Anti-Spike Antibody Level Following COVID-19 Vaccine 4 Doses in Patients on Maintenance Hemodialysis in Government Hospital, Myanmar

Khin Phyu Pyar[1]*, Sai Aik Hla[2], Kyaw Thu Yein Lwin[3], Win Kyaw Shwe[3], Lay Maung Maung[4], Ye Min Hein[4], Lynn Htet Aung[4], Myo Min Thant[4], Myo Maung Maung[4], Moe Htun Zaw[4], Zar Ni Htet Aung[5], Nyan Lin Maung[5], Sai Su Phone[5], Kyaw Zay Ya[5], Aung Phyoe Kyaw[5], Zay Phyo Aung[5], Myo Thant Kyaw[5], Zaw Lin Oo[5], Sit Min[5], Kaung Myat Oo[6] and Myat Ko Ko[6]

[1]Professor and Head/ Senior Consultant Physician and Nephrologist, Department of Medicine/Nephrology, Defence Services Medical Academy/ No. (1) Defence Services General Hospital (1000-Bedded), Yangon, Myanmar

[2]Senior Consultant Physician, No. (1) Defence Services General Hospital (1000-Bedded), Yangon, Myanmar

[3]Consultant Nephrologist, Department of Nephrology, No. (1) Defence Services General Hospital (1000-Bedded), Yangon, Myanmar

[4]Nephrology Fellow, Department of Nephrology, Defence Services Medical Academy, Yangon, Myanmar

[5]Consultant Physician, No. (1) Defence Services General Hospital (1000-Bedded), Yangon, Myanmar

[6]Pathologist, No. (1) Defence Services General Hospital (1000-Bedded), Yangon, Myanmar

*Corresponding author: Khin Phyu Pyar, Professor and Head/ Senior Consultant Physician and Nephrologist, Department of Medicine/ Nephrology, Defence Services Medical Academy/ No. (1) Defence Services General Hospital (1000-Bedded), Yangon, Myanmar

Abstract

Background: Patients with end stage renal disease (ESRD) on maintenance hemodialysis (ESRD on MHD) are at high risk of contracting SARS-CoV-2 and developing severe COVID-19 infection. An altered immunologic response to COVID-19 vaccines was reported in this population. This study aimed to assess the level of anti-Spike antibody 2 weeks after 4 doses of COVID-19 vaccine in patients on MHD.

Methods: A cross-sectional descriptive study was conducted in August 2022 among patients with ESRD on MHD who received COVID-19 vaccine 4 doses; last dose was 2 weeks ago. Data were collected by using standardized forms and analysis was done.

Results: A total of 61 patients with ESRD on maintenance hemodialysis (ESRD on MHD) were included; all patients had raised anti-Spike antibody level; the median anti-Spike antibody level was 3912 U/mL. The mean age was 51.15 ± 12.85 years. The older age group (over 50 years) had higher anti-Spike antibody level than younger age group (less than 50 years), 4175.5 U/mL and 3024.5 U/mL respectively. Mean BMI (dry weight) was 19.93 ± 2.83 kg/m2. Anti-Spike antibody level was highest in normal BMI group 4117 U/mL; 3180 U/mL in overweight group; and, the lowest 1680 U/mL in underweight group. This study included male 26 (42.6%) and female 35 (57.4%); no difference in anti-Spike antibody level between male (3928 U/mL) and female (3912 U/mL). Nearly 70% of them had history of COVID-19 infection and they had higher anti-Spike antibody level (4400 U/mL) than those without infection (2355 U/mL). Those with diabetes mellitus had significantly higher anti-Spike antibody level (11,935 U/mL) than those without diabetes mellitus (3,155 U/mL). Anti-Spike antibody level in smokers (3149 U/mL) was lower than that of non-smoker (4059 U/mL). Those who got vaccinated in the morning had higher antibody level (4232 U/mL) than who got in the afternoon (3003 U/mL). Antibody response decreased with falling hemoglobin; mild anemia (4232 U/mL); moderate anemia (3103.5 U/mL); and severe anemia (1680 U/mL). Presence of diabetes mellitus was the only significant predictor for anti-Spike antibody level on univariable analysis.

