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RESEARCH ARTICLE

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Accuracy of infection reporting in US nursing home ratings

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Abstract

Objective: To assess the accuracy of nursing home-reported data on urinary tract infections (UTIs), which are publicly reported on Nursing Home Care Compare, and pneumonia, which are not publicly reported.

Data Sources and Study Setting: We used secondary data for 100% of Medicare fee-for-service beneficiaries in the United States between 2011 and 2017.

Study Design: We identified Medicare fee-for-service beneficiaries who were nursing home residents between 2011 and 2017 and admitted to a hospital with a primary diagnosis of UTI or pneumonia. After linking these hospital claims to resident-level nursing home-reported assessment data in the Minimum Data Set, we calculated the percentages of infections that were appropriately reported and assessed variation by resident- and nursing home-level characteristics. We developed a claims-based nursing home-level measure of hospitalized infections and estimated correlations between this and publicly reported ratings.

Data Extraction Methods: Medicare fee-for-service beneficiaries who were nursing home residents and hospitalized for UTI or pneumonia during the study period were included.

Principal Findings: Reporting rates were low for both infections (UTI: short-stay residents 29.1% and long-stay residents 19.2%; pneumonia: short-stay residents 66.0% and long-stay residents 70.6%). UTI reporting rates increased when counting additional assessments, but it is unclear whether these reports are for the same versus a newly developed UTI. Black residents had slightly lower reporting rates, as did nursing homes with more Black residents. Correlations between our claims-based measure and publicly reported ratings were poor.

Conclusions: UTI and pneumonia were substantially underreported in data used for national public reporting. Alternative approaches are needed to improve surveillance of nursing home quality.

KEYWORDS
patient safety, pneumonia, public reporting, quality of care, urinary tract infection

What is known on this topic

- A central feature of the US government's strategy to monitor and improve nursing home care is public reporting of facility-level quality indicators and star ratings.
- However, these quality measures are mostly based on unverified nursing home-reported data, and have long been suspect based on poor correlations with other aggregate measures of quality and small government investigations.
- Recent work that has linked resident-level nursing home and hospital data nationally indicates some data items, including on major injury falls and pressure ulcers, are substantially inaccurate, but infection reporting has not been systematically investigated.

What this study adds

- We assessed the accuracy of nursing home-reported data on urinary tract infections, which are publicly reported, and pneumonia, which are not publicly reported.
- Reporting rates were low for both measures, though higher for pneumonia. Black residents had slightly lower reporting rates, as did nursing homes with more Black residents.
- Correlations between our claims-based measures of both infections and Centers for Medicare and Medicaid Services nursing home ratings were poor.

1 | INTRODUCTION

Longstanding public concern over the quality of care in US nursing homes[1–10] was intensified by the COVID-19 pandemic, which led to the deaths of over 184,000 nursing home residents.[11] The topic featured in President Biden's 2022 State of the Union Address; at the same time, the administration proposed policy changes to improve nursing home accountability and transparency.[12] Many of these reforms, and the federal government's Nursing Home Care Compare (NHCC) infrastructure on which they will build, rely heavily on public reporting of facility quality to correct information asymmetries between providers and consumers. As such, it is crucial for the reported quality measures to be both useful and valid; however, a growing body of evidence indicates the underlying data may be substantially inaccurate.

The NHCC website acts as the most readily available and publicly accessible source for comparing nursing facilities across three domains: health inspections, nurse staffing, and quality of care. To allow easier interpretation, the Centers for Medicare and Medicaid Services (CMS) summarize information within each domain into a five-star rating and also assign each home an overall rating. The data behind the quality of care indicators, called the Minimum Data Set (MDS), document patient-level functional status and clinical conditions that are additionally used to determine care plans and Medicare payments.[13] During the development and testing phases of the latest iteration of the MDS instrument, item reliability was high, including in comparisons between research and facility nurses.[14] However, MDS data are self-reported by nursing homes, loosely examined for accuracy, and rarely lead to penalties if misreported.[15]

Two national studies directly validating MDS items for falls and pressure ulcers against Medicare claims for the same conditions found substantial underreporting by nursing homes, with only 57.5% of major injury falls[16] and 59.7% of pressure ulcer cases[17] leading to a hospitalization reported in the MDS among long-stay residents. Other studies have also documented discrepancies between MDS items or quality measures and alternative data sources including medical records, hospital claims, care processes, or rehabilitation outcomes.[18–31] However, most of these findings have been limited by small sample sizes, reliance on the MDS itself for key information, or aggregate data for comparison.

