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Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19), has drastically affected long-term care residents and staff, who accounted for 5% of US cases and a striking 31% of US deaths in 2020 before vaccines became available. Skilled nursing facility (SNF) patients require high-touch care to meet their daily needs, limiting the feasibility of some infection control measures used in other settings such as maintaining physical distance and limiting time with other people. Additionally, SNF patients tend to be older, frail, and experience multiple chronic conditions, putting them at the highest risk of SARS-CoV-2 complications, including death. The prevalence of SARS-CoV-2 infection and death in SNFs has prompted investment in and evaluation of modifiable factors to reduce transmission and associated morbidity and mortality.

Skilled nursing facilities serve both people requiring long-term care and people requiring post-acute skilled nursing and rehabilitative care following a hospitalization. The COVID-19 pandemic...
complicates the benefits and burdens of post-acute care in an SNF. Individuals and families in need of post-acute care services may be reluctant to enter SNFs for short-term rehabilitation, given unclear risks of SARS-CoV-2 infection within SNFs. In the absence of clear data outlining the risk of SARS-CoV-2 infection and associated complications among patients receiving post-acute care, people requiring such care may forego an SNF admission despite an existing need.

A wide variety of people seek post-acute care in SNFs following hospitalization, with varying risk profiles for contracting SARS-CoV-2 and experiencing severe illness. Previous studies have identified person-level characteristics that increase risk of death from SARS-CoV-2 among the broader nursing home population, including advanced age, male sex, cognitive and functional impairment, chronic kidney disease, and overall frailty. It is unknown whether these same factors influence infection risk for post-acute patients, who compared to long-stay residents, are a more transient but clinically acute SNF population.

The objective of this study was to determine the risk of testing positive for SARS-CoV-2 following a post-acute care admission to an SNF and the absolute risk of death. We examined temporal trends in SARS-CoV-2 infection and mortality rates, as well as person-level risk factors for infection during a post-acute SNF stay.

### Methods

#### Data Sources

We used Minimum Data Set (MDS) and electronic health record data from a large provider of post-acute and long-term care operating close to 300 SNFs in 24 states at the time data were collected. The MDS includes a large and diverse set of demographic and clinical measures that are collected for all patients of Medicare- and Medicaid-certified SNFs. Clinical MDS assessments are completed on admission and regularly afterward until discharge or death. The EMR data elements used include daily census records to identify daily disposition and transfers, clinical diagnoses including COVID-19, and SARS-CoV-2 test results. The use of this data set to identify people with SARS-CoV-2 using diagnoses and test results has been used in other studies.

#### Sample

The sample consisted of patients admitted to any of the operator’s SNFs for post-acute care between January 1 and December 31, 2020. Patients admitted from the hospital with an admission, 7-day, or 14-day MDS assessment were included in the sample. All patients were tracked until discharge or until 100 days postadmission, which is the last day Medicare reimburses for post-acute care and is a typical cutoff for SNF admission. We extracted diagnoses from the MDS admission assessment. The set of explanatory variables included demographic characteristics, physical and cognitive functional measures, clinical conditions, and month of admission. The demographic characteristics were age, sex, and race (White, Black, and other). Functional status was captured by the 28-point Morris Activities of Daily Living (ADL) scale score and Cognitive Function Scale (CFS) score from the MDS admission assessment. The Morris ADL measure ranges from 0 to 28, with higher scores indicating more impairment. The 4-point CFS measures cognitive function. A score of 1 indicates no cognitive impairment, whereas scores of 2, 3, and 4 denote mild, moderate, and severe cognitive impairment, respectively. For our analysis, we grouped patients into 4 functional categories based on the combination of CFS and ADL scores: high ADL impairment (ADL score >18, the 50th percentile value) with moderate to severe cognitive impairment (CFS score 3 or 4); high ADL impairment with no or mild cognitive impairment (CFS score 1 or 2); low ADL impairment (ADL score ≤18) with moderate to severe cognitive impairment; and low ADL impairment with no or mild cognitive impairment.

We extracted diagnoses from the MDS admission assessment including chronic kidney disease, chronic obstructive pulmonary disease (COPD) or asthma, coronary artery disease, diabetes, heart failure, and hypertension. Calendar time was controlled for with a string of dummy variables representing SNF admission in each calendar month of 2020. Admission month is essential to account for because of the substantial temporal variation in virus prevalence, care practices, and broader health care system and community dynamics over the course of the pandemic, all of which may potentially influence infection and mortality risk.