Conclusions: All patients with ESRD on MHD had raised anti-Spike antibody level 2 weeks after 4 doses of COVID-19 vaccine and the level was not inferior to that of health care worker. Those with diabetes mellitus had higher level of anti-Spike antibody. Anti-Spike antibody level was relatively higher in age over 50 years; normal BMI; non-smokers; near normal hemoglobin; shorter duration of HD less than 6 months; those with past history of COVID-19 infection; and those who got vaccination in the morning.

Keywords: Anti-Spike protein antibody; COVID-19; vaccination; end stage renal disease (ESRD); maintenance hemodialysis (MHD)

Introduction

Vaccine program has been launched in Myanmar since January 2021; Covaxin and Covishield are the only two main vaccines available initially. Later, Sinopharm, Sinovac, Sputnik, Pfizer, Moderna, Johnson and Johnson has been accessible. Patients with end stage renal disease on maintenance hemodialysis (ESRD on MHD) are in priority group for immunization as their immunity is low. First, two doses of vaccine were given with the interval of 4-6 weeks; first dose in January/February 2021 and second dose in March/April 2021. Third and fourth doses were given in December 2021 and June 2022 respectively. In Myanmar, nearly half of the population got two doses August 2022 [1].

Vaccine stimulates the individual to produce protective antibody level. It begins few days after vaccination; then, the level continues to rise till 6 months. Vaccination elicits robust SARS-CoV-2-specific immune memory regardless of prior infection. The protective antibody response, both quantity and quality, was better in vaccinated individuals than that of natural infection [2]. The combination of a previous SARS-CoV-2 infection and vaccination, hybrid immunity, had the greatest protection against SARS-CoV-2 infections [3,4] as well as the longest duration of protectivity [5,6]. The protective antibody response can be measured with anti-Spike antibody level 2 weeks after vaccination till 6 months.

In uremia, both anemia and bone marrow suppression step down the immune system; impaired renal function was reported as independent risk factor for acquiring severe COVID-19 infection and mortality [7]. Patients on MHD had high mortality because they had other comorbid conditions: age, diabetes mellitus, anemia, hypertension, ischemic heart disease and cerebro-vascular disease [7,8]. In addition, they were vulnerable to COVID-19 infection as they had to travel to the dialysis center two to three times per week; they exposed to patients with asymptomatic COVID-19 infection and health care workers. Not only the immunity but also the antibody response was related with renal function; those with chronic kidney disease stage 5 (ESRD) had poorer response than those with stage 4 [9]. The immune response following COVID-19 vaccine in patients on MHD was generally comparable to healthy population in some studies [10-12]. On the other hand, lower immune response was found in others [13].

Reported clinical predictors of antibody positive response toward COVID-19 vaccination were age, previous infection [14],

immunosuppressive therapy, body mass index, iron deficiency anemia [15,16] and serum albumin level [14]. Longer vintage of end-stage kidney disease, and lower pre-vaccination serum albumin were related with response to vaccine in patients on MHD [17]. In addition, the time of the day of vaccination determined antibody response because of circadian clocks in the adaptive immune response [18]. The antibody response related with the time of day of vaccination, vaccine type, age, sex, and days post-vaccination [19]; antibody level was higher in those who received vaccine in the afternoon than those who were vaccinated in the morning [19]. Therefore, the data on the anti-Spike antibody which directly reflected the protective efficacy of 4 doses of COVID-19 vaccine in patients on MHD was required in Myanmar. Therefore, this study aimed to assess the level of the anti-Spike antibody to 4 doses of COVID-19 vaccine among patients on MHD in Yangon, Myanmar.

Methods

Study design and population

A cross-sectional descriptive study was conducted in August 2022. Patients on MHD who had 4 doses of COVID-19 vaccine, the last dose at least 2 weeks ago were included after getting informed consent. This study was approved by the Hospital Research and Ethics Committee of No. (1) Defence Services General Hospital (1000-Bedded) Mingaladon, Yangon.

