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Jana Preis *

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Research Article

Effect of Covid19 Pandemic on Preventive Vaccinations Among Patients with The End Stage Kidney Disease At New York Harbor VA Medical Center

Christopher Alessandro [1], Naveera Arif [1], Ruoyu (Luie) Wang [1], Marc Ganz [1], Menachem Jacobs [1], Dan Viderman [2], Jana Preis [3]*, Natalie Viderman [4]

[1] 4th year medical student, SUNY Downstate College of Medicine, NY, USA.

[2] freshman student, University of Michigan at Ann Arbor, MI, USA.

[3] Chief of Medical Service, Northport VA Medical Center, Northport, NY, USA.

[4] Sophomore at Hunter College High School, NYC, USA.

***Corresponding Author:** Jana Preis, Chief of Medical Service, Northport VA Medical Center, Northport, NY, USA.

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Abstract:

Background: The COVID-19 pandemic revealed challenges and barriers in achieving high preventive vaccination rates. This study aimed to explore the effects of the pandemic on vaccination rates in patients with end stage kidney disease (kidney dialysis) patients in New York City. These patients compose a challenging cohort as their transplant optimization includes routine vaccinations including pneumococcal, flu, Hepatitis A and B, meningococcal, H flu, HPV, Tdap, RZV, and Covid.

Materials and Methods: This study population consisted of 142 participants from two Veteran Affairs hospitals in New York City. Vaccination and demographic information were compiled via EMR and compared to long term US vaccination rates using exact binomial tests. Secondary analysis using generalized estimating equations was used to compare vaccination rates pre- and post-pandemic within the Brooklyn VA population controlling for demographic variables.

Results: The combined vaccination rate for the post-pandemic period was found to be significantly lower than the pre-pandemic rate in the general US population for several vaccines, including Hepatitis A (CI: 0.088, 0.098; $p<0.001$), Influenza (CI: 0.68, 0.69, $p<0.001$), Meningococcal (CI: 0.34, 0.35; $p<0.001$), MMR (, CI: 0.51, 0.52; $p=0.001$), and TDAP (CI: 0.18, 0.20; $p<0.001$). Secondary analysis using generalized estimating equations controlling for age, race, and time on dialysis within the Brooklyn VA population revealed increases in post-pandemic vaccination rates for Shingles (subunit; B=1.03; 95% Wald CI: .178, 1.87; p=.018) and Hepatitis B (B=-.739; 95% Wald CI: .084, 1.39; p=.027), while a significant decrease was observed for Hep A (B=-2.65; 95% Wald CI: -4.4, -.90; p=.003).

Conclusion: This data demonstrates that post-pandemic vaccination rates in VA dialysis patients is lower than the past 10-year US average for several vaccines including Hepatitis A, Influenza, Meningococcal, MMR, and TDAP. Mixed effects of pre- and post-pandemic vaccination rates within the Brooklyn VA were also found with a decreased vaccination rate for Hepatitis A, and increased rates for Shingles and Hepatitis B. Further study is needed to evaluate pandemic's effect on these rates, disease prevention, and identify the reasons contributing to vaccine hesitancy vs. acceptance.

Key words: pandemic; COVID19; vaccination; transplants; compliance; hemodialysis

Introduction

The outbreak of COVID-19 had a significant impact on the field of medicine which affected protocols, treatments, and preventative measures such as vaccination for chronic disease [1]. One of the main challenges to achieving high vaccination rates in the United States is vaccine hesitancy, which refers to a reluctance or refusal to be vaccinated. Vaccine hesitancy can be caused by multiple factors including misinformation, mistrust of the medical establishment, and poor access to healthcare [2]. Although there are recognized side-effects of vaccination such as myocarditis, their widespread reporting and misinformation surrounding severity have contributed to vaccination hesitancy [3]. Systemic issues in vaccination adherence have been exacerbated by the pandemic, with approximately a quarter of the population of high-income countries with access to vaccines being unsure or unwilling to receive the COVID-19 vaccines [2].

The nature of the pandemic impact on vaccination rates is an area of active research and is perhaps especially pertinent to patient populations with compromised immune status, such as transplant candidates who experience significant delays in obtaining the necessary operations and decreased overall quality of care [4]. Kidney transplantation is among the most common solid-organ transplants worldwide [5]. Live donor transplantation has become the optimal treatment for kidney failure as it offers improved quality of life and reduced mortality at lower costs to healthcare and in comparison, to maintenance dialysis [6]. Vaccination is crucial in optimizing kidney transplant candidates, as it helps protect these immunocompromised patients from vaccine-preventable diseases (VPDs) and improves their chances of successful transplantation [7]. Patient optimization in preparation for receiving transplants involves patients being up to date with vaccination series, including pneumococcal, flu, Hepatitis A and B, meningococcal, H flu, HPV, Tdap, RZV, and Covid vaccines [8, 9].