In this study, we examined how accurately nursing homes report urinary tract infections (UTIs) and pneumonia, the two most common infections in nursing homes[32,33] prior to the COVID-19 pandemic, which are associated with missed care,[34] preventable hospital readmissions,[35,36] functional limitations, and death.[37] By linking MDS assessments with Medicare hospitalizations at the resident level, we assessed national reporting rates of the infections. A unique aspect of our analysis is the simultaneous assessment of an MDS item that is used to calculate star ratings (UTI) and an MDS item that is not used by NHCC (pneumonia) to shed light on how incentives shape reporting and thus potential policy solutions.

2 | METHODS

2.1 | Data

We used hospital admission data and skilled nursing facility (SNF) claims from the Medicare Provider Analysis and Review (MedPAR) file for 100% of Medicare beneficiaries who were full-year fee-for-service enrollees in 2011–2017. The last 3 months of 2015 were excluded to allow for a period of transition from International Classification of Diseases, Ninth Revision, Clinical Modification (ICD9-CM) to the Tenth Revision (ICD10-CM). We extracted beneficiaries' demographics and chronic conditions from the Master Beneficiary Summary File (MBSF).

We used MDS 3.0 assessments from 2011 to 2017, focusing on two items: (1) I2000, where facilities report whether the beneficiary

TABLE 1 Minimum Data Set (MDS) 3.0 items on infections.

Item[a]	Description	Coding instruction	Look-back period	Possible responses
I2000	Pneumonia		7 days	1 if the condition is active; 0 otherwise
I2300	UTI (last 30 days)	Code only if all the following are met: 1. Physician, nurse practitioner, physician assistant, or clinical nurse specialist or other authorized licensed staff as permitted by state law diagnosis of a UTI in last 30 days 2. Sign or symptom attributed to UTI, which may or may not include but not be limited to: fever, urinary symptoms (e.g., peri-urethral site burning sensation, frequent urination of small amounts), pain or tenderness in flank, confusion or change in mental status, change in character of urine (e.g., pyuria) 3. "Significant laboratory findings" (The attending physician should determine the level of significant laboratory findings and whether or not a culture should be obtained) and 4. Current medication or treatment for a UTI in the last 30 days	30 days	1 if the condition is active; 0 otherwise
I8000	Additional active diagnoses	Enter diagnosis on line and ICD codes in boxes	7 days	Up to 10 ICD-9-CM or ICD-10-CM codes
H0100A	Indwelling catheter (including suprapubic catheter and nephrostomy tube)	Check the box if the appliance is used at any time in the past 7 days	7 days	1 if the appliance is used; 0 otherwise

Abbreviations: ICD, International Classification of Diseases; UTI, urinary tract infection.
[a]I2000 item for pneumonia is not required to be reported on most MDS discharge assessments after 2011. I2300, I8000, and H0100A items are required to be reported on MDS discharge assessments.

had pneumonia in the past 7 days, and (2) I2300, which asks whether the beneficiary had a UTI that satisfied the four criteria listed in Table 1 in the past 30 days. Item I2300 is used to create a publicly reported quality measure to reflect the percentage of long-stay residents who have UTI in the nursing home and is included in the five-star rating calculations, whereas item I2000 is not used for reporting. We also searched I8000, an open-text field for reporting up to 10 other active conditions for any documentation of UTI or pneumonia diagnosis. If reported here, a UTI would not count in the publicly reported measures. Finally, we used item H0100A to determine whether a resident had an indwelling catheter, a risk factor for UTIs.[38–40]

Facility characteristics were extracted from the Certification and Survey Provider Enhanced Reporting (CASPER) dataset and LTCFocus.[41] NHCC quality measures and star ratings were obtained from the NHCC website.[42]

2.2 | Identification of UTI and pneumonia in claims data

Older adults are at high risk of asymptomatic UTI[38,43]; at the same time, overdiagnosing and overtreatment occurs in both nursing homes[43,44] and hospitals.[45,46] To minimize inaccuracies in infection diagnoses, we identified hospital claims with primary ICD9-CM or ICD10-CM diagnosis codes for UTI or pneumonia code (Appendix A; Appendix Table 1). We also expected primary UTI cases would meet the four criteria required for reporting on the MDS. Hospital admission claims with any secondary diagnosis codes related to these infections are considered in the Appendix. We further required the diagnoses to be present on admission to exclude hospital-acquired infections.