Data collection and procedure

Demographic characteristics (sex, age, height, dry weight, smoking status, vintage of MHD, comorbidity (hypertension, diabetes mellitus) and nutritional status (hemoglobin, serum albumin) were collected using a standardized case report form. They received the same type of COVID-19 vaccine and they were doing HD in the same HD center. The name of each COVID-19 vaccine, date of each vaccination, timing of the day of vaccination of the last dose, timing of SARS-CoV-2 infection, and blood level of anti-Spike antibody were recorded. The data were checked by two medical officers and then, supervision, completeness, and consistency of collected data were performed by the principle investigator.

Anti-Spike antibody was measured according to 'Double-antigen sandwich principle'. Total duration of assay was 18 minutes. For first incubation, 20 μL of sample, biotinylated SARS CoV 2 S RBD specific recombinant antigen and SARS CoV 2 S

RBD specific recombinant antigen labeled with a ruthenium complex) were done to form a sandwich complex. Then, second incubation was performed after addition of streptavidin-coated microparticles, the complex becomes bound to the solid phase via interaction of biotin and streptavidin. The reaction mixture was aspirated into the measuring cell where the microparticles were magnetically captured onto the surface of the electrode. Next, unbound substances were removed with ProCell/ProCell M. Later, application of a voltage to the electrode to induce chemiluminescent emission was done; it was measured by a photomultiplier. Finally, the results were determined via a calibration curve, instrument specifically generated by 2 point calibration; and, a master curve was provided via the reagent barcode or e barcode. These samples were measured by using Cobas E411 immunoassay analyzer.

Working definition

Body mass index (BMI) was a person's weight in kilograms divided by the square of height in meters, nan indicator of body fatness. BMI was categorized as underweight (< 18.5 kg/m2), normal weight (18.5 to 24.9 kg/m2), overweight (25.0 to 29.9 kg/m2) and (≥ 30.0 kg/m2) obese. Dry body weight was taken for calculation of BMI. Comorbidity was a presence of more or additional medical conditions or diseases in COVID-19 patients. Smoking status was classified into smoker and non-smoker. Smoker was defined if patient was still smoking at the time of estimation of blood test irrespective of duration of smoking. Nonsmoker was defined if patient stopped smoking at the time of estimation of blood test irrespective of duration of quitting.

History of COVID-19 infection was defined if patient had signs and symptoms of COVID-19 infection with positive nasopharyngeal swab tests either with rapid test or PCR method. Vaccination in the morning was defined if vaccination was done from 08:00 hour to 12:00 hour; vaccination in the afternoon was defined if vaccination was done from 12:00 hour to 18:00 hour. Duration of maintenance hemodialysis was defined as total duration since first HD. Hemoglobin was normal if ≥11gm%; mild anemia was defined if hemoglobin was 8-10.9 gm%; moderate anemia was defined if hemoglobin was 6-7.9 gm% and, severe anemia was defined if hemoglobin was < 6 gm%. Serum albumin was normal if it was more than 30 mg% and was low if it was less than 30 mg%.

Statistical analysis

Total samples of 61 patients taking MHD were analyzed by SPSS version 26.0 for MacOS. Descriptive statistics was done, continuous variables were assessed normality by Shapiro-Wilk test. Normally distributed data were expressed as mean±SD and non-normal data were expressed as Median (IQR). Categorical data were expressed in frequency and percentage. Antibody differences between group variables were assessed by Mann-Whitney U test and Kruskal Wallis test. Univariable and multivariable analysis was used by linear regression model. The significant level, alpha was set as p value<0.05.

Results

A total of 61 patients on MHD doing hemodialysis at renal unit of Defence Services General Hospital, Yangon were included. Table 1 showed baseline characteristics of patients on maintenance hemodialysis. Mean age was 51.15 ± 12.85 years; male to female ratio was 4:6 (26 male and 35 female). Mean BMI was 19.93 ± 2.83 kg/m2. Ten patients (16.4%) had having type 2 diabetes mellitus; twelve patients (19.7 %) were smokers. Forty patients (65.5 %) had history of covid 19 infection; median duration from last vaccination was 39 (IQR, 3) days. Forty-three patients (70.5 %) were vaccinated in the morning and 18 patients (29.5 %) in the afternoon. Median (IQR) anti-Spike antibody level was 3912 (5300) U/mL.