From 2010 to 2016, rates of adherence to vaccination series in the United States were robust, with vaccination rates maintaining 80.4% for DT, DTP3, or DTaP, 92.5%, Polio, 90.8%, MMR, 80.0%, Haemophilus influenzae type b (Hib), 91.4%, Hep B, 90.3% for one or more doses of Varicella, 81.4% for four or more doses of PCV, and 69.7% for the combined 7-vaccine series [10]. Vaccination rates have decreased globally since the inception of the COVID-19 pandemic. The COVID-19 pandemic has significantly impacted healthcare systems worldwide, leading to disruptions in routine care and vaccination programs [11-13].

The VA population also has a high burden, especially in the context of the COVID pandemic. A study done on the VA population (n=1,178) found that 71% of Veterans (n=1,178) reported not wanting to get vaccinated for COVID [14]. The main reasons included skepticism (36%), concerns about side-effects (20%), preferred using few medications (19%), preferring to wait as the vaccine was new (22%), and distrust of the healthcare system (18%) [14]. These perspectives may suggest a distrust of healthcare, as well as a lack of widespread education about the vaccine in this population. It would be helpful to see how the pandemic changed skepticism in this community and if these veterans already had low rates of vaccination before the pandemic ever touched the nation.

This study aims to investigate the effects of the COVID-19 pandemic on the vaccination rates among kidney transplant candidates in two Veteran Affairs (VA) hospitals in New York City and compare them to the pre-pandemic vaccination rates in the general United States population.

Materials and Methods

The study population consisted of kidney dialysis patients from two Veteran Affairs (VA) hospitals in New York City, the Brooklyn VA and Manhattan VA. Inclusionary and exclusionary criteria were created based on authors' discretion. Inclusionary criteria included adults who have been on dialysis since prior to the beginning of the COVID pandemic in New York, March 20, 2020. Data was collected from electronic medical records including age, gender, and race. Vaccination history and time on dialysis was also collected. Exclusionary criteria included death before initiation of data gathering and patients no longer receiving dialysis at the VA hospitals. Vaccine information was obtained for the following vaccines: MMR, Varicella, Shingles (live), Shingles (subunit), Hepatitis B, Pneumo, Influenza, TDAP, Hep A, HPV, and Meningo. These vaccines were chosen as they are necessary for kidney transplant optimization [8, 9]. Pre-pandemic vaccination doses were cut off to 1.5 years prior to March 20, 2020. Post-pandemic vaccination doses were cut off an equivalent 1.5 years after March 20, 2020. These periods were selected to create a balanced comparison of vaccination pre- and post-pandemic as data gathering initiated 1.5 years after the beginning of the pandemic.

Data analysis included descriptive statistics to summarize demographic and clinical characteristics of the study population. The primary analysis used exact binomial tests to compare post-pandemic vaccination rates among the combined Brooklyn and Manhattan VA populations to pre-pandemic vaccination rates in the general US population. Secondary analysis was done within the Brooklyn VA population due to increased data availability. Chi-squared tests were used to compare vaccination rates before and after the start of the pandemic within the Brooklyn VA population. Logistic regression using generalized estimating equations was calculated to determine rates of vaccination before and after the beginning of the COVID-19 pandemic while controlling for age, race, and time on dialysis in the Brooklyn VA. The regression coefficient (B) and 95% Wald Confidence Intervals were used to interpret the results of the logistic regression. Statistical significance was set at $p<0.05$. All statistical analyses were conducted using R version 4.0.3 (15).