#### Statistical Analysis

We used standard measures to describe our sample, including means and standard deviations for continuous variables and frequencies and proportions for categorical variables. We then computed the crude rate of each outcome according to calendar month of admission. Because the timing of SARS-CoV-2 infection is important for gauging how likely it was to have been acquired in the SNF, we calculated infection rates based on days since SNF admission.
1-14 days, 15-30 days (30 days is the median post-acute length of stay in this sample), and 31-100 days.

We examined the association between the explanatory variables and testing positive for SARS-CoV-2 using a parametric survival model with SNF random effects. The combined outcome of SARS-CoV-2 infection and subsequent mortality was not examined using this multivariable approach because the prevalence was particularly low (0.8% overall). We opted for a parametric approach rather than semiparametric Cox regression to overcome violation of proportional hazards. We assumed an exponential distribution for time to infection because of the relatively short follow-up period, and because in general the risk of contracting SARS-CoV-2 was unlikely to be different on any given day during the course of a post-acute stay.

Data were analyzed with Stata MP, version 16.0. Null hypotheses were tested with a 2-sided type I error rate of 0.05.

Results

The sample included 45,094 adults admitted to one of 286 SNFs for post-acute care following a hospitalization. The median age of the sample was 76 years; 55% were female and 75% were White. Forty-six percent of the sample had ADL scores above 18, and 21%, 15%, and 3% had mild, moderate, and severe cognitive impairment, respectively. Additional patient characteristics are summarized in Table 1. The sample was 76 years; 55% were female and 75% were White. Forty-six percent of the sample had ADL scores above 18, and 21%, 15%, and 3% had mild, moderate, and severe cognitive impairment, respectively. Additional patient characteristics are summarized in Table 1. The number of admissions decreased from 5284 in January 2020 to a low of 1981 in April 2020 during the first US wave of the pandemic. Admission volume trended upward after that, reaching 3435 in December 2020, still below prepandemic levels.

Table 1 Sample Characteristics (N = 45,094)

| Characteristic | Value |
|---------------|-------|
| Age, median (IQR) | 76 (67-85) |
| Age, n (%) | <65 y 9133 (20) |
| | 65-69 y 5256 (12) |
| | 70-74 y 6438 (14) |
| | 75-79 y 6621 (15) |
| | 80-84 y 6406 (14) |
| | 85-89 y 5864 (13) |
| | ≥90 y 5373 (12) |
| Female sex, n (%) | 24,883 (55) |
| Race, n (%) | White 33,685 (75) |
| | Black 4937 (11) |
| | Other 6470 (14) |
| ADL summary score, mean (SD) | 16.8 (5.4) |
| ADL score quartile, n (%) | 0-13 12,309 (27) |
| | 14-18 11,892 (26) |
| | 19-20 11,254 (25) |
| | 21-28 9639 (21) |
| CFS score, n (%) | 1 (cognitively intact) 26,472 (61) |
| | 2 (mild impairment) 9375 (21) |
| | 3 (moderate impairment) 6489 (15) |
| | 4 (severe impairment) 1376 (3) |
| Dementia, n (%) | 8854 (20) |
| Congestive heart failure, n (%) | 10,667 (24) |
| Coronary artery disease, n (%) | 10,953 (24) |
| Asthma or COPD, n (%) | 11,791 (26) |
| Chronic kidney disease, n (%) | 13,346 (30) |
| Hypertension, n (%) | 33,208 (74) |
| Diabetes, n (%) | 17,728 (39) |
| Month of admission, n (%) | January-March 19,308 (49) |
| | April-June 7687 (19) |
| | July-September 12,749 (32) |
| | October-December 11,608 (26) |

Table 2 summarizes temporal variation in SARS-CoV-2 infection rates. Across all months, 5.7% of patients tested positive within 100 days of admission, with 1.0% testing positive within 1-14 days, 1.4% within 15-30 days, and 3.4% within 31-100 days. We observed an initial peak in infection rates among patients admitted in April 2020, 7.9% of whom tested positive during their post-acute SNF stay, followed by a second peak among patients admitted in November 2020, 11.6% of whom subsequently tested positive. These peaks coincide with the first and third waves of the US pandemic.

