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RESEARCH LETTER

Association of Kidney Function With 30-Day Mortality Following SARS-CoV-2 Infection in Nursing Home Residents: A Retrospective Cohort Study

To the Editor:

Nursing home residents are a high-risk group for adverse outcomes from severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection owing to advanced age, multimorbidity, and frailty.[1-4] Chronic kidney disease (CKD) is a significant independent predictor of mortality in nursing home residents with SARS-CoV-2[2,3] and in the general population.[4-9] However, the relationship between CKD stage and SARS-CoV-2 mortality has not been explored among nursing home residents. We described the association between kidney function and all-cause 30-day mortality following SARS-CoV-2 diagnosis among nursing home residents. We hypothesized that mortality would increase progressively with worsening kidney function.

This retrospective cohort study linked nursing home electronic health record data to Minimum Data Set (MDS) assessments to identify nursing home residents with an incident SARS-CoV-2 infection between March 1, 2020 and December 31, 2020 (Table S1, Figure S1). The main exposure of interest was kidney function, categorized according to the KDIGO definition (ie, G1-G5)[10] using each resident's median baseline estimated glomerular filtration rate (eGFR) (Item S1). The outcome was all-cause mortality within 30 days of the resident's SARS-CoV-2 diagnosis. We included a number of baseline person-level characteristics to better isolate the independent association between kidney function and all-cause mortality following SARS-CoV-2 infection. These included age, sex, comorbidities (Table S2), medication use within 7 days prior to SARS-CoV-2 diagnosis (Table S3), and calendar month of diagnosis.

To model the association between kidney function and death following SARS-CoV-2 infection, we used multivariable logistic regression models and postestimation commands to calculate the adjusted probability of mortality and adjusted risk ratios (Item S2). We also explored whether the association differed by other known risk factors for SARS-CoV-2 mortality (diabetes status and glycemic control, age, and degree of functional and cognitive impairment; Item S2) and tested alternative modeling specifications (Item S2) and approaches to characterizing baseline kidney function (Item S1). Brown University's Institutional Review Board approved the study and waived the requirement for informed consent.

During calendar year 2020, 6,798 residents had a confirmed new SARS-CoV-2 infection and met the cohort inclusion requirements (Figure S1). Overall, 75% of the study cohort were non-Hispanic White and 61% were female; residents in the G5 group had lower rates of cognitive and functional impairment but higher rates of most comorbidities (Table S4). Fifteen percent died within 30 days of SARS-CoV-2 diagnosis. In adjusted analyses, mortality risk was progressively greater with worse kidney function: 10.1% (95% CI, 8.3%-11.9%) of those in the G1 group died within 30 days, while 23.2% (95% CI, 18.6%-27.7%) of those in the G5 group did. Compared with group G1, the risk of death ranged from 1.4 (95% CI, 1.2-1.7) times higher for group G2 to 2.3 (95% CI, 1.8-3.0) times higher for group G5 (Table 1).

Adjusted mortality was generally greater with worse kidney function among subgroups with known risk factors for SARS-CoV-2 mortality (Figure 1). Stability analyses that used alternative model specifications (Tables S5-S7) or methods of categorizing kidney function (Tables S8 and S9) were consistent with the main analysis.

Studies have shown higher SARS-CoV-2 mortality among hospitalized older adults with CKD, and among nursing home residents with kidney failure or decreased kidney function documented in the MDS.[2,6,9] Our study corroborates and expands upon these findings by using creatinine-based determination of kidney function, allowing a more granular assessment of how level of kidney function is associated with mortality.

Our study has a number of limitations. The outcome was all-cause mortality rather than cause-specific SARS-CoV-2 mortality, which may be of separate interest. Our method for classifying kidney function may have misclassified some individuals. We also may have incomplete information about deaths among residents who were discharged from and not readmitted to the nursing home. However, hospitalization rates were higher for residents with worse kidney function, who already had higher mortality, suggesting that our estimates would, if anything, underestimate deaths for these residents.

