The Impact of Telehealth on Hospitalization of Skilled Nursing Facility Patients During the COVID-19 Pandemic

Francis X. Campion, MD, FACP[1,2,3] (iD), Aanchal Mathur, MS[4] (iD) and Beata Konczewski, MS[5] (iD)

[1]Digital Health, MITRE Corporation, Bedford, Massachusetts, USA; [2]Atrius Health, Boston, Massachusetts, USA;
[3]Harvard Medical School, Boston, Massachusetts, USA; [4]Carnegie Mellon University, Pittsburgh, Pennsylvania, USA;
[5]Change Healthcare, Optum, Nashville, Tennessee, USA

Corresponding Author: Francis X. Campion, Email: fcampion@mitre.org

Abstract

Importance: This large claims data analysis documents lower hospitalization rates among patients receiving telehealth during a skilled nursing facility (SNF) stay compared with patients who did not receive telehealth. These findings based on care during the COVID-19 pandemic support the call for telehealth to become a routine option even after the public health emergency ends.

Objective: The COVID-19 Telehealth Impact Study was designed to describe the natural experiment of telehealth adoption during the pandemic. This focused analysis is intended to assist program development for the large population of patients cared for in SNFs.

Design, Setting, Participants: In March 2020, the MITRE Corporation and Mayo Clinic founded the COVID-19 Healthcare Coalition (C19HCC) and Telehealth Impact Study in order to respond to the pandemic. Reported here are trends based on a data set of 668,533 patients cared for in SNFs between January 2020 and March 2021.

Main Outcomes and Measures: Rates of hospitalization within 60 days of admission to the SNF for patients who received telehealth and those who did not receive telehealth during their SNF stay are reported. In addition, subgroups of patients based on the clinical diagnoses for which they received professional services from physicians and other providers are reported.

Results: Among the 668,533 patients meeting the criteria for admission to a SNF, 97,204 (14.5%) had at least one telehealth visit. Among telehealth patients, 40.1% received just one telehealth visit per 30 days and 9.4% received 10 or more telehealth visits per 30 days. Patients in all six diagnostic cohorts, who had at least one telehealth visit, experienced significantly lower rates of hospitalization compared with patients who received no telehealth despite having a higher average disease burden measured by the Charlson Comorbidity Index. Absolute rates of hospitalization rates dropped between 1.25% (dementia) and 1.87% (orthopedic) for clinical groups. The relative hospitalization rates dropped between 22% (cardiovascular) and 33% (dementia).

Conclusions and Relevance: These results underscore the potential benefits of using virtual care in SNFs to lower hospitalization rates and improve outcomes. We encourage continued study of digital health services for patients in post-acute settings and promotion of insurance coverage in the years to come as new best practices emerge.

Plain Language Summary

The study evaluated the impact of telehealth on patients in Skilled Nursing Facilities (SNF) during the COVID-19 pandemic using healthcare claims data. There were 668,533 patients with SNF stays across the United States between January 1, 2020, and March 31, 2021. We analyzed the correlation between telemedicine visits during the SNF stay and subsequent acute care hospitalization within 60 days of SNF admission. The percentage of patients who received at least one telehealth visit during their SNF stay was 14.5%. Patients in all six diagnostic groups experienced significantly lower hospitalization rates than patients who received no telehealth despite having a higher average disease burden as measured using the Charlson Comorbidity Index (CCI). These findings underscore the potential benefits of using virtual care in SNFs to improve outcomes.

Telemedicine enables medical care in a virtual environment and is increasingly used to connect clinicians and patients in need. During the COVID-19 pandemic, telehealth became critically important for many patients in SNFs when social distancing to limit infection became imperative. Telemedicine enabled access to routine care and the urgent assessment of emerging health problems by primary care and specialty clinicians. Telemedicine likely enabled quicker triage, earlier diagnosis, and treatment decisions, but the full impact on care for patients in SNFs is still emerging.

