Journal of Nephrology (2023) 36:601–603
https://doi.org/10.1007/s40620-023-01596-x

RESEARCH LETTER

Risks of in-hospital death and hospital length of stay of 7 days or longer among end-stage renal disease patients hospitalized with COVID-19: a retrospective cohort study in five California medical centers

Marc Reiterman[1] · Robert Atwill[2] · Heejung Bang[3] · Andrew I-Wei Chin[4]

Received: 14 October 2022 / Accepted: 12 February 2023 / Published online: 4 April 2023

Keywords COVID-19 · ESRD · In-hospital death · Hospital length of stay

Abbreviations

COVID-19	Coronavirus disease 2019
ESRD	End-stage renal disease
LOS	Length of stay
ICD-10-CM	International Classification of Diseases, 10th Revision, Clinical Modification
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
UC	University of California

Patients with pre-existing chronic health conditions, including End-Stage Renal Disease (ESRD) requiring dialysis, are at high risk for hospitalization with COVID-19. Kidney failure leads to a poorly regulated immune system [1], and susceptibility to infections, which is the second most reported cause of death in the ESRD population.

Studies of hospitalized ESRD patients early in the COVID-19 pandemic have reached different conclusions, with some finding that ESRD conveys an independent risk for in-hospital death [2], and others not finding this association [3]. We sought to examine ESRD as an independent risk factor for poor outcomes in individuals hospitalized with COVID-19 over an 18 month time period through the pandemic. We compared in-hospital death and hospital length of stay (LOS) ≥ 7 days in ESRD patients to that of non-ESRD patients in a diverse Western US population.

We used the University of California (UC) COVID-19 Research Database which includes patients from 5 UC hospitals. This retrospective study included patients ≥ 18 years of age at hospital admission with and without ESRD, who tested positive for COVID-19 by polymerase chain reaction nasal swab within 30 days prior to or at any time during their hospitalization. We included patients admitted between February 12th, 2020 and September 6th, 2021, who were discharged alive or who died by September 7th, 2021 (study end). Patients had ESRD if their admission included the ICD-10-CM code N18.6. We excluded patients with active kidney transplants but included patients with failed allografts on dialysis. For patients with multiple hospital admissions, only their index hospitalization associated with a positive COVID-19 test was included. Individuals were excluded if they were transferred into ($N = 556$) or out of ($N = 136$) the UC hospital system, admitted to an inpatient obstetric service ($N = 146$), or still hospitalized at the study end date.

Factors used in the analysis included: demographic variables (age, sex, race/ethnicity), major comorbid conditions noted on or before the date of index hospital admission, hospital admission period, area deprivation index (a measure of socioeconomic disadvantage), and COVID-19 vaccination status (≥ 1 vaccination recorded in the UC system prior to index hospital admission). The analyses of hospital LOS were performed only among patients who were discharged alive.

An unadjusted and two multivariable-adjusted logistic regression models for both in-hospital death and hospital

✉ Marc Reiterman
mreiterman2@gmail.com

1 Graduate Group in Epidemiology, University of California, Davis, Davis, CA 95616-5270, USA

2 School of Veterinary Medicine, University of California, Davis, Davis, CA, USA

3 Division of Biostatistics, Department of Public Health Sciences, University of California, Davis, Davis, CA, USA

4 Department of Internal Medicine, School of Medicine, University of California, Davis, Sacramento, CA, USA

Table 1 Odds ratios for in-hospital death and hospital LOS of 7 days or longer among patients with and without ESRD (the group without ESRD is the referent)

Outcomes	Odds ratio	95% confidence interval	*p* value
In-hospital death			
Unadjusted ($N=5761$)	1.48	1.09, 2.01	0.013
Adjusted model 1 ($N=5761$)[a]	1.39	1.00, 1.91	0.047
Adjusted model 2 ($N=5761$)[b]	0.86	0.61, 1.22	0.413
Matched propensity score analysis ($N=850$)[c]	0.75	0.45, 1.24	0.257
Hospital length of stay (< 7 vs ≥ 7 days)[d]			
Unadjusted ($N=5260$)	1.69	1.37, 2.09	< 0.001
Adjusted model 1 ($N=5260$)[e]	1.58	1.27, 1.97	< 0.001
Adjusted model 2 ($N=5260$)[f]	1.15	0.91, 1.45	0.231
Matched propensity score analysis ($N=747$)[g]	1.06	0.72, 1.55	0.779