Our chief reason for using SNF claims was to assess reporting on the MDS in circumstances in which we could ascertain that a nursing home had information about an infection, based on their own recording of it as a diagnosis on a claim. Hence, for SNF claims, we used the primary diagnosis code and the first secondary diagnosis code field.

2.3 | Linkage of MDS and claims data

We linked MDS assessments to the identified infection claims using beneficiary identification numbers and dates of service to construct a sample of infection events that started in nursing homes and led to hospitalization. Nursing homes are required to complete discharge MDS assessments, including reporting of diagnosed UTIs (though not pneumonia) when residents are admitted to a hospital. To create a tight episode of care transfer, we required the resident to be discharged from the nursing home (to go to a hospital) and admitted to the hospital within 1 day and to be discharged from the hospital and readmitted to the same nursing home within 1 day. Though the latter is not required for reporting, it allowed our estimation to be more

conservative since in these cases a nursing home is more likely to be informed about the hospitalization.

We also linked to other MDS assessments post-hospitalization by the same nursing home within 7 days of hospital discharge for pneumonia and 30 days of hospital discharge for UTI. Since the discharge assessment does not require reporting of pneumonia, the post-hospitalization assessment is where we would expect the infection to be reported. For UTIs, the post-hospitalization assessment served as an additional opportunity in our analysis for nursing homes to report the UTI in case it could not be ascertained by the nursing home prior to hospitalization, though the MDS guidelines indicate the discharge assessment should be corrected after the information is known.

For SNF claims with UTI or pneumonia, we linked all MDS assessments within the time frame covered by the claim, since it is not possible to know exactly when a particular infection was active. Details are in Appendix B and Appendix Figures 1–3.

2.4 | Outcomes

We created three binary variables for the hospital claims sample to indicate whether infections were reported on the MDS. For UTI, the main reporting indicator was whether the infection was reported on the discharge MDS assessment, and a second indicator was whether the infection was reported on either the discharge assessment or the earliest post-hospitalization assessment that was within the look-back period. For pneumonia, the binary indicator was whether the infection was reported on any MDS completed within 7 days of the resident's hospital discharge and readmission to the same nursing facility. In the SNF claims sample, infections were flagged as reported if any of the linked MDS assessments reported the condition.

We also constructed a claims-based infection rate for each nursing home for pneumonia and separately UTI, defined as the number of hospital claims with a primary diagnosis for the infection per 100 Medicare fee-for-service residents in 2017.

2.5 | Other variables

At the resident level, we obtained age, sex, race, dual status (a binary indicator of whether the resident was dually enrolled in Medicare and Medicaid in the month of their hospital admission), and disability status (a binary indicator of whether disability was the current reason for Medicare entitlement) from the MBSF. We defined residents as short stay if they had a 5-day prospective payment system (PPS) assessment within 100 days prior to nursing home discharge, and as long-stay otherwise. To measure health status, we created indicators for each of 27 chronic conditions and Charlson/Elixhauser comorbidity scores using diagnosis codes from all hospital claims within a year prior to the infection claim.[47]

At the nursing home level, we categorized nursing homes by region, ownership type, and size based on tertiles of the national resident population distribution. We also created nursing home-level measures of race and dual status (Appendix C).[48,49] Annual average NHCC ratings and quality measures were also calculated for each nursing home.

We also created subgroups of hospital claims where the linked MDS documented UTI or pneumonia in the I8000 open-text item and where the MDS documented indwelling catheters.