Results

Post-pandemic rates of vaccination were combined from the Brooklyn and Manhattan VA populations. There were 142 participants in total (98% male) with an average age of 69. Participants were dialysis patients within the Brooklyn and Manhattan VA hospitals who passed the inclusionary and exclusionary criteria. The population was 79% African American, 8% White, and 13% Other. Participants had a combined vaccination rate of: 51.4% for MMR, 57.7% for Shingles, 82.4% for Hep B, 68.3% for Influenza, 19.0% for TDAP, 9.2% for Hep A, 26.1% for HPV, and 34.5% for Meningococcal vaccines. These values were compared to 10-year pre-pandemic vaccination rates of the general United States population using exact binomial tests. The general population had a pre-pandemic vaccination rate of: 65% for MMR, 52% for Shingles, 82% for Hep B, 91% for Influenza, 83% for TDAP, 42% for Hep A, 26% for HPV, and 74% for Meningococcal vaccines. Vaccination rates in the combined VA group compared to the general United states population were less for Hepatitis A ($p<0.001$, CI: 0.088, 0.098), Influenza ($p<0.001$, CI: 0.68, 0.69), Meningococcal ($p<0.001$, CL: 0.34, 0.35), MMR ($p=0.001$, CI: 0.51, 0.52), and TDAP ($p<0.001$, CI: 0.18, 0.20). There was no significant difference in vaccination rates of Hepatitis B ($p=1$, CI: 0.82, 0.83), HPV ($p=1$, CI: 0.26, 0.27), and shingles ($p=0.17$, CI: 0.57, 0.58).

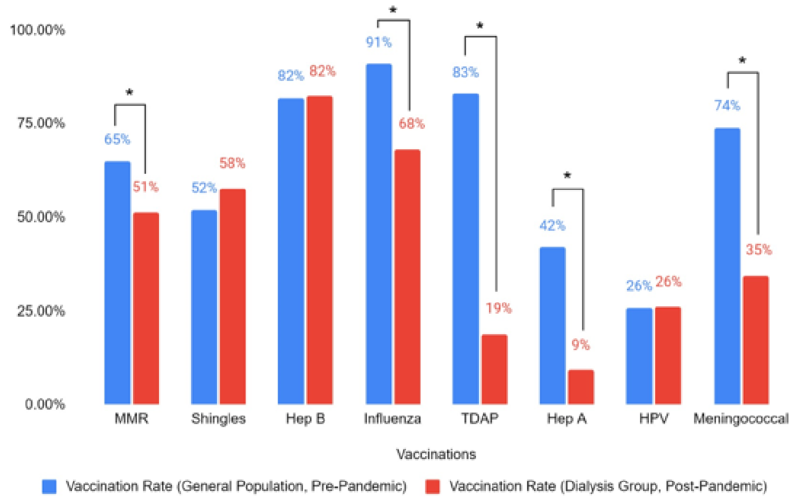

Figure 1: Exact binomial tests comparing vaccination rates pre-pandemic in the general United States population (blue) to post-pandemic vaccination rates for dialysis patients within the Brooklyn and Manhattan VA hospitals (red). Asterisks signify $p<0.05$.

Secondary analysis was performed within the Brooklyn VA. Chi Squared analysis was used to compare vaccination rates before and after the beginning of the COVID-19 pandemic in New York (March 1, 2020). Additionally, a logistic regression using generalized estimating equations was calculated to determine rates of vaccination before and after the beginning of the COVID-19 pandemic controlling for age, race, and time on dialysis in the Brooklyn VA. Vaccines in this secondary analysis include MMR, Varicella, Shingles (live), Shingles (subunit), Hepatitis B, Pneumo, Influenza, TDAP, Hep A, HPV, and Meningo. Several vaccines had equivalent pre- and post- pandemic values, and they were excluded from analysis. The final analysis includes Shingles (subunit), Hepatitis B, Influenza, TDAP, and Hep A vaccines. Post-pandemic vaccination rates decreased for Hep A (OR=.077; CI: .009, .634; p=.003). Rates of shingles (subunit; OR=2.6; CI: .73, 9.3; p=.130), Hep B (OR=2.0; CI: .83, 4.9; p=.12), Influenza (OR=1.7; CI: .686, 4.3; p=.248), and TDAP (OR=1.4; CI: .554, 3.5; p=.49) did not differ pre- and post- pandemic.

Using generalized estimating equations, patients' age, race, and time on dialysis was controlled when determining changes in pre- and post-pandemic vaccination rates. Using this method, Shingles (subunit; B=1.03; 95% Wald CI: .178, 1.87; p=.018) and Hep B (B=.739; 95% Wald CI: .084, 1.39; p=.027) were found to have higher vaccination rates post-pandemic. Hep A (B=-2.65; 95% Wald CI: -4.4, -.90; p=.003) was found to have a lower post-pandemic vaccination rate. Influenza (B=.59; 95% Wald CI: -.23, 1.4; p=.16) and TDAP (B=.332; 95% Wald CI: -.39, 1.0; p=.36) did not have significantly different rates.