Table 3 summarizes the hazard of SARS-CoV-2 infection by patient characteristics and month of admission. Patients in the 3 functional categories representing greater cognitive and functional impairment had between a 1.45 to 1.92 times higher risk of contracting SARS-CoV-2 compared with patients in the least-impaired category (all statistically significant at P < .001). Patients with diabetes had a 1.14 times higher risk of infection than those without diabetes (P < .01). We observed no significant differences in infection risk by age or other chronic conditions. Risk of infection among Black and White patients was similar, whereas patients of other races had slightly lower infection risk (hazard ratio 0.84 vs White, P = .021). Patients admitted in April 2020 and from October to December 2020 had higher risk of infection than those admitted in other months.

Table 4 shows a comparison of mortality rates following SNF admission for patients with and without known SARS-CoV-2 infection. Of all newly admitted patients, 0.8% contracted SARS-CoV-2 and died, with a range of 0.2% to 1.9% across months (peaking in November 2020). By contrast, 6.7% of all newly admitted patients died without known infection, with a more stable range of 6.2%-6.9% across all months except for April 2020, when a peak of 8.2% was observed.

Discussion

This study summarizes the risks of infection and death with SARS-CoV-2 among approximately 45,000 post-acute care patients admitted to SNFs in 2020 during the pandemic. Similar to the general population and coinciding with the first and third US waves of the SARS-CoV-2 pandemic, infection rates and subsequent risk of death in the post-acute SNF population were highest for patients admitted March to April 2020 and October to December 2020. The absolute risk of contracting SARS-CoV-2 during a post-acute care stay in a nursing home and also dying were relatively low. That said, the risk of death
within the SNF. For this reason, all efforts to decrease community transmission of SARS-CoV-2 do in
community transmission risk to people who require close contact to meet basic daily needs.

Becoming infected with SARS-CoV-2 during a post-acute care stay and subsequently dying was a relatively small risk when compared to the overall risk of death among post-acute care patients. Individuals who require post-acute care in an SNF following a hospitalization represent a population with complex underlying conditions that predispose them to death with or without SARS-CoV-2. At the same time, those who did contract SARS-CoV-2 during their SNF stay had nearly double the rate of death as those who were not infected. For people with complex conditions, options for post-acute care outside of SNFs are often insufficient to meet the significant medical and personal care needs after hospitalization. People with complex health needs will continue to require the acuity of care delivered in an SNF after hospitalization. We must invest in the workforce, environment, and skill sets required to provide quality SNF care to high-risk individuals in our communities.

Death with SARS-CoV-2 more than doubled from February to March and again from September to October of 2020. Improvements after the first peak in deaths may reflect improved infection control strategies and treatment modalities in SNFs following the initial presentation of SARS-CoV-2. Future study should examine SARS-CoV-2 infection rates during SNF post-acute care stays following subsequent peaks in community SARS-CoV-2 infection. Deaths without

### Table 3

| Covariate | Hazard Ratio (95% CI) | P    |
|-----------|----------------------|------|
| Age < 65 y | 0.97 (0.84, 1.13)    | .73  |
| Age 65-69 y | 1.05 (0.93, 1.28)    | .28  |
| Age 70-74 y | 1.04 (0.88, 1.23)    | .63  |
| Age 75-79 y | Referent             |      |
| Age 80-84 y | 1.05 (0.91, 1.22)    | .50  |
| Age 85-89 y | 1.09 (0.94, 1.27)    | .25  |
| Age ≥ 90 y  | 1.15 (0.98, 1.35)    | .09  |
| Female sex  | 1.09 (1.00, 1.18)    | .043 |
| Race, White | Referent             |      |
| Race, Black | 1.00 (0.85, 1.16)    | .96  |
| Race, Other | 0.84 (0.73, 0.97)    | .021 |
| ADL < 19, CFS < 3 | Referent          |      |
| ADL ≥ 19, CFS < 3 | 1.45 (1.31, 1.60)  | <.001|
| ADL < 19, CFS ≥ 3 | 1.92 (1.64, 2.25)  | <.001|
| ADL ≥ 19, CFS ≥ 3 | 1.57 (1.38, 1.79)  | <.001|
| Congestive heart failure | 0.98 (0.89, 1.07) | .615 |
| Coronary artery disease | 1.01 (0.92, 1.11) | .76  |
| Asthma/COPD | 0.96 (0.88, 1.04)    | .28  |
| Chronic kidney disease | 1.06 (0.97, 1.17)  | .20  |
| Hypertension | 1.05 (0.95, 1.17)    | .30  |
| Diabetes | 1.14 (1.04, 1.25)    | <.01 |