2.6 | Statistical analysis

We analyzed national reporting rates of infection on the MDS for both the hospital and SNF claims samples, stratified by infection type and short-stay versus long-stay residents. To assess disparities in reporting associated with any resident-level or nursing home-level characteristics, we built multilevel logit models with nursing home random intercepts, adjusted by the covariates described above. In these models, for UTI, the outcome was the reporting indicator for the discharge assessment in the main sample of hospitalized cases; for pneumonia, the outcome was the reporting indicator for the post-hospitalization assessment in the main sample of hospitalized cases. We disaggregated facility-level and resident-level associations with race and dual status to examine differences in reporting attributable to each. For easier interpretation, we present average predicted reporting probabilities for residents in our sample, using their actual characteristics for all variables except those of interest, which were set at realistic values based on observed sample distributions. See Appendices D and E for details of this model as well as a similar model with nursing home fixed effects.

Lastly, we explored the associations between our claims-based infection measures and NHCC measures. Specifically, we grouped nursing homes into quintiles based on their claims-based infection rates, and then calculated the within-quintile percentages of four- or five-star rated homes and means of the NHCC measures. Finally, we calculated the Spearman rank and Pearson coefficients to estimate the correlations between the claims-based and NHCC measures.

3 | RESULTS

3.1 | Resident characteristics

Our final sample included 249,906 UTI and 183,139 pneumonia hospital admission claims linked to an appropriate MDS assessment in 2011–2017 (Table 2). In both infection groups, residents were on average 80 years old, more likely to be female, more likely to be dually enrolled Medicare and Medicaid, and with numerous chronic conditions.

3.2 | National reporting rates of infections

For UTI diagnosis hospital claims, reporting rates were higher for short stay than long-stay residents and substantially higher when counting

TABLE 2 Characteristics of Medicare fee-for-service beneficiaries with hospital infection diagnosis claims.

	UTI diagnosis hospital admission claims[a]		Pneumonia diagnosis hospital admission claims[a]	
	Short stay	Long stay	Short stay	Long stay
Count	107,856	142,050	93,087	90,052
Age	79.47	80.02	79.65	81.97
Female	61.9%	68.8%	56.8%	64.1%
Dually eligible for Medicare and Medicaid	57.0%	84.7%	51.3%	82.9%
Disability	8.9%	10.7%	8.0%	7.3%
Comorbidity Score	6.13	4.20	6.56	4.38
Number of chronic conditions	12.52	12.41	12.55	12.50
Race				
White	78.7%	76.0%	82.5%	83.2%
Black	14.0%	16.0%	10.7%	9.7%
Hispanic	5.0%	5.6%	4.5%	4.8%
Asian	1.3%	1.4%	1.5%	1.4%
American Indian	0.5%	0.6%	0.5%	0.6%
Other	0.5%	0.4%	0.4%	0.4%

Abbreviation: UTI, urinary tract infection.

[a]UTI diagnosis claims were hospital admission claims where the first diagnosis code was for a UTI and was present on admission. Pneumonia diagnosis claims were hospital admission claims where the first diagnosis code was for a pneumonia and was present on admission.

post-hospitalization MDS assessments (Table 3). Specifically, 29.1% and 19.2% of UTIs were reported on discharge MDS assessments among short-stay and long-stay residents, respectively, whereas 62.4% and 54.7% were reported when post-hospitalization MDS assessments were considered. Among residents with an indwelling catheter (37,250 for short stay, 34,102 for long stay), 34.5% (short stay) and 25.9% (long stay) of UTIs were reported on the discharge MDS assessment, with higher reporting on post-hospitalization assessments.

We identified 711,993 SNF claims that reported UTIs, but only 79.0% of these reported the UTI on any MDS assessment during the same billing period, even though the same facility completed both forms. Likewise, we found that in 2.1% of short-stay and 1.5% of long-stay cases of hospitalization for UTI, nursing homes reported UTIs in the free-form section of the MDS (I8000) that does not get used by NHCC for public reporting but did not report in the I2300 section that is used for public reporting.

For pneumonia hospital claims, 66.0% (short stay) and 70.6% (long stay) were reported in post-hospitalization MDS assessments. We identified 818,840 SNF claims with pneumonia diagnosis, and in 81.7% of these cases, pneumonia was reported on an MDS assessment that was completed during the billing cycle by the same facility. Similarly, in 3.3% of short-stay and 3.8% of long-stay cases of pneumonia hospitalization, nursing homes reported the infection in the free-form section of the MDS but did not report in the section it is specifically requested. Reporting rates for hospital claims with secondary infection diagnoses are in Appendix F and Appendix Table 4.