Greater than 1.3 million patients receive care in more than 15,000 SNFs in the United States.[1] In one pre-pandemic study of SNF rehabilitation residents, the use of telehealth was associated with improved clinical outcomes and patient satisfaction scores. The study also highlighted cost savings with the use of telehealth as it reduced the use of physical therapy services.[2] In a more recent pre-pandemic study, the use of telehealth was associated with a significantly lower rate of hospital admissions compared to traditional emergency department-based care in a similarly aged population of SNF patients. The authors extrapolated the findings to suggest that telehealth services could reduce care escalation by as much as 80%.[3]

The COVID-19 Healthcare Coalition was formed in March 2020, at the onset of the COVID-19 pandemic, to facilitate collaboration across the healthcare, academic, and technology communities to solve problems and save lives.[4] The COVID-19 Telehealth Impact Study was carried out as a voluntary effort by the Telehealth Work Group to track the rapidly evolving use of telehealth solutions across the United States. The project team previously reported results on telehealth trends in all 50 states and sub-studies in the use of telehealth for the care of patients with diabetes and mental health disorders.[5,6]

This study reports the use of telehealth in a very large cohort of SNF patients across the United States during the first year of the COVID-19 pandemic. We describe the use of telehealth for clinical ter groups and evaluate correlations with subsequent hospitalizations occurring within 60 days of SNF admission. Approved for Public Release; Distribution Unlimited. Public Release Case Number 23-1970. ©2023 The MITRE Corporation. ALL RIGHTS RESERVED.

Methods

The MITRE Institutional Review Board approved the study as part of the Telehealth Impact Study. The claims data came from large healthcare claims files provided by Change Healthcare (Nashville, Tennessee), representing more than 50% of private insurance claims in the United States. Data were deidentified in accordance with HIPAA (Health Insurance Portability and Accountability Act of 1996) privacy requirements, and no identifying information of individuals or covered entities was utilized. Data spanned from January 1, 2020, to March 31, 2021, including telehealth and non-telehealth activity.

The data set consisted of claims from physicians and other providers for professional services from the private insurance marketplace, including employers, unions, and other purchasing groups. Included are some Medicare Advantage programs and Medicaid programs using private insurance carriers. The study used "submitted claims" from providers to insurers rather than "closed claims" after payment determination in order to allow early identification of trends during the unfolding pandemic.

The data set includes patient care episodes from all 50 states, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands. We used the date of the first professional claim to define the day of SNF admission. For patients with more than one SNF admission during the study period, we used only the initial SNF admission. A hospitalization was counted if it occurred within 60 days of their SNF admission. The end of a stay in an SNF facility was defined by the day of the last professional billing encounter with an absence of claims for the following 60 days. Six clinical categories were created based on the 111 most common ICD-10-CM (International Classification of Diseases, Tenth Revision, Clinical Modification) codes used across the entire cohort at the time of SNF admission:

1. CARDIOVASCULAR: Cardiovascular/pulmonary/renal
2. DEMENTIA
3. DIABETES: Diabetes/obesity
4. NEUROLOGICAL: Neurologic/pain
5. ORTHOPEDIC: Orthopedic/post-op/wound/infection
6. OTHER

Each clinical encounter was then assigned to one of the six categories. Patients receiving care for multiple conditions during their SNF stay were classified into more than one category. The dataset was divided into telehealth and non-telehealth cohorts using telehealth modifiers (95 and GT) and procedure codes (G0425-G0427, G2010-G2012, 99421–99423) on their associated claims. If a patient had one or more telehealth visits at any time during their SNF stay, they were assigned to the telehealth group.

The data were cleaned, processed, and evaluated to calculate the percentage of the population based on age, gender, and clinical category. A two-tailed p-value was calculated and compared against an alpha of 0.05 to determine whether the difference between the two population proportions was significant. Welch's t-test was used to compare the CCI scores of the telehealth and non-telehealth populations.[7] The crude hospitalization rates were calculated using the patient identifier flag in the dataset and evaluated at the 95% confidence interval. The

Gradient Boost Machine method for classification was used to predict hospitalizations and to gain more insights from the data. Because of the unequal distribution of the outcome of interest (hospitalization), SMOTE oversampling technique was applied to balance the dataset.[8]

Results

Of the 668,533 patients meeting criteria for admission to an SNF facility, 97,204 (14.5%) had one or more telehealth visits. Age distribution was statistically similar in the telehealth and non-telehealth groups, with the largest groups being 71 to 80 years old (Table 2). There were slightly more females in the telehealth group compared to the non-telehealth group. The cardio category had the largest number of patients in both groups. Among the 668,533 distinct patients, there were 939,339 clinical category assignments. On average, each patient belonged to 1.4 categories (Table 1).