While more severe cognitive and functional impairments are significant predictors of SARS-CoV-2 mortality among nursing home residents,[2,3] even adjusting for and stratifying by these factors we find a large association between decreased eGFR and mortality that is greater with worsening kidney function. This suggests that kidney function, while related to age, multimorbidity, and frailty, is independently associated with death following SARS-CoV-2. Despite widespread availability of vaccines to nursing home residents, SARS-CoV-2 remains a threat. Understanding which individuals are particularly vulnerable will remain important for risk mitigation strategies.

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Supplementary Material

Supplementary File (PDF)

Figure S1; Items S1-S2; Tables S1-S9.

Table 1. Thirty-Day All-Cause Mortality Among Nursing Home Residents Who Tested Positive for SARS-CoV-2, by GFR Category

	G1 (eGFR >90)	G2 (eGFR 60-89)	G3a (eGFR 45-59)	G3b (eGFR 30-44)	G4 (eGFR 15-29)	G5 (eGFR <15 or Dialysis)
Unadjusted model						
Probability	7.31% (5.90%-8.72%)	15.56% (13.79%-17.34%)	17.92% (15.57%-20.28%)	18.91% (15.82%-22.00%)	24.70% (20.36%-29.05%)	18.32% (14.00%-22.64%)
Risk ratio	1.00 (reference)	2.13 (1.77-2.55)	2.45 (2.00-3.01)	2.59 (2.08-3.21)	3.38 (2.60-4.39)	2.51 (1.85-3.39)
Adjusted model						
Probability	10.09% (8.33%-11.85%)	14.46% (12.98%-15.94%)	16.35% (14.31%-18.39%)	17.42% (14.78%-20.06%)	21.76% (17.75%-25.78%)	23.16% (18.62%-27.70%)
Risk ratio	1.00 (reference)	1.43 (1.19-1.72)	1.62 (1.34-1.96)	1.73 (1.41-2.12)	2.16 (1.69-2.75)	2.30 (1.77-2.97)

Median baseline serum creatinine was used to calculate estimated glomerular filtration rate (eGFR, in mL/min/1.73 m^2), which was categorized in G (glomerular filtration rate) categories per the KDIGO 2012 guideline[10] (dialysis determined by a Minimum Data Set indicator for dialysis treatment). Adjusted model adjusts for resident characteristics including age, sex, long stay status, degree of cognitive and functional impairment, comorbidities, medication use during the 7 days prior to SARS-CoV-2 infection, and calendar month of SARS-CoV-2 diagnosis. Predicted probabilities and risk ratios were calculated following logistic regression, with 95% CI in parentheses. Models clustered robust standard errors at the nursing home facility level.

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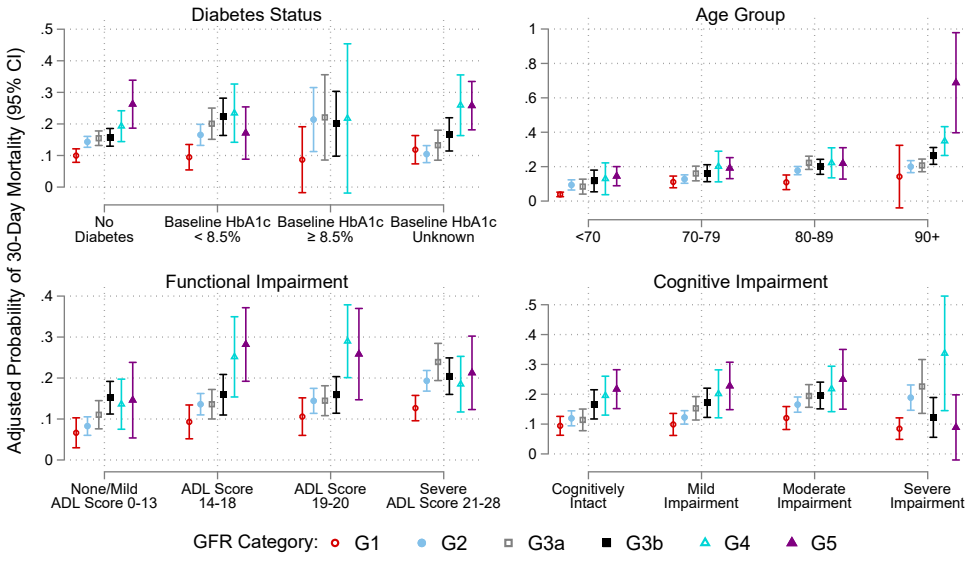