Notably, the long-stay reporting rate for UTI (19.2% on discharge assessment; 54.7% with post-hospitalization assessment), which is used for public reporting, was lower than the short-stay reporting rate for UTI (29.1% on discharge assessment; 62.4% with post-hospitalization assessment), which is not used for public reporting. The long-stay reporting rate for UTI was also lower than the long-stay reporting rate for pneumonia (70.6%), which is not used for public reporting.

3.3 | Disparities in reporting rates

To allow comparisons with other studies,[16,17] we focused on disparities in reporting by race; however, Appendix Table 2 provides associations with other characteristics. Table 4 presents predicted reporting rates for Black versus White residents who were living in nursing homes with different mixes of race using the fitted parameters of the logistic multilevel model and the characteristics of residents in our sample. For long-stay residents, MDS infection reporting rates were on average lower for those living in a nursing home with a higher percentage of residents who were Black. Holding race mix fixed, residents who were Black had lower reporting rates for both infections compared with residents who were White. Specifically, in a nursing home with 10% Black residents, reporting rates for Black residents were lower by 2.1 percentage points (pp) for UTI and 2.1 pp for pneumonia than reporting rates for White residents. Short-stay residents had similar results. Individual-level race associations were similar in a model with nursing home fixed effects (Appendix Table 3).

3.4 | Correlations between claims-based infection rates and NHCC measures

Nursing homes with higher claims-based infection rates were less likely to have four- or five-star ratings (Table 5). For UTI, among

TABLE 3 National reporting rate of infections by identification sources and short- versus long-stay, 2011–2017 (%).

	UTI			Pneumonia	
Method of identifying infection in nursing home	*N*	Percent of claims with UTI reported on discharge MDS (25th percentile, 75th percentile)[a]	Percent of claims with UTI reported on discharge MDS[a] or post-hospitalization MDS (25th percentile, 75th percentile)[b]	*N*	Percent of claims with pneumonia reported on post-hospitalization MDS (25th percentile, 75th percentile)[c]
Short stay					
Hospital infection claims[d]	107,856	29.1 (15.4, 40.0)	62.4 (48.1, 80.0)	93,087	66.0 (50.0, 83.3)
Hospital infection claims[d] + Indwelling catheter[e]	37,250	34.5 (12.5, 50.0)	64.7 (50.0, 94.4)	—	—
SNF infection claims[f]	711,993	79.0 (72.3, 90.3)	—	818,840	81.7 (75.5, 91.6)
Long stay					
Hospital infection claims[d]	142,050	19.2 (7.1, 40.0)	54.7 (40.0, 70.0)	90,052	70.6 (57.1, 87.5)
Hospital infection claims[d] + Indwelling catheter[e]	34,102	25.9 (0.0, 41.7)	56.2 (33.3, 80.0)	—	—

Abbreviations: MDS, Minimum Data Set; SNF, skilled nursing facility; UTI, urinary tract infection.
[a]Nursing homes are required to report item I2300 on the MDS discharge assessment to document whether a resident had a UTI in the past 30 days. Therefore, we used the MDS discharge assessment within 1 day prior to the hospitalization to assess UTI reporting.
[b]A post-hospitalization MDS assessment for UTI was the first MDS completed within 30 days after the resident returned to the same nursing home after hospitalization. If a nursing home reported a UTI on the MDS discharge assessment or the post-hospitalization assessment, the UTI was counted as being reported by the nursing home.
[c]A post-hospitalization MDS assessment for pneumonia was the first MDS completed within 7 days after the resident returned to the same nursing home after hospitalization and was used to assess the reporting of pneumonia. Nursing homes are not required to report item I2000 on the MDS discharge assessment to document whether a resident had pneumonia in the past 7 days after 2011. Therefore, only post-hospitalization MDS assessments were used to assess the reporting of pneumonia.
[d]Hospital infection claims for UTI were hospital admission claims from MedPAR with a primary diagnosis code for UTI that was present on admission. Hospital infection claims for pneumonia were hospital admission claims from MedPAR with a primary diagnosis code for pneumonia that was present on admission.
[e]Nursing homes are required to report item H0100A about whether residents used indwelling catheter in the past 7 days. We subset the sample of hospital infection claims to those matched to an MDS discharge assessment with an indwelling catheter documented in H0100A.
[f]SNF infection claims were claims from MedPAR with the first or second diagnosis code related to UTI or pneumonia. Any MDS that matched within the SNF stay was used to assess reporting. Since Medicare covers the first 100 days at a nursing home, all residents from SNF claims were short-stay residents.

