

A Mobile Health–Based Survey to Assess COVID-19 Vaccine Intent and Uptake Among Patients on Dialysis



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Received 18 September 2021; revised 29 November 2021; accepted 6 December 2021; published online 13 December 2021

Kidney Int Rep (2022) 7, 633–637; <https://doi.org/10.1016/j.ekir.2021.12.006>

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INTRODUCTION

Patients with kidney failure on dialysis suffer high rates of COVID-19–associated hospitalizations and mortality.^{1–3} Vaccination is crucial to mitigate the risks of COVID-19, but concerningly, 1 in 5 patients receiving in-center hemodialysis are vaccine hesitant.^{4,5} Recent studies in the general population have shown that COVID-19 vaccine intent may change in an individual over time,⁶ suggesting that vaccine intent may not perfectly correlate with vaccine uptake.

In this study, we assessed the longitudinal relationship between COVID-19 vaccine intent and uptake among patients on dialysis, which has not been previously described. To assess COVID-19 vaccine intent, we conducted a mobile health (mHealth)–based survey which is a scalable, low-cost, and acceptable mode of survey administration for patients on dialysis.^{7–9,S1}

We examined whether patient demographics, employment status, marital status, neighborhood social vulnerability, and dialysis-related medical history were associated with vaccine intent and uptake (Supplementary Methods). To measure neighborhood social vulnerability, we used census tract-level Social Vulnerability Index, a composite of 15 census indicators of socioeconomic status, household composition and disability, minority status and language, and housing type and transportation.^{S2,S3}

We hypothesized that patients with social risk factors, including unemployed individuals, racial/ethnic minorities, and those living in neighborhoods with

greater social vulnerability, would be less likely to have vaccine intent and uptake related to social disadvantage.^{S4} We also hypothesized that vaccine uptake would be lower than vaccine intent because of access-related barriers, and patients with social risk factors would be less likely to successfully convert their vaccine intent into vaccine uptake.

RESULTS

Survey Respondents

Of 1465 patients on dialysis, 1055 had listed cell phone numbers in the electronic health record. The 1055 patients were sent the mHealth–based survey via text message to assess COVID-19 vaccine intent (Supplementary Figure S1); 47 returned with errors (e.g., unreachable or landline number). Of the remaining 1008 patients, 310 responded to the survey (response rate 31%). Two participants died before vaccines were widely available, leaving 308 participants in the analysis of vaccine intent and uptake. Respondents were a median age of 61 years and majority male (60%) and on in-center hemodialysis (78%).

Predictors of Vaccine Intent and Uptake

A total of 242 of 308 (79%) participants intended to get the COVID-19 vaccine, and 66 of 308 (21%) did not. Younger, Black, or Hispanic participants and those residing in more socially vulnerable census tracts were less likely to have COVID-19 vaccine intent in unadjusted analyses (Supplementary Table S1). In