Figure 1. Adjusted 30-day all-cause mortality following SARS-CoV-2 infection by glomerular filtration rate (GFR) category and SARS-CoV-2 risk factors. In nearly all subgroups, mortality increases with advancing GFR category, suggesting kidney function is associated with SARS-CoV-2 mortality independent of these risk factors. Models adjust for all resident characteristics other than the risk factor under investigation, including age, sex, long stay status, degree of cognitive and functional impairment, comorbidities, medication use during the 7 days prior to SARS-CoV-2 infection, and calendar month of SARS-CoV-2 diagnosis. Predicted probabilities were calculated following logistic regression. Models clustered robust standard errors at the nursing home facility level. Owing to collinearity, adjusted probability of mortality was not estimable for residents in the G5 group with hemoglobin A_{1c} ≥8.5%.

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RESEARCH LETTER

Seroresponse to SARS-CoV-2 Vaccines Among Maintenance Dialysis Patients

To the Editor:

As of October 2021, 3 SARS-CoV-2 vaccines are available in the United States, and all appear highly effective in the general population. Studies suggest high seroresponse to messenger RNA vaccines among maintenance dialysis patients, albeit lower than that in the general population.[1-6] Data regarding adenoviral vector vaccines and predictors of vaccine nonresponse are limited by small sample sizes.[7] Accordingly, we retrospectively analyzed seroresponse to SARS-CoV-2 vaccines among maintenance dialysis patients, updating an earlier report.[8]

DCI is a national not-for-profit provider caring for more than 15,000 patients at 260 outpatient dialysis clinics across 29 states. As of January 2021, DCI physicians had the option of activating a SARS-CoV-2 vaccine protocol, in which anti–spike immunoglobulin G antibodies (SAb-IgG) were measured monthly with routine lab work (details in Item S1). We obtained demographic and clinical data, vaccination dates, and SAb-IgG titers from the DCI electronic health record. We excluded patients with previously diagnosed COVID-19 or positive SAb-IgG titer before or within 10 days after first vaccine dose.

In primary analyses, seroresponse was defined by at least one ≥1 SAb-IgG titer ≥1 U/L at 14-74 days after completion of a vaccine series. Because samples for antibody titers were drawn alongside monthly labs, most patients have 2 assessments in this 60-day period. Associations of demographic and clinical factors with vaccine seroresponse were analyzed using multivariable log Poisson regression with robust variances. Secondary analyses used alternate definitions of vaccine seroresponse: (1) ≥1 SAb-IgG titer ≥2 U/L at 14-74 days after vaccine series completion, and (2) SAb-IgG titer ≥1 U/L on the first assessment at least 14 days after vaccine series completion. This study was reviewed and approved by the WCG IRB (Work Order 1-1456342-1) with exemption for informed consent. Statistical analyses were performed using SAS v9.4.

Between January 1 and June 30, 2021, 1,528 patients (437 BNT162b2/Pfizer, 766 mRNA-1273/Moderna, and 325 Ad26.COV2.S/Janssen recipients) across 130 dialysis facilities had SAb-IgG titers measured after SARS-CoV-2 vaccination (Fig S1). Baseline characteristics were similar to those of the broader DCI vaccinated patient population. Between 14 and 74 days after vaccine series completion,