TABLE 4 Adjusted differences in reporting rates by infections, nursing home race mix for short- and long-stay residents.

	UTI			Pneumonia		
	Adjusted mean[a,b]		Difference (P)	Adjusted mean[a,b]		Difference (P)
NH percentage of residents who are Black	White	Black	White–Black	White	Black	White–Black
Short stay						
10%	30.9	27.0	3.8 (<0.001)	67.6	65.9	1.7 (0.003)
50%	27.2	23.6	3.6 (<0.001)	60.3	58.5	1.8 (0.003)
Long stay						
10%	20.7	18.6	2.1 (<0.001)	71.5	69.4	2.1 (<0.001)
50%	15.9	14.2	1.7 (<0.001)	63.9	61.6	2.4 (<0.001)

Abbreviations: NH, nursing home; UTI, urinary tract infection.
[a]The reporting rates for long-stay and short-stay residents were separately modeled using logistic multilevel models with nursing home random intercepts. The model adjusted for individual-level variables of age, sex, race, comorbidity score, disability status, and chronic conditions, nursing home-level variables of size, region, ownership type, and both individual-level and nursing home-level variables of Medicaid-Medicare dual status and race.
[b]The reporting rates are average predicted reporting rates for residents in our sample, using their actual characteristics except for the race variables of interest, and the fitted parameters of the logistic multilevel models. The percentage of Hispanic, Asian, American Indian and Other residents was set to 0; the percentage of White residents was one minus the percentage of Black residents.

nursing homes with the lowest claims-based UTI rates (0.5 primary UTI diagnosis hospital claims per 100 residents on average), 48.3% and 63.1% of nursing homes had a four or five-star overall rating and quality measure rating, respectively. Among nursing homes with the highest claims-based UTI rate (4.5 primary UTI diagnosis hospital claims per 100 residents on average), 27% had a four- or five-star

TABLE 5 Correlations between claims-based infection rates[a] and nursing home compare measures in 2017.

Infection type	The number of NH	Quintiles of claims-based infection rates, means, 10th, 90th percentiles[b]	Percent of NHs with four- or five-star ratings		NH average ratings		
			Overall rating	Quality measure rating	Overall rating	Quality measure rating	MDS long-stay UTI measure[c]
UTI	3742	0	46.7	55.9	3.44	3.81	3.19
	1916	0.5 (0.3, 0.7)	48.3	63.1	3.50	4.02	2.90
	1928	1.0 (0.8, 1.2)	39.5	51.8	3.24	3.73	3.28
	1946	1.5 (1.3, 1.8)	36.4	47.5	3.13	3.61	3.37
	1903	2.3 (1.9, 2.7)	29.8	41.4	2.96	3.42	3.61
	1960	4.5 (3.0, 6.7)	27.0	35.3	2.82	3.21	4.01
Correlation coefficients between claims-based infection rates and measure[d]					−0.181***	−0.186***	0.111***
Pneumonia	7079	0	43.4	52.2	3.34	3.70	–
	1684	0.4 (0.2, 0.5)	51.6	59.4	3.60	3.96	–
	1692	0.7 (0.6, 0.8)	37.9	49.4	3.19	3.65	–
	1674	1.0 (0.9, 1.2)	36.1	46.2	3.12	3.53	–
	1705	1.6 (1.3, 1.9)	34.8	40.6	3.07	3.41	–
	1689	3.3 (2.1, 5.1)	31.3	35.9	2.96	3.23	–
Correlation coefficients between claims-based infection rates and measure[d]					−0.101***	−0.121***	–

Abbreviations: NH, nursing home; UTI, urinary tract infection.