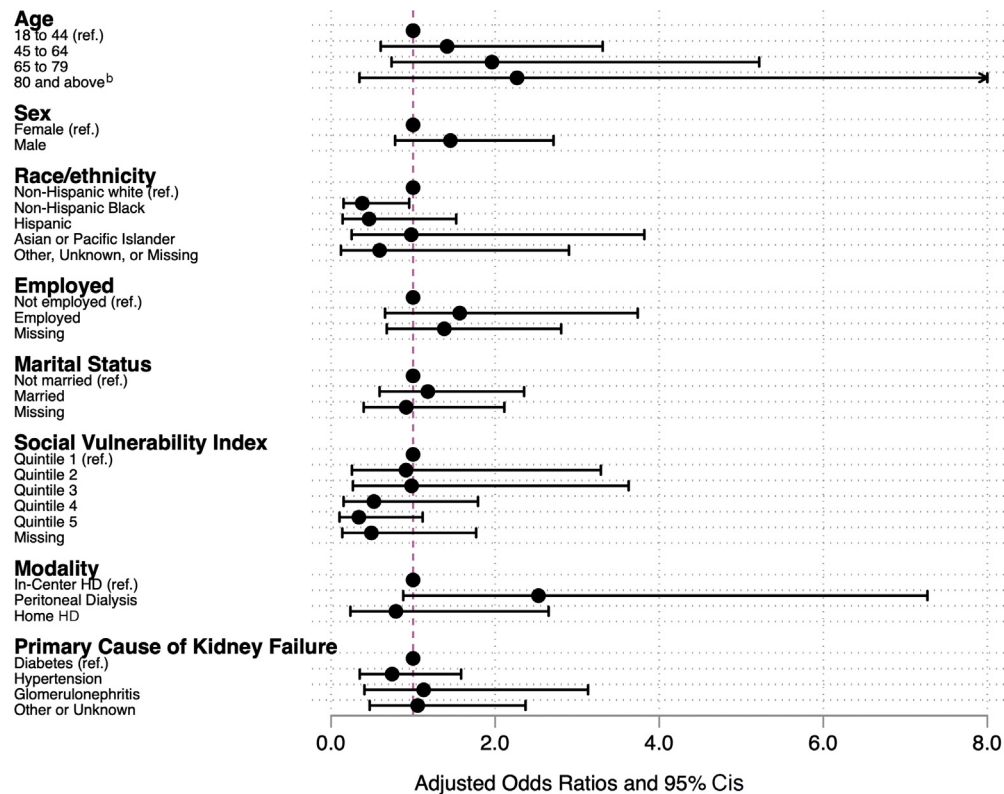


Figure 1. Predictors of COVID-19 vaccine intent,^a multivariable model ($N = 308$). ^aResponse to the question: “An FDA-authorized vaccine for COVID-19 (coronavirus) will soon be available to you for free. Will you get the COVID-19 vaccine? Reply “1” for Yes or “2” for No.” Multivariable logistic regression adjusted for age categories, sex, race/ethnicity, employment status, marital status, Social Vulnerability Index quintile, dialysis modality, and primary cause of kidney failure. ^bUpper limit of CI truncated. FDA, Food and Drug Administration, HD, hemodialysis; Ref., reference.

multivariable adjusted analyses, non-Hispanic Black participants (adjusted odds ratio 0.38, 95% CI 0.15–0.95) were less likely to have vaccine intent than non-Hispanic White participants (Figure 1). Age, sex, employment status, marital status, census tract-level Social Vulnerability Index, dialysis modality, or cause of kidney failure was not statistically significantly associated with vaccine intent in adjusted analyses.

Among the 242 participants with COVID-19 vaccine intent, 225 (93%) had vaccine uptake, and 17 (7%) did not get the vaccine. Patients aged 18 to 44 years were less likely to ultimately receive the COVID-19 vaccine, compared with older age groups ($P = 0.001$; Table 1). Of the 66 participants who did not intend to get the vaccine, 44 (67%) had vaccine uptake, and 22 (33%) did not. Older patients without initial vaccine intent were more likely to receive the COVID-19 vaccine, compared with younger patients ($P = 0.04$; Supplementary Table S2).

Across all mHealth-based survey respondents, younger, Black, unemployed, and single participants were less likely to have COVID-19 vaccine uptake in unadjusted analyses (Supplementary Table S3). In multivariable adjusted results, younger age was

statistically significantly associated with lower vaccine uptake, with participants aged 18 to 44 years (adjusted odds ratio 0.23, 95% CI 0.09–0.58) less likely to have vaccine uptake compared with those aged 45 to 64 years. Other sociodemographic and clinical characteristics were not associated with vaccine uptake in adjusted analyses (data not shown). Clustering standard errors at the dialysis facility level did not meaningfully change results.

DISCUSSION

In this cohort study of patients on dialysis in a New York City-based dialysis organization, 79% of survey respondents intended to get the COVID-19 vaccine. Contrary to our hypothesis, vaccine uptake (87%) was higher than vaccine intent. Among patients who were initially vaccine hesitant (no vaccine intent), 67% went on to receive the vaccine. Younger age and social risk factors, including race/ethnicity and neighborhood social vulnerability, were associated with lower vaccine intent and uptake.

Our study is the first, to our knowledge, to longitudinally follow patients on dialysis and

Table 1. Characteristics of participants with positive vaccine intent, by vaccine uptake ($n = 242$)