Covariate adjustment in multivariable-adjusted regression models was performed in a sequential manner as follows:

[a]Adjusted model 1 was adjusted for the demographic variables sex, age category, and race/ethnicity, and for hospital admission period (Pearson chi-square goodness of fit test: $p < 0.001$)

[b]Adjusted model 2 was adjusted for demographic variables, hospital admission period, acute neurological conditions, cardiac arrhythmias, cardiac valvular disease, major cardiac disease, cerebrovascular disease, coagulopathy, diabetes, and hypertension (goodness of fit test: $p = 0.285$)

[c]One-one matched propensity score analysis with scores computed from acute neurological conditions, cardiac arrhythmias, cardiac valvular disease, major cardiac disease, cerebrovascular disease, coagulopathy, diabetes, and hypertension, and adjusted for the demographic variables sex, age category, and race/ethnicity, and for hospital admission period

[d]The analyses of hospital LOS were performed only among patients who were discharged alive

[e]Adjusted model 1 was adjusted for demographic variables, and for hospital admission period (goodness of fit test: $p = 0.873$)

[f]Adjusted model 2 was adjusted for demographic variables, hospital admission period, peripheral vascular disease, cardiac arrhythmias, major cardiac disease, diabetes, and hypertension (goodness of fit test: $p = 0.053$)

[g]One-one matched propensity score analysis with scores computed from peripheral vascular disease, cardiac arrhythmias, major cardiac disease, diabetes, and hypertension, and adjusted for the demographic variables sex, age category, and race/ethnicity, and for hospital admission period

For full regression model fits, see Supplemental Appendix

LOS ≥ 7 days were employed. Adjusted model 1 included the three demographic variables, and hospital admission period. Adjusted model 2 included these variables plus comorbid conditions with a univariate association ($p \leq 0.15$) with both the outcome and the study exposure, which caused a ≥ 10% change in the unadjusted exposure-outcome odds ratio when added as a factor to the unadjusted model. The model fits were assessed using the Pearson chi-square goodness of fit test. Alternative analyses to model 2 were also performed using one–one matched propensity score analyses with scores computed from the confounders identified, and which adjusted for the demographic variables and hospital admission period in a subsequent stratified logistic regression analysis.

Additional analyses studied independent risk factors associated with in-hospital death and hospital LOS ≥ 7 days among all patients, using backward logistic regression models. Risk factors for the demographic variables, hospital admission period, and comorbid conditions with odds ratios significant at the p = 0.05 level in two-sided tests were retained in each of the models.

After applying the inclusion and exclusion criteria, 5761 eligible patients were admitted to the hospital with a diagnosis of COVID-19 either within 30 days prior to or during their index hospitalization and were discharged alive or died during the study period. Of the 5761 patients, 425 (7.4%) had ESRD, 5,260 (91.3%) were discharged alive, and 501 (8.7%) died.

Table 1 shows our statistical models fitted for in-hospital death and hospital LOS ≥ 7 days. Without adjustment, ESRD patients hospitalized for COVID-19 had a significantly higher odds of in-hospital death than patients without ESRD. However, once comprehensively adjusted (model 2), there was no excess risk of death for ESRD patients. Similarly, the odds of hospital LOS ≥ 7 days was not significantly higher for ESRD patients in the adjusted analysis. Sensitivity analyses yielded qualitatively similar results for these two outcomes. See the Supplemental Appendix for

additional analyses. We found that only 24 study patients had a COVID-19 vaccine dose recorded in the UC health system prior to their index hospital admission.

When adjusted for demographic and pre-existing comorbid conditions of patients on dialysis, we did not find that ESRD was independently associated with a higher risk/odds for in-hospital death or hospitalization ≥ 7 days for an index hospitalization with COVID-19. Our retrospective study spanned approximately 1.5 years of the COVID-19 pandemic, one of the longer time periods studied. With the longer study duration, the dominant strain of the SARS-CoV-2 virus in the community, and which caused hospitalizations, likely changed over the course of the study. However, including hospital admission period did not substantially affect these results.

