them unvaccinated. Testing during admissions yielded 4 positive results. Another 4 patients (all unvaccinated) and 2 nurses (one vaccinated) were found to be positive later on. Furthermore, the doctor of the special isolation wing was tested positive for SARS-CoV-2, although he was fully vaccinated and developed antibodies after his second dose and two weeks before the cluster of cases. After the full implementation of the measures (protection measures, frequent sampling, ban on visits, completion of vaccination of patients and staff), the last positive case appeared 20 days after the first case and the operation of the special ward was suspended 45 days later (from 16 March to 30 April 2021).

In terms of incident tracking, the initial cases were attributed to the hospital of origin or attendants, since the overall control of the staff was negative. Two cases were of unknown origin (frequent contact with each other - one of the two is considered the first case), 8 cases (34.7%) were considered to be of hospital origin or by a companion, 9 individuals (37.1%) were infected by another patient (close contacts) and 4 people (17.4%)

Table 3. Vaccination status in infected and uninfected persons.

			Full vaccination		Total
			No	Yes	
Infection	Yes	People	20	3	23
		% of infected	87.0%	13.0%	100.0%
		% of total	19.2%	2.9%	22.1%
	No	People	19	62	81
		% of infected	23.5%	76.5%	100.0%
		% of total	18.3%	59.6%	77.9%

were estimated to have been infected by staff found positive.

Regarding infected individuals' outcome, from the 23 people, 9 (39.1%) had to be transferred to the hospital, 5 of whom finally died (21.7%). Recovery without the need for hospital admission was achieved in 14 people (60.9%), and 4 people (17.4%) recovered after hospitalization (Figure 2). Age was statistically significantly related ($p < 0.05$) to the severity of the disease (Figure 3).

All patients were administered the same therapeutic regimen with dexamethasone and azithromycin (or respiratory quinolone) on symptoms and only the need

to administer oxygen with a venturi mask $> 35\%$ was an indication for hospital referral, given the heavy load on the health system at that time.

43.5% (10 people) of positive cases were asymptomatic, half of which had received at least 1 dose of the vaccine. More specifically, 3 were fully vaccinated and 2 had received 1 dose of vaccine. Of the 13 who showed symptoms, 92.3% had not been vaccinated and 1 person had received 1 dose of vaccine. Sixteen patients were diagnosed asymptomatic and 5 of them (31.2%) showed symptoms such as fever or desaturation on the 9th day.

The mean values of CRP, white blood cells and lymphocytes at diagnosis were 1.9 mg/dl, 6425/ μ l and 1303/ μ l respectively. Considering all the parameters that showed a statistically significant correlation with the COVID-19 infection, it appears that full vaccination significantly protects against the possibility of infection. A person who is fully vaccinated is 19 times more likely not to be infected than someone who is not vaccinated (b coefficient = 19,478, 95% CI 5,114 to 74,186, $p < 0.001$). Although the sample is small, there is also evidence of a negative correlation of vaccination with the presence of infection symptoms (spearman rho = -0.441, $p = 0.035$).

The maximum viral load, as estimated from the detection cycles in PCR (cycle threshold-CT), seems to show a statistically significant correlation with the probability of death ($p < 0.05$), although the sample is quite small. In fact, considering gender and age, it seems that having a high viral load (CT < 25) is associated with

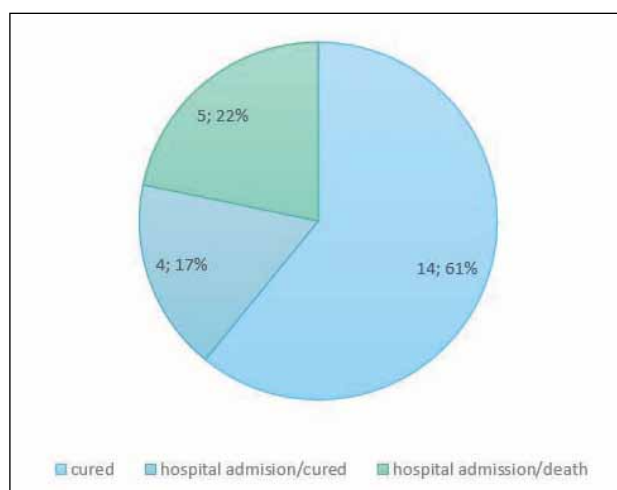


Figure 2. Disease outcome in infected persons (number of persons, percentage).