Characteristic	Vaccine intent, vaccine uptake $n = 225, n (\%)$	Vaccine intent, no vaccine uptake $n = 17, n (\%)$	<i>P</i> value
Sociodemographics			
Age (yr)			
18–44	17 (8)	7 (41)	0.001
45–64	97 (43)	7 (41)	
65–79	89 (40)	3 (18)	
≥80	22 (10)	0 (0)	
Sex			
Male	141 (63)	9 (53)	0.446
Female	84 (37)	8 (47)	
Race/Ethnicity			
Non-Hispanic White	82 (36)	3 (18)	0.083
Non-Hispanic Black	78 (35)	10 (59)	
Hispanic	21 (9)	1 (6)	
Asian or Pacific Islander	36 (16)	1 (6)	
Other, unknown, or missing	8 (4)	2 (12)	
Employment			
Full-time or part-time	52 (23)	3 (18)	0.591
Retired (age)	39 (17)	2 (12)	
Retired (disabled)	41 (18)	2 (12)	
Unemployed	17 (8)	3 (18)	
Homemaker, medical leave, or student	10 (4)	0 (0)	
Missing	66 (29)	7 (41)	
Marital status			
Married	96 (43)	4 (24)	0.155
Divorced or separated	19 (8)	2 (12)	
Widowed	14 (6)	0 (0)	
Single	55 (24)	4 (24)	
Missing	41 (18)	7 (41)	
Census tract-level SVI ^a			
Quintile 1	46 (23)	3 (19)	0.519
Quintile 2	44 (22)	2 (13)	
Quintile 3	42 (21)	2 (19)	
Quintile 4	36 (18)	3 (19)	
Quintile 5	28 (14)	5 (31)	
Dialysis-related medical history			
Modality			
In-center hemodialysis	172 (76)	12 (71)	0.325
Peritoneal dialysis	43 (19)	3 (18)	
Home hemodialysis	10 (4)	2 (12)	
Primary kidney failure cause			
Diabetes	73 (32)	7 (41)	0.847
Hypertension	56 (25)	4 (24)	
Glomerulonephritis	28 (12)	2 (12)	
Cystic kidney disease	11 (5)	0 (0)	
HIV	2 (1)	0 (0)	
Malignancy	5 (2)	1 (6)	
Posttransplant	21 (9)	2 (12)	
Other or unknown	29 (13)	1 (6)	

SVI, Social Vulnerability Index

^aAmong patients with nonmissing SVI. Higher quintile of SVI indicates greater neighborhood social vulnerability.Percentages may not add to 100% because of rounding. *P* values presented for Fisher exact tests for categorical variables.

examine the relationship between vaccine intent and uptake. Our results highlight that vaccine hesitancy is a dynamic phenomenon and can change in a given individual amidst evolving circumstances. This suggests the need for ongoing patient-oriented interventions among individuals with kidney failure who currently remain vaccine hesitant. After receiving the survey, many patients asked questions about the vaccines and vaccine

availability, suggesting that similar surveys could be used as tools to stimulate conversations and shared decision-making.

Our findings are concordant with the health belief model, a widely used framework that identifies 6 factors influencing health-related behaviors: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy.⁵⁵ For example, we consistently found that younger

patients were less likely to have vaccine intent and uptake, perhaps because of lower perceived severity of COVID-19 or lower perceived benefits from the vaccine. Of note, in March 2021 during the study period, vaccines became available and were distributed to dialysis facilities for administration during dialysis, which likely minimized perceived barriers and increased vaccine uptake. Being offered the vaccine during dialysis and seeing other patients receive the vaccine may have served as cues to action prompting vaccine acceptance, particularly for patients who did not initially intend to get the vaccine.

We found that patients with social risk factors were less likely to have vaccine intent and uptake, which informs efforts to target interventions toward these vulnerable subpopulations. The sociodemographic variables that we investigated capture all 5 dimensions of social risk factors, as outlined in a conceptual framework by the National Academies of Sciences, Engineering, and Medicine: (i) socioeconomic position, (ii) race, ethnicity, and cultural context, (iii) gender, (iv) social relationships, and (v) residential and community context.^{S4} Our analysis suggests that race/ethnicity and residential and community context were the most predictive of vaccine intent and uptake among patients on dialysis. An nationwide analysis by Garcia *et al.*⁴ also found racial disparities in COVID-19 vaccine intent among patients on in-center hemodialysis, whereas Bowman *et al.*^{S6} did not find racial/ethnic differences in vaccine uptake in a dialysis organization in Virginia. Reasons cited for vaccine hesitancy among patients on hemodialysis include lack of trust, the desire for more information, lack of confidence in vaccine efficacy, and concerns about safety and side effects.^{4,S7,S8} Given the significant racial/ethnic disparities in COVID-19 incidence and mortality among patients with kidney failure,^{1,S9,S10} equitable vaccine deployment is crucial to prevent further exacerbation of disparities seen with COVID-19. Our results showing that the majority of vaccine hesitant individuals on dialysis ultimately had vaccine uptake lend credence to continued efforts to counsel patients about the COVID-19 vaccine.

Our results have several limitations. Our study was limited to patients with listed cell phone numbers in the electronic health record, which may have contributed to selection bias. While we found that text messaging was a feasible mode of survey administration among patients on dialysis, our survey was very short, and thus, future studies are needed to confirm feasibility of mHealth-based survey administration in the dialysis population. Our sample size was relatively

modest and may have had limited power to detect statistically significant predictors of vaccine intent and uptake. The high vaccine intent and uptake seen in our survey respondents may not be fully generalizable to all dialysis patients because of selection bias. However, an analysis of vaccine uptake in another dialysis organization in Virginia showed similarly high vaccine uptake.^{S6}

In summary, we found that vaccine uptake was higher than vaccine intent, with the majority of vaccine hesitant patients ultimately having vaccine uptake. Our findings highlight that vaccine intent is dynamic and modifiable, calling for the targeted delivery of interventions to address vaccine hesitancy in this vulnerable population.