Table 1: Baseline characteristics of patients on MHD (n=61).

Variables	n (%)	Mean ± SD	Median (IQR)
Age		51.15 ± 12.85	
Age groups			
≤ 50 years	32 (52.5)		
> 50 years	29 (47.5)		
BMI (kg/m²)		19.93 ± 2.83	
BMI groups			
Underweight	15 (24.6)		
Normal weight	44 (72.1)		
Overweight	2 (3.3)		
Sex			
Male	26 (42.6)		
Female	35 (57.4)		
History of COVID-19 infection	40 (65.6)		
Diabetes mellitus	10 (16.4)		

Smoking	12 (19.7)	
Vaccine doses		
5 doses	0 (0)	
4 doses	61 (100)	
Timing of vaccination		
Morning	43 (70.5)	
Afternoon	18 (29.5)	
Duration from last infection (days)		404 (151)
Duration from last vaccine (days)		39 (3)
Anti-Spike Ab level (U/mL)		3912 (5300)

Table 2 revealed anti-Spike antibody level and age groups in patients on MHD. Median (IQR) anti-Spike antibody level in older age group (patients>50 years of age) was higher than that of younger age group (patients with age≤50 years): 4175.5 (4894) U/mL vs 3024.5 (5375) U/mL. It was not statistically significant (z=-0.549, p=0.583). Anti-Spike antibody level and sex is shown in Table 3. Median (IQR) anti-Spike antibody levels were 3928 (5678) U/mL in male and 3912 (5364) U/mL in female; there was no significant difference between sex, (z=-0.496, p=0.620). Table 4 demonstrated anti-Spike antibody level among different BMI groups in patients on MHD. The patients with normal weight had the highest median anti-Spike antibody level, 4117 (6698) U/mL; those with underweight had lowest level, 1680 (6443) U/mL; those with overweight was 3180 U/mL; and they were not statistically significant (z=2.948(2), p=0.229).

Table 2: Anti-Spike antibody level and age groups in patients on MHD (n=61).

Age groups	Median (IQR)	Z statistics (df)	*p* value*
≤ 50 years	3024.5 (5375)	-0.549	0.583
> 50 years	4175.5 (4894)		

Table 3: Anti-Spike antibody level and sex in patients on MHD (n=61).

Sex	Median (IQR)	Z statistics (df)	p value*
Male	3928 (5678)	-0.496	0.62
Female	3912 (5364)		

Table 4: Anti-Spike antibody level among different BMI groups in patients on MHD (n=61).

BMI groups	Median (IQR)	Z statistics (df)	p value*
Underweight	1680 (6443)		
Normal weight	4117 (6698)	2.948 (2)	0.229
Overweight	3180		

Table 5: Anti-Spike antibody level and previous COVID-19 infection in patients on MHD (n=61).

Previous COVID-19 infection	Median (IQR)	Z statistics (df)	p value*
Yes	4400 (5284)	-1.701	0.089
No	2355 (4250)		

Anti-Spike antibody level and status of previous COVID-19 infection are revealed in Table 5. The patients with previous covid-19 infection had higher median anti-Spike antibody level, 4400 (5284) U/mL than the patients without previous infection 1680 (6443) U/mL; however, it was not statistically significant (z=-1.701, p=0.089). Table 6 illustrated anti-Spike antibody level and diabetes mellitus. The patients with type 2 diabetes mellitus had significantly higher median anti-Spike antibody level, 11935 (9309) U/mL than those without type 2 diabetes mellitus 3155 (4489) U/mL, (z=-2.261, p=0.024). Table 7 showed anti-Spike antibody level and status of smoking. Non-smokers had higher median anti-Spike antibody level (4059 U/mL) than smokers (3149 U/mL) although it was not statistically significant (z=-0.472, p=0.637). Table 8 revealed anti-Spike antibody level and vaccination injection time of day. The patients who got last vaccination in the morning had higher median anti-Spike antibody level (4232 U/mL) than who got vaccinated in the afternoon (3003 U/mL); however, it was not statistically significant (z = -1.693, p = 0.090). Table 9 demonstrated anti-spike antibody level and duration of HD. Those with shortest duration of HD had highest anti-spike antibody level (4909.5 U/mL) though