[a]The claims-based infection rate was calculated as the total number of UTI or pneumonia hospital diagnosis claims identified for a nursing home in 2017 divided by the number of Medicare fee-for-service residents in the nursing home, multiplied by 100.

[b]Quintiles were assigned based on the distribution of claims-based UTI or pneumonia rates for nursing homes with at least one UTI or pneumonia hospital claim in 2017.

[c]The MDS long-stay UTI measure is calculated as the percentage of long-stay residents with an assessment where the I2300 item indicates an active urinary tract infection within the last 30 days.

[d]Spearman rank correlation coefficient was calculated for correlation between claims-based UTI or pneumonia rate and ratings, and Pearson correlation coefficient was calculated for correlation between claims-based and MDS-based UTI rates.

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$ at 5% significance level.

overall rating and 35.3% had a four- or five-star quality measure rating. Results were similar for pneumonia.

However, these trends were weak. Claims-based UTI and pneumonia rates correlated poorly with NHCC measures, with correlations of −0.181 (UTI) and −0.101 (pneumonia) with overall ratings, and −0.186 (UTI) and −0.121 (pneumonia) with the quality measure ratings. The correlation between the claims-based UTI rates and the MDS-based long-stay UTI quality measure was 0.111.

4 | DISCUSSION

We identified US nursing home residents between 2011 and 2017 who were hospitalized with a primary diagnosis of UTI or pneumonia and found their infections were substantially underreported on MDS assessments, which are used to create publicly reported measures on NHCC. We found UTI reporting increased considerably if we counted post-hospitalization MDS assessments (from 19.2% to 54.7% for long-stay residents). However, even then 42.0% of hospitalized UTIs were not reported; among pneumonia cases, 31.7% were not reported. These findings question the accuracy of nursing home-reported data and the validity of their derivative NHCC quality measures.

The higher reporting of UTI when considering post-hospitalization assessments may have reasonable explanations but nonetheless amounts to large fractions of missing UTIs in the reported quality measures. Practice patterns may vary in how nursing homes diagnose, treat, and manage UTI and pneumonia, depending on facility and staff resources, the availability of diagnostic testing, provider skill, and overall resident-specific care goals.[50,51] These may impact decisions to hospitalize as well as the information available at the time of nursing home discharge. However, discharge assessments can be submitted up to 14 days after discharge and be corrected as needed afterwards. Nonetheless, in practice, nursing homes may administratively

prefer to report the UTI in new assessments submitted after hospitalization. This complicates quality measurement in two ways: first, it is impossible to know whether the post-hospitalization reported UTI is the original or a newly developed condition; second, UTIs among individuals who do not return to the same nursing home would remain unreported (Appendix G).

The low reporting rates echo previous studies on falls and pressure ulcers, which also assessed MDS reporting using Medicare claims.[16,17] Very few studies have directly assessed MDS infection items.[19,21,52,53] One regional validation study of the MDS 2.0 UTI item used prospective surveillance and medical records and found 57.9% of UTI cases were reported.[52]

The use of MDS data to create publicly reported measures to both inform consumers and increase competition may create a strong disincentive to accurately report resident conditions, especially when data are not routinely verified and the penalties for misreporting are nearly nonexistent. To assess this, we compared reporting rates between an infection measure that is publicly reported (UTIs) and one that is not (pneumonia) from the same section of the MDS. The UTI long-stay reporting rate, which is used for public reporting, was 51.4 percentage points (pp) lower than the pneumonia long-stay reporting rate, or 15.9 percentage points lower if counting post-hospitalization assessments for UTI. Similarly, the UTI long-stay reporting rate was lower than the short-stay UTI reporting rate, which is not publicly reported, by 10.0 pp, or 7.7 pp if counting post-hospitalization assessments. The smaller difference here relative to the pneumonia comparison might be explained by a spillover effect. These differences suggest public reporting may be an important disincentive, but the low pneumonia reporting rates indicate that even without the disincentive, achieving accurate reporting may be difficult for administrative or other reasons. For example, in about 20% of both UTI and pneumonia cases that were documented in SNF claims, the same facility did not report the infection on a linked MDS assessment from the same billing period.