Vaccine	Vaccination Rate (General Population, Pre-Pandemic)	Vaccination Rate (Dialysis Group, Post-Pandemic)	Confidence Interval	p-value
MMR	65%	51%	(0.51, 0.52)	0.001
Shingles	52%	58%	(0.57, 0.58)	0.17
Hep B	82%	82%	(0.82, 0.83)	1
Influenza	91%	68%	(0.68, 0.69)	<0.001
TDAP	83%	19%	(0.18, 0.20)	<0.001
Hep A	42%	9%	(0.088, 0.098)	<0.001
HPV	26%	26%	(0.26, 0.27)	1
Meningococcal	74%	35%	(0.34, 0.35)	<0.001

Table 1: Exact binomial tests comparing vaccination rates pre-pandemic in the general United States population ("Vaccination Rate (Population)") to post-pandemic vaccination rates for dialysis patients within the Brooklyn and Manhattan VA hospitals ("Vaccination Rate (Dialysis Group)").

Vaccine	Regression Coefficient (B)	95% Wald Confidence Interval	p-value
Shingles (subunit)	1.03	(0.178, 1.87)	0.018
Hepatitis B	0.739	(0.084, 1.39)	0.027
Influenza	0.59	(-0.23, 1.4)	0.16
TDAP	0.332	(-0.39, 1)	0.36
Hep A	-2.65	(-4.4, -0.9)	0.003

Table 2: Secondary analysis using generalized estimating equations compared vaccination rates pre- and post-pandemic. This analysis controlled for age, race, and time on dialysis within the Brooklyn VA population. Positive regression coefficients indicate higher post-pandemic vaccination rates and, conversely, negative regression coefficients indicate lower post-pandemic vaccination rates.

Discussion

Vaccination is an essential component of the optimization process for kidney transplant candidates [7]. This study aimed to evaluate whether the COVID-19 pandemic has influenced the vaccination rates among the kidney transplant candidates. Our primary results indicated that the post-pandemic vaccination rates among the kidney transplant candidates in the combined VA group are significantly less than the 10-year pre-pandemic vaccination rates in the general U.S. population for Hepatitis A, Influenza, Meningococcal, MMR and TDAP. There were no significant differences in the vaccination rates of Hepatitis B, HPV, and shingles. Secondary analysis via the Chi-squared test revealed that among the kidney transplant candidates in Brooklyn VA, the vaccination rate for Hepatitis A significantly decreased after the pandemic, while the vaccinations rates for Shingles, Hepatitis B, influenza and TDAP remained comparable pre- and post- pandemic. After controlling for the patient's age, race and time on dialysis, post-pandemic vaccination rate for Hepatitis A remains significantly decreased in kidney transplant candidates. However, the vaccination rates for Shingles and Hepatitis B increased significantly post-pandemic while the vaccination rates for Influenza and TDAP remained comparable pre- and post-pandemic.

The finding of significant decrease in post-pandemic vaccination rates among the kidney transplant candidates compared to pre-pandemic rates in the general U.S. population is consistent with prior studies that report a similar decline. A study by McDonald and colleagues found that the vaccination rates for childhood vaccines, especially the MMR vaccine, had an overall decline pattern in England during the first 15 weeks of 2020 [11]. Similar declines in childhood vaccination rates have also been observed in many countries including the United States, Scotland, Israel and Indonesia [3, 11-13, 16]. A report that compares Michigan's vaccination rates in May 2020 with 2016-2019 has found a sharp decrease in vaccination rates for all vaccines recommended between the age of birth to 24 months, except the initial dose of Hepatitis B, which is often given in the hospital shortly after birth [13]. The California Department of Public Health also reported a greater than 40% decrease in pediatric vaccinations in April 2020, compared to the same period in the previous year [17].

Although these studies are targeting a different population than our study, the reasons contributing to the decline in vaccination rates may be similar. In order to minimize the spread of COVID-19 and the burden on the healthcare system, different countries have implemented a variety of public health measures, such as social distancing, lockdown, suspension of vaccine campaigns, and stay-at-home orders [3, 13]. While beneficial for the prevention and control of COVID-19, these measures also decreased people's accessibility to vaccines and led to delay in routine care. Furthermore, other factors, such as diversion of medical resources from non-emergent care and the fear of COVID-19 exposure could have also made it harder for people to get routine vaccines [2]. In the United States, Hepatitis A vaccine is recommended before traveling to endemic areas [18]. It's possible that the travel restriction imposed during the pandemic also contributed to our finding of decreased post-pandemic Hepatitis A vaccination in the secondary analysis.