there was no relation between duration of HD and antibody level. In Table 10, anti-spike antibody level and hemoglobin level are shown. Anti-spike antibody level decreased with falling hemoglobin: 4232 U/mL in those with mild anemia (8-10.9 gm%); 3103.5 U/mL in those with moderate anemia (6-7.9 gm%); and 1680 U/mL in those with severe anemia (<6 gm%). The serum albumin level was normal (≥ 30 mg%) in all patients.

Table 6: Anti-Spike antibody level and diabetes mellitus in patients on MHD (n=61).

Type 2 Diabetes	Median (IQR)	Z statistics (df)	p value*
Yes	11935 (9309)	-2.261	0.024
No	**3155 (4489)**		

Table 7: Anti-Spike antibody level and status of smoking in patients on MHD (n=61).

Smoking	Median (IQR)	Z statistics (df)	*p* value*
Yes	3149 (4406)	-0.472	0.637
No	4059 (6940)		

Table 8: Anti-Spike antibody level and vaccination injection time of day in patients on MHD (n=61).

Time of the day vaccination	Median (IQR)	Z statistics (df)	*p* value*
Morning	4232 (7621)	-1.693	0.09
Afternoon	3003 (4932)		

Table 9: Anti-spike antibody level and duration of dialysis in patients on MHD (n=61).

HD Duration	Frequency (%)	Median (IQR)
< 6 months	20 (32.8)	4909.5 (6837)
6 months to 1 year	8 (13.1)	2036.5 (2870)
1 to 2 years	12 (19.7)	1943.5 (3374)
2 to 3 years	7 (11.5)	4895.9 (6155)
3 to 4 years	13 (21.3)	4660.0 (9526)
> 4 years	1 (1.6)	371

Table 10: Anti-Spike antibody level and hemoglobin level in patients on MHD (n=61).

Hb (gm%)	Number (percent)	Median Anti-spike antibody level (IQR)	Remark
Normal (≥11gm%)	3 (4.9)	3681	
Mild anemia (8-10.9 gm%)	31 (50.8)	4232 (9539)	
Moderate anemia (6-7.9 gm%)	20 (32.8)	3103.5 (12129)	
Severe anemia (<6 gm%)	7 (11.5)	1680 (2421)	
Total	61 (100)	3912 (5300)	

Independent predictors for spike antibody level in patients on MHD is demonstrated in Tables 11-13. Presence of diabetes was the significant predictors for anti-Spike antibody level in patients on MHD both in univariable analysis (β = 4187.08, p = 0.003, adjusted R2 = 0.125) and in multivariable analysis (β = 4160.63, p = 0.005, adjusted R2 = 0.112). The anti-Spike antibody level was not associated with age (β = 23.32, p = 0.583, adjusted R2 = -0.012), sex (female) (β = -328, p = 0.764, adjusted R2 = -0.015), smoking status (β = -469.57, p = 0.606, adjusted R2 = -0.006), history of covid infection (β = -1069.98, p = 0.432, adjusted R2 = -0.015), duration from last vaccination (β = 90.50, p = 0.595, adjusted R2 = -0.012) and vaccination time (afternoon) (β = -1816.73, p = 0.123, adjusted R2 = 0.024). Anti-spike antibody level was neither related with hemoglobin nor serum albumin.

Table 11: Anti-Spike antibody level and serum albumin level in patients on MHD (n=61).

Serum albumin (gm%)	Number (percent)	Median Anti-spike antibody level (IQR)	Remark
Normal (≥ 30 mg%)	61 (100)	3912 (5300)	
Low albumin (< 30 mg%)	0		
Total	61 (100)	3912 (5300)	

Table 12: Independent predictors for spike antibody level in patients in patients on MHD (n=61).