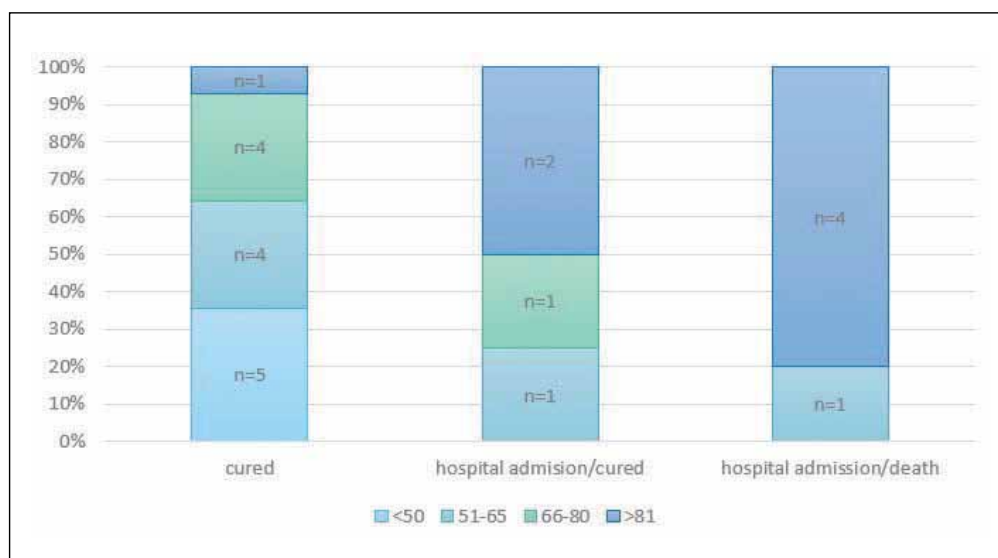


Figure 3. Age and the disease outcome.

an approximately 50-time higher risk of death than the lowest viral load (b coefficient = 48,728, 95% CI 1,061 to 2238,403, $p < 0.05$).

DISCUSSION

At a time of increasing demands from health systems, it is necessary to draw conclusions from the plethora of incidents managed by health facilities at a local level, from both the public and private sector. Since there is much confusion about the quality and type of information provided to the public and health professionals, it is important to disseminate scientifically valid information to the medical community and the public [7–9].

In the present study we were not able to draw clear conclusions about therapeutic interventions, but significant findings emerged regarding vaccination effectiveness. Research has so far shown that vaccination

effectiveness increases with booster vaccination, achieving levels of effectiveness that exceed 90% [10–13]. Protection levels decline several months after vaccination, leading to the possibility of future booster shots. Table 4 presents some of these studies. Vaccination is even more effective regarding symptomatic disease. This study has found similar levels of efficacy, reaching 95% for documented disease and 100% for serious disease needing hospitalization, even though the sample size was rather small. However, an environment of mass exposure to the virus is not easy to find, so this study contributes to the evaluation of vaccine efficacy.

In a closed community such as a rehabilitation center, where there is significant and close contact between medical, nursing staff and patients, the spread of a highly infectious virus would quickly lead to a lockdown of the facility [14]. However, nobody among the vaccinated

Table 4. Effectiveness of mRNA vaccines according to several studies.

	Effectiveness regarding documented infection			
	Effectiveness 14 days after first dose	Effectiveness 14 days after second dose	Effectiveness 42 days after second dose	Effectiveness >69 days after second dose
Bianchi, Francesco Paolo, et al. <i>Vaccines</i> (2021) [10]	97.7%	94.8%	83%	81%
Angel, Yoel, et al. <i>JAMA</i> (2021) [12]		81%		
Dagan, Noa, et al. <i>New England Journal of Medicine</i> (2021) [13]	46%	92%		
Polack, Fernando P., et al. <i>New England Journal of Medicine</i> (2020) [11]	52.4%	94.8%		
Present study		95.4%		
	Effectiveness regarding symptomatic infection			
	Effectiveness 14 days after first dose	Effectiveness 14 days after second dose	Effectiveness 42 days after second dose	Effectiveness >69 days after second dose
Bianchi, Francesco Paolo, et al. <i>Vaccines</i> (2021)[10]	99.2%	97.2%	85%	88%
Angel, Yoel, et al. <i>JAMA</i> (2021) [12]		97%		
Dagan, Noa, et al. <i>New England Journal of Medicine</i> (2021) [13]	57%	94%		
Present study		100%		

persons (patient or staff) appeared to have the disease, and the few who were infected were asymptomatic. All the measures required by the literature and local legislation [15] (personal protection measures, frequent sampling, suspension of visitation, completion of vaccination of patients and staff) played an important role in case control.

A separate explanation could be given for the 3 cases of vaccinated individuals who were found positive. In the first case, the diagnosis was made 1 day after the second dose, therefore it was possible that no antibodies had developed, given the patient's age. In the second case, although no antibodies were measured, the presence of diabetes mellitus could lead to a reduced immune response, which has been reported in the existing literature [16]. The World Health Organization had proposed another type of vaccine than mRNA in patients with diabetes due to a lack of efficacy data in these populations initially [17]. In the 3rd case, that of a doctor, increased exposure to the virus due to the daily examination of patients (the same doctor was in charge of taking the samples in the emergency room) as well as the fact that, due to the increased demands and needs of the patients, he had to change protective equipment several times during the day in order to examine patients. These procedures reasonably increase the likelihood of error, despite adequate training and knowledge. Studies have shown that the nursing staff became infected in 80% of cases when the uniform was removed [18]. At this point, the illusion of the protection of the vaccine should be emphasized, since the development of a high titer of antibodies could lead to a lack of vigilance.

The use of cycle thresholds in PCR was not associated with the duration of positivity but seems to be related to the severity of the disease, as other studies have shown in the past [19], making it a useful tool, especially in the elderly.

In conclusion, the most important result of the study is that the application of complete vaccination significantly protects against the possibility of infection or severe disease. Vaccinated people were found to be about 20 times less likely to become infected while none were significantly ill in the study population. It is important, however, to emphasize that full protection is achieved 10 days after the 2nd vaccine dose. On the other hand, measuring antibodies following vaccination does not appear to guarantee immunity and may predispose to careless or even dangerous behavior.

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