Even with low reporting, comparisons would still be possible if underreporting occurred similarly across facilities. However, our model showed Black residents and nursing homes with a higher percentage of Black residents had disproportionally lower reporting rates for UTI and pneumonia, after adjusting for other resident and nursing home-level characteristics including dual status. Such differences may come from structural, interpersonal, and cultural roots that perpetuate racism[54]; nonetheless, such unexplained variance makes systematic comparisons challenging.

Our claims-based infection rates analysis indicated the NHCC ratings provide some signal of quality related to infection, since among the 20% of nursing homes with the fewest hospitalizations, about 48% had four- or five-star ratings, while among the 20% of nursing homes with the most hospitalizations, only 27% did. This may be because the overall ratings reflect multiple dimensions of quality and nursing homes with high infection rates may perform better on noninfection dimensions. However, considering the severity of these infections, and that the difference in the claims-based infection rates was nine times higher in the latter group, this signal may be weak. Statistically, our claims-based infection rates had poor correlations with ratings and MDS-based UTI measures, consistent with other studies that have also found poor correlations between NHCC measures and other indicators for quality of care such as hospital readmission, rehabilitation results, and complaints.[24,25,27–31] Although five-star ratings are derived from a complicated formula involving many other measures, the low correlations indicate that the ratings and even the MDS-based UTI quality measure itself are not informative and effective at distinguishing nursing homes with high versus low risks of developing severe UTI or pneumonia that led to hospitalization. Improvements in reporting across MDS-based measures could impact quality ratings, and more so for facilities with more underreporting, such as nursing homes with more Black residents. However, further investigation would be required to describe how nursing homes would shift relatively, since reporting rates do not necessarily reflect underlying infection rates.

Our study has limitations. First, we only studied reporting for Medicare fee-for-service beneficiaries. Second, claims data can contain diagnosis errors and hospitals might overdiagnose patients with asymptomatic UTI.[45,46] However, this should be less likely in our sample of hospital claims with primary infection diagnosis. We also separately analyzed ICD-9CM and ICD-10CM data in Appendix H and found consistent results. Third, we only studied reporting rates for UTI or pneumonia severe enough to lead to hospitalization, so these results may not extend to less severe infections that might have been treated in-house or in outpatient settings. This also would suggest our sample contained more observations from nursing homes that were more likely to send their residents with UTI or pneumonia to a hospital, which would not threaten the internal validity of our results but may mean our results do not generalize well to reporting rates among nursing homes that provide more in-house care. Lastly, we may have overestimated reporting rates since we conservatively identified infections by requiring residents to return to the same nursing homes within 1 day of hospital discharge and by counting reporting on multiple assessments. Likewise, our final samples required linkage with assessments, so any case for which an appropriate assessment was not found was not included in our analysis.

During the period of our study, Medicare payments were based on a classification system called Resource Utilization Groups, Version IV (RUG-IV). Since 2019, however, payments have been determined by the Patient Driven Payment Model (PDPM), a shift from basing payments primarily on therapy minutes to basing payments on resident resource needs given their functional and clinical status. It is important to consider how this shift could impact reporting rates for UTIs and pneumonia. Under both systems, UTIs are not included in the list of conditions that can drive assignment to a group or case-mix index, and thus we do not expect UTI reporting rates to change with the new payment model. Pneumonia, on the other hand, could affect reimbursement under both payment models, though more so under the new model. If so, reporting could have improved for pneumonia after 2019. However, since pneumonia is not a publicly reported quality measure, by itself, it is not a good case for studying the tension between public reporting and reimbursement. Here, we included

pneumonia as a comparison point for UTIs, which are publicly reported from the same section of the MDS.

This study has important policy implications. As consumers and the government rely on NHCC to inform themselves, monitor resident health, and drive competition, it is imperative to provide valid and useful measures that reflect quality of care. The existing data collection system that relies on nursing homes to self-report certain clinical-event-based conditions does not provide accurate measures of falls, pressure ulcers, or UTIs on NHCC.[16,17] CMS can use the fee-for-service claims and managed care encounter records of a range of health care services from its Medicare and Medicaid programs to supplant or supplement MDS-based measures and as auditing tools. These data would not provide information on individuals who are not beneficiaries of these programs and some, especially from Medicaid, have their own data quality issues. However, more accurate quality measures for a large fraction of the nursing home population may be better than inaccurate measures for all.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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