Predictors	Univariable			Multivariable		
	β	Adjusted R^2	*p* value	β	Adjusted R^2	*p* value
Age	23.32	-0.012	0.583			
Sex (Female)	-328.37	-0.015	0.764			
BMI	153.38	-0.006	0.426			
Diabetes mellitus	4187.08	0.125	0.003	4160.63	0.112	0.005
Smoking	-469.57	-0.006	0.606			
History of COVID-19 infection	-1069.98	-0.015	0.432			
Duration from last vaccination	90.5	-0.012	0.595			
Time of the day vaccination	-1816.73	0.024	0.123			

Table 13: Association of hemoglobin, total protein, albumin and globulin with anti-spike antibody level in patients with maintenance hemodialysis.

Parameters	*rho* value	*p* value
Hb	0.18	0.166
Total Protein	0.022	0.866
Albumin	0.121	0.354
Globulin	-0.122	0.35

Discussion

A total of 61 patients on MHD doing hemodialysis at renal unit of Defence Services General Hospital, Yangon were included. All patients (100%) had raised anti-Spike antibody level 2 weeks after receiving 4 doses of COVID-19 vaccine (Covaxin, Covishield, Sinopharm, Sinovac); median (IQR) anti-Spike antibody level was 3912 (5300) U/mL. The mean (SD) of antibody level in health care worker after 4 doses in same study area was 3734.19±2470.43 U/mL [7]. Therefore, anti-Spike antibody level of patients on MHD was not different from that of health care worker. It was contrary to previous report that nearly 90% patients on MHD had antibody response [20,21]. It was hard to confirm the fact "the antibody level in patients on MHD was lower than that of age and sex matched population" [20] because age and sex were not matched.

In this study, anti-Spike antibody level in older age group (4175.5 U/mL) was higher than that of younger age group 3024.5 (5375 U/mL; however, it was not statistically significant. The difference may be more pronounced if age was classified at 60 years rather than 50 years. It was contrary to former reports; antibody responses decreased with increasing age in normal population as well as patients on MHD [20]. The degree of immune response varies with the functional status of kidney. Several reports mentioned that antibody response decreased with falling renal function; those with CKD Stage 5 had lower response than those with Stage 4. On the other hand, the immune response following vaccination in patients with chronic kidney disease stage 4 and 5, and those on dialysis were almost comparable [10,11]. In this study, all patients were on MHD (Stage 5); therefore, relation between CKD Stage and antibody response could not be seen.

Historically, males and females have shown different reactions to vaccines of many kinds [22,23]. In few reports, female had higher antibody response [24,25]. On the other hand, men had significantly higher efficacy of vaccine in one study [26]. Nevertheless, anti-Spike antibody levels in both sexes were almost the same in this study. The patients with normal BMI had the highest median anti-Spike antibody level, 4117 (6698) U/mL in this study. The patients with underweight had lowest level, 1680 (6443) U/mL and that of overweight was 3180 U/mL Relation between BMI and antibody response had several controversial points. Antibody response in severe obesity (BMI > 40) was related with type of vaccine in one study where the antibody titers against SARS-CoV-2 spike antigen after CoronaVac and BNT162b2 vaccines was analyzed among different body weight. Their finding was "those vaccinated with BNT162b2 were found to be significantly higher than those vaccinated with CoronaVac" [27]. Low antibody response was seen in people with central obesity in one study [28]. The study from UK mentioned that Covid-19 vaccine effectiveness was comparable across all BMI categories; however, increased risks of severe COVID-19 outcomes for people with underweight or obesity when compared with a healthy weight [29]. The study from Myanmar, antibody response was positively related with BMI in health care worker [30]. The patients with previous covid-19 infection had higher median anti-Spike antibody level, 4400 U/mL than the patients without previous infection 1680 U/mL; it confirmed the former reports though statistically not significant in this study [14,31]. This finding was similar to that of normal population; infected vaccinated participants had superior antibody levels across time compared to naïve-vaccinated people [32-34]. The effect was pronounced with booster doses and also protection

against variants- the Omicron [6,35].