Vaccination against SARS-CoV-2, which reduces severe disease, hospitalizations, and death, was introduced in California in late December 2020. Therefore, subjects included in the last 9 months of the study may have received a COVID-19 vaccine. We sought to identify hospitalized patients who had received ≥ 1 vaccination and only found 24 patients. Our database identified patients who had a vaccination recorded within (or information transferred to) the UC health system, whereas population vaccination was primarily through community vaccination clinics, pharmacy chains, and dialysis clinics. Therefore, our database likely undercounted the number of vaccinated patients. It is also possible that the vaccines worked as advertised, reducing hospitalizations for COVID-19 [4]. Nonetheless, adjusting for limited information about COVID-19 vaccination status in the analysis did not affect the results.

While our conclusions are similar to those found in a prior study [3], differences in cohort/regional resources [5], time periods and analytical/adjustment methods may account for why we did not find ESRD to be a risk factor for poor outcomes as noted in another large study [2]. With ongoing mutations of the SARS-CoV-2 virus, wide availability of vaccines, and direct anti-viral therapeutics, further studies need to continue exploring the potential vulnerabilities of the ESRD population to COVID-19.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40620-023-01596-x.

Acknowledgements We would like to thank Miriam Nuño for her assistance with ICD-10-CM codes for the comorbid conditions included in our study.

Author contributions MR performed the overall design, implementation, and statistical analysis of the study. All authors contributed to the statistical design and analysis plan of the study and interpretation of results, and contributed to writing, revision and review of this manuscript.

Funding HB was partly supported by the National Institutes of Health through grant UL1 TR001860.

Data availability The detailed pseudonymized patient data used for this study are potentially re-identifiable and are therefore not shared.

Declarations

Conflict of interest The authors have no conflicts of interest to declare.

Study approval This study utilized the University of California COVID-19 Research data set and was granted an exemption for human subjects protection by the UC Davis Institutional Review Board (protocol# 1604619–1).

Ethical Statement Written informed consent was not required to conduct this study. It was granted an exemption for human subjects protection by the UC Davis Institutional Review Board (protocol# 1604619–1).

Human participants or Animals This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent For this type of study formal consent is not required.

References

1. Vaziri ND, Pahl MV, Crum A, Norris K (2012) Effect of uremia on structure and function of immune system. J Ren Nutr 22(21):149–156. https://doi.org/10.1053/j.jrn.2011.10.020
2. Ng JH, Hirsch JS, Wanchoo R, Sachdeva M, Sakhiya V, Hong S, Jhaveri KD, Fishbane S, Northwell COVID-19 Research Consortium and the Northwell Nephrology COVID-19 Research Consortium (2020) Outcomes of patients with end-stage kidney disease hospitalized with COVID-19. Kidney Int 98(6):1530–1539. https://doi.org/10.1016/j.kint.2020.07.030
3. Naaraayan A, Nimkar A, Hasan A, Pant S, Durdevic M, Elenius H, Nava Suarez C, Basak P, Lakshmi K, Mandel M, Jesmajian S (2020) End-stage renal disease patients on chronic hemodialysis fare better with COVID-19: a retrospective cohort study from the New York Metropolitan Region. Cureus 12(9):e10373. https://doi.org/10.7759/cureus.10373
4. Haas EJ, Angulo FJ, McLaughlin JM, Anis E, Singer SR, Khan F, Brooks N, Smaja M, Mircus G, Pan K, Southern J, Swerdlow DL, Jodar L, Levy Y, Alroy-Preis S (2021) Impact and effectiveness of mRNA BNT162b2 vaccine against SARS-CoV-2 infections and COVID-19 cases, hospitalizations, and death following a nationwide vaccination campaign in Israel: an observational study using national surveillance data. Lancet 397(10287):1819–1829. https://doi.org/10.1016/S0140-6736(21)00947-8
5. Hick JL, Hanfling D, Wynia M, Toner E (2021) Crisis standards of care and COVID-19: What did we learn? How do we ensure equity? What should we do? NAM Perspectives. Discussion, National Academy of Medicine, Washington, DC. https://doi.org/10.31478/202108e