### Table 4

| Admission Month | No. of Admissions | Patients With Outcome (%) | Died, no Prior SARS-CoV-2 Infection | Died After SARS-CoV-2 Infection |
|-----------------|-------------------|----------------------------|-------------------------------------|---------------------------------|
| January         | 5284              | 93.0                       | 6.9                                 | 0.2                             |
| February        | 4438              | 93.1                       | 6.3                                 | 0.6                             |
| March           | 4022              | 91.7                       | 6.9                                 | 1.4                             |
| April           | 1981              | 90.3                       | 6.2                                 | 1.5                             |
| May             | 2189              | 92.8                       | 6.9                                 | 0.4                             |
| June            | 3332              | 93.4                       | 6.2                                 | 0.4                             |
| July            | 3776              | 93.3                       | 6.5                                 | 0.2                             |
| August          | 3970              | 93.2                       | 6.3                                 | 0.5                             |
| September       | 4494              | 92.5                       | 6.8                                 | 0.7                             |
| October         | 4353              | 91.8                       | 6.8                                 | 1.4                             |
| November        | 3820              | 92.0                       | 6.1                                 | 1.9                             |
| December        | 3435              | 91.9                       | 6.8                                 | 1.3                             |
| Total           | 45,094            | 92.4                       | 6.7                                 | 0.8                             |

All patients were tracked until discharge or until 100 days postadmission.
SARS-CoV-2 peaked in April of 2020. Many aspects of care were altered for all patients because of the emergence of SARS-CoV-2, such as visitation bans and changes in admission criteria that likely affected who was admitted to nursing homes for post-acute care and the type of care they received.

In our sample, more than half of SARS-CoV-2 infections occurred more than 30 days after SNF admission, yet the median post-acute length of stay was 30 days. This suggests that length of stay may be associated with infection risk. Patients requiring additional time in the SNF may experience a prolonged risk of exposure and more opportunities to become infected. Another potential explanation may be that people requiring longer lengths of stay also have increased needs that prevent physical distancing and adherence to infection mitigation strategies.

Limitations

This study has important limitations. First, data were derived from a single SNF operator, and it is unclear how generalizable the findings are to patients admitted to SNFs nationally. Second, patients receiving post-acute care in SNFs during the pandemic may differ from usual post-acute patients in important ways. For example, post-acute patients during COVID-19 may be more functionally impaired than usual patients, who may have been more able to substitute SNF care with other types of post-acute care, such as home health care. We did not compare incidence and outcomes of SARS-CoV-2 in a comparable group of people who went to SNF for post-acute care vs home for post-acute care. Third, our intent was to describe the independent risk factors for adverse SARS-CoV-2 outcomes among post-acute SNF patients, so none of the estimates should be interpreted as causal. Fourth, lack of testing capacity during the early portion of the pandemic may have resulted in an undercounting of cases, specifically asymptomatic ones in the first few days of admission to SNF. Fifth, we could not ascertain prior SARS-CoV-2 infection and related death with certainty for all patients. For instance, patients may have previously experienced SARS-CoV-2 infection unrelated to the hospital or SNF stay. Last, our estimates likely undercount deaths that occurred outside the nursing home, such as in the hospital.

Conclusions and Implications

The decision to pursue post-acute care in an SNF following hospitalization is multifaceted and has been further complicated by concerns about contracting SARS-CoV-2. This study demonstrated increased risk of SARS-CoV-2 infection for post-acute care recipients who remained in the SNF more than 30 days, those with cognitive and functional impairment, and those admitted in months of community surges. The absolute risk of infection and death with SARS-CoV-2 during a post-acute care stay remained small across the study in relation to the risk of death without SARS-CoV-2 in this high-risk population, though this pilot work requires further validation and study. This study provides additional context of the risks and benefits of a post-acute care stay in an SNF during the SARS-CoV-2 pandemic. Knowledge of the specific risk factors for SARS-CoV-2 infection and death among post-acute care residents in SNFs allows for individualized planning during a complex transition in care.

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