DISCLOSURE

SLT reports receiving consulting fees for Bayer AG and funding from Scanwell Health, unrelated to the submitted work. FL is currently involved in clinical trials involving HHD devices sponsored by CVS and Outset Medical; has participated in advisory boards with Medtronic Inc., Quanta Dialysis Technologies Ltd., and Janssen Pharmaceutical; had a speaking arrangement with Janssen Pharmaceutical and has received honoraria from NxStage; is a medical advisor for Accordant; and is a member of the American Society of Nephrology (ASN) Quality Committee. VS has received speaking honoraria from Baxter and is a member of the ASN COVID-19 Home Dialysis Sub-Committee. MRT reports receiving equity in Iris OB Health and consulting with Boston Scientific. JS reports receiving consulting fees from Alkermes, Bayer AG, and Kaneka, unrelated to this work, and co-chairs the American Society of Nephrology COVID-19 Response Team and Emergency Partnership Initiative. All the other authors declared no competing interests.

ACKNOWLEDGMENTS

SLT is supported by funding from the Weill Cornell Medicine Dean's Diversity and Healthcare Disparity Research Award, National Institute of Diabetes and Digestive and Kidney Diseases F32DK122627, and the National Kidney Foundation Young Investigator Grant. The funders had no role in the study design, manuscript preparation, or decision to submit the article for publication.

AUTHOR CONTRIBUTIONS

SLT and JS conceptualized the study; DML and TSP performed data queries; SLT performed statistical analysis; all authors interpreted the results; SLT drafted the paper; SAI and JS provided supervision; all authors revised the

manuscript for important intellectual content and approved the final version of the manuscript.

SUPPLEMENTARY MATERIAL

[Supplementary File \(PDF\)](#)

Supplementary Methods.

Supplementary Reference.

Table S1. Characteristics of Survey Respondents with and without COVID-19 Vaccine Intent (N = 308).

Table S2. Characteristics of Participants without Vaccine Intent, by Vaccine Uptake (n = 66).

Table S3. Characteristics of Respondents with and without COVID-19 Vaccine Uptake (N = 308).

Figure S1. Mobile Health Survey Text Messages.

STROBE Statement.

REFERENCES

1. United States Renal Data System (USRDS). 2020 annual data report: epidemiology of kidney disease in the United States. USRDS. Accessed July 1, 2021. <https://adr.usrds.org/2020/>
2. US Department of Health and Human Services. Office of the Assistant Secretary for Planning and Evaluation. Advancing American kidney health: 2020 progress report. US Department of Health and Human Services, Office of the Assistant Secretary for Planning and Evaluation. Accessed July 1, 2021. <https://aspe.hhs.gov/pdf-report/advancing-american-kidney-health-2020-progress-report>
3. Ziembra R, Campbell KN, Yang TH, et al. Excess death estimates in patients with end-stage renal disease - United States, February-August 2020. *MMWR Morb Mortal Wkly Rep.* 2021;70:825–829. <https://doi.org/10.15585/mmwr.mm7022e2>
4. Garcia P, Montez-Rath ME, Moore H, et al. SARS-CoV-2 vaccine acceptability in patients on hemodialysis: a nationwide survey. *J Am Soc Nephrol.* 2021;32:1575–1581. <https://doi.org/10.1681/ASN.2021010104>
5. Andrian T, Koppe L, Novel E, et al. COVID-19 vaccine acceptance amongst hemodialysis patients: a French survey. *Clin Kidney J.* 2021;14:1985–1986. <https://doi.org/10.1093/ckj/sfab084>
6. Fridman A, Gershon R, Gneezy A. COVID-19 and vaccine hesitancy: a longitudinal study. *PLoS One.* 2021;16:e0250123. <https://doi.org/10.1371/journal.pone.0250123>
7. Mejia C, Libby BA, Bracken ML, et al. Interest in digital dietary support among adults with kidney failure receiving hemodialysis. *J Ren Nutr.* 2021;31:327–332. <https://doi.org/10.1053/j.jrn.2020.06.004>
8. Bonner A, Gillespie K, Campbell KL, et al. Evaluating the prevalence and opportunity for technology use in chronic kidney disease patients: a cross-sectional study. *BMC Nephrol.* 2018;19:28. <https://doi.org/10.1186/s12882-018-0830-8>
9. Hussein WF, Bennett PN, Pace S, et al. The mobile health readiness of people receiving in-center hemodialysis and home dialysis. *Clin J Am Soc Nephrol.* 2021;16:98–106. <https://doi.org/10.2215/CJN.11690720>