From the authors' perspectives, it would be reasonable to think that in adults, the vaccines that require relatively frequent reinjection, such as the influenza vaccine, would be more affected by the pandemic and thus have decreased vaccination rates. However, it is not necessarily the case in kidney transplant candidates. Compared to the general U.S. population before the pandemic, the kidney transplant candidates have significantly decreased post-pandemic vaccination rates for not only Hepatitis A and influenza, but also MMR, Meningococcal, and TDAP vaccines. While the decrease in Hepatitis A vaccine can also be potentially explained by travel restriction, the decrease in the vaccination rates for MMR, Meningococcal and TDAP requires further explanation, as they are generally recommended before adulthood in the United States and does not require frequent reinjection after the only dose is given, or first series is completed. For example, the MMR vaccine is recommended to be administered as a 2-dose series (at 12-15 months, and then age 4 to 6) and does not require additional booster. Our findings may suggest that the significant difference between the vaccination rates in kidney transplant candidates and the general U.S. population is not a result of the COVID-19 pandemic, but rather a reflection of a pre-existing vaccine disparity from long before the pandemic. This is especially concerning as these routine vaccines are not only important for the immunocompromised kidney transplant candidates, but also as a required part of their optimization process for the transplant. The delay or lack of vaccination is thus creating a barrier for kidney transplant, which can be the ultimate treatment for end stage renal disease in these patients. Interestingly, after controlling for demographic factors and time on dialysis, the vaccination rates for Shingles and Hepatitis B have significantly increased post-pandemic in this group. The high rates for Shingles may be attributed to it being a single dose in adulthood, compared to others that must be continuously checked and updated due to multiple doses. Regarding the Hepatitis B vaccine series, despite being a multi-dose series, it may have higher rates due to the smaller period of time between each dose compared to those of Hepatitis A or MMR [19]. These trends also demonstrate that other variables, such as racial background or accessibility to vaccines, may also impact a patient's preference for which vaccines they are willing to take. Overall, our results demonstrate that the effort to improve vaccination rates in kidney transplant candidates may require a comprehensive approach that possibly involves both vaccine education and systematic policy changes.

There are many possible barriers to vaccination that can be especially prevalent in this population compared to the general United States population. For example, ongoing medical treatment and chronic medical conditions are associated with lower vaccination rates partially due to less opportunities for vaccination [20, 21]. Additionally, these patients are more likely to receive care from specialized physicians who may be less likely than primary providers to suggest vaccination [20]. Under vaccination is also prevalent in older populations such as this one, as our population had an average age of 69 years. Although older adults are more susceptible to vaccine preventable diseases, target vaccination rates are often not met due to people's attitudes and beliefs regarding vaccinations, questioning about vaccine safety and effectiveness, perceived susceptibility to disease, and not being aware of a need for vaccination. Improvement in vaccination rates can occur with public educational campaigns and by introducing communication between this at-risk population and healthcare providers regarding risks and benefits of vaccination, especially given their immunocompromised state [20, 21].

There are several limitations in our study. First, we have a relatively small sample size, which may not be representative of the larger population and thus, limit the generalizability of our results. Additionally, this study only looked at two VA hospitals in New York City, and the results may not be applicable to kidney transplant candidates at other hospitals or in other regions. The primary results of the study focused on the previous 10-year vaccination rates in the general population compared to the post-pandemic rates in the VA dialysis population. To be most representative, the 10-year vaccination rate would come from a similar cohort from the VA and/or dialysis population. Additionally, there is a question of comparing the 10-year vaccination rates to not only post-pandemic, but also pre-pandemic values as this can further inform to what degree the pangemic had on vaccination rates. However, pre-pandemic vaccination rates were not available from the Manhattan population, so this analysis was not done.

Conclusion

This study demonstrated an overall decrease in post-pandemic vaccination rates among the kidney transplant candidate's pre-pandemic vaccination rates in the general U.S. population. These findings highlight the need for improved vaccination education and policies targeting kidney transplant candidates, who may have lower vaccination rates compared to the general population due to pre-existing disparities exacerbated by the pandemic. Thus, the impact of the COVID-19 pandemic on vaccination rates among kidney transplant candidates is made clear through this study, underscoring the need for targeted efforts to improve vaccination access and utilization in this vulnerable population. Future studies should aim to identify the underlying reasons for low vaccination rates in this population and develop interventions to improve vaccination rates.

Conflicts of interest

No conflicts reported

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