Diabetes mellitus was well known for poor immunity, prone to both bacterial and viral infections. It was found to be independent risk factor for severity/morbidity of COVID-19 infection as well as mortality. In this study, patients with type 2 diabetes mellitus had significantly higher anti-Spike antibody level, 11935 U/mL than those without type 2 diabetes mellitus 3155 U/mL. Presence of diabetes mellitus was the significant predictors for anti-Spike antibody level in patients on MHD both in univariable analysis and in multivariable analysis. Most of the studies reported diabetics had low antibody response to COVID-19 vaccine; a few found the reverse [30]. Though variables such as age, type of diabetes, BMI, glycemic control, eGFR, type of vaccine, numbers of administered doses, and re-vaccination intervals were affecting the antibody response, the immunogenicity of the vaccines was low in patients with diabetes mellitus compared to healthy controls [36-38]. Non-smokers had higher median anti-Spike antibody level, 4059 U/mL than smokers 3149 U/mL in this study. It gave another evidence that smokers had low antibody response [28,39,40]. The patients who got last vaccination in the morning had higher median anti-Spike antibody level, 4232 U/mL than who got vaccinated in the afternoon 3003 U/mL; it neglected the circadian response of T cell to vaccination [18,19, 41-45].

In this study, those with shortest duration of HD had highest antibody level; however, there was no significant relation between duration of HD and anti-spike antibody level. Longer vintage of ESRD was related with response to vaccine in some report [17]. "Longer dialysis time resulted in higher maximum antibody titers" reported from the study done in Japan [20]. Nutritional status plays a role in immunity. Hemoglobin and serum albumin level generally reflect nutritional status. Lower pre-vaccination serum albumin determined the antibody response in patients on MHD [17]; nevertheless, all patients in this study had normal serum albumin. Low hemoglobin level was one of the predictors of morbidity and mortality in COVID-19 infection. In this study, anti-spike antibody level decreased with falling hemoglobin: 4232 U/mL in those with mild anemia; 3103.5 U/mL in those with moderate anemia, and 1680 U/mL in those with severe anemia. Nearly half of them had iron deficiency anemia; therefore, it provided the previous evidence "iron deficiency limits adaptive immunity and responses to COVID-19 vaccines" [15,16, 46-50].

Limitation of the Study

Because of low resource setting, there were several limitations. The sample size was small in this study. Future larger studies are required particularly relation between anti-Spike antibody level and its co-founders particularly diabetes mellitus. Moreover, serial estimation of anti-Spike antibody level on monthly basis would be helpful to determine exact timing of peak level and lowest level, the best timing for booster doses. In addition, the study should also include both cellular and humoral responses following vaccination [51-55].

Conclusion

Patients with ESRD on MHD had 100% antibody response 2 weeks after 4 doses of COVID-19 vaccine. Their antibody level was not lower than that of health care workers who received 4 doses. Anti-Spike antibody level was relatively higher in non-smokers; normal BMI; those with less anemia; those with HD duration of less than 6 months; those with past COVID-19 infection; and those who got vaccination in the morning although it was not significant statistically. Anti-Spike antibody level was significantly related with diabetes mellitus; patients with ESRD on MHD with diabetes mellitus had higher level of antibody.

Recommendation

Personal protective measures like wearing masks are most important in prevention of COVID-19 infection. Vaccination should be prioritized to risk group; those on MHD particularly in incenter-hemodialysis. Attention should be more to the vulnerable: smokers; abnormal BMI; anemia; and, longer HD duration of more than 6 months. Vaccination should be given in the morning to enhance circadian response.

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Declaration of Conflict of Interest

The authors declared no potential conflicts of interests with respect to authorship and publication of this article.

Ethical Approval

This study was approved by Hospital Research and Ethic Committee from Defence Services General Hospital (1000-Bedded) Mingaladon, Myanmar. Informed consent was also taken from each patients on MHD.

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