Table 1. Distribution of patients in skilled nursing facilities by clinical category

Clinical Category	Distinct Patients in Each Group (n)
Cardiovascular	404,638
Dementia	80,478
Diabetes	101,142
Neurological	193,518
Orthopedic	128,118
Other	31,445

The violin plot (Figure 1) shows the distribution of frequencies of telehealth encounters across the telehealth population. There were 40.1% of patients who received one telehealth visit per 30 days during their SNF stay.
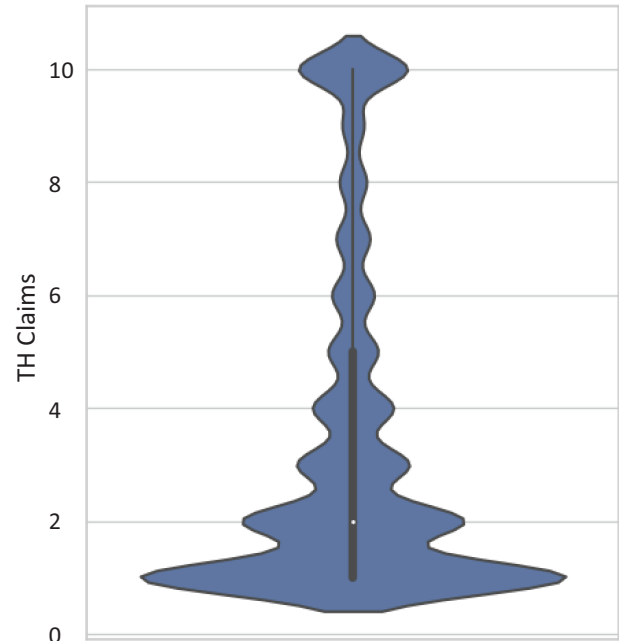

Fig. 1. Rates of telehealth use by patients in skilled nursing facilities (telehealth visits per 30 days). TH claims: telehealth claims.

Table 2. Characteristics of telehealth and non-telehealth patients in skilled nursing facilities

Parameters	Non-TH Patients (n)	Non-TH (%)	TH Patients (n)	TH (%)	P-value
Age (years)					
21–30	1,345	0.2	230	0.2	0.838455
31–40	4,012	0.7	849	0.9	0.393645
41–50	9,800	1.7	1,880	1.9	0.675296
51–60	35,487	6.2	6,151	6.3	0.6345
61–70	98,273	17.2	17,373	17.9	0.156106
71–80	151,450	26.5	25,742	26.5	0.145709
81+	270,964	47.4	44,979	46.3	0.900685
Gender					
Male	246,825	43.2	41,000	42.2	
Female	324,505	56.8	56,203	57.8	
Clinical Category					
Cardiovascular	347,933		56,705		
Dementia	66,754		13,724		
Diabetes	85,894		15,248		
Neurological	165,787		27,731		
Orthopedic	110,586		17,532		
Other	26,312		5,133		

Non-TH: non-telehealth claims; TH: telehealth.

There were 9.4% of patients who received at least 10 telehealth visits per 30 days.

The average CCI score was calculated for each clinical category for the telehealth and non-telehealth populations. In all clinical categories, except for the dementia category, the telehealth population had a significantly higher average disease burden than the non-telehealth group (Table 3).

Patient distribution by the number of telehealth visits per 30 days is listed in Table 4. Across all clinical categories, the hospitalization rate was significantly lower among patients who received at least one telehealth visit compared with those who received no telemedicine during their SNF stay (Table 5). Absolute rates of hospitalization rates dropped between 1.25% (dementia) and 1.87% (orthopedic) for clinical groups. The relative hospitalization rates dropped between 22% (cardiovascular) and 33% (dementia).

To understand the effects and statistical significance of characteristics in the dataset and their association with hospitalization (Table 2), a classification was performed (Figure 2). Results from the classification indicate that all variables were significant at the 0.05 level, with the exception of total charges. A detailed listing of classification coefficients and feature importance histogram can be found in Appendices A and B.

Discussion

This study examined the impact of telemedicine visits in SNFs during the first 15 months of the COVID-19 pandemic. From our large population sample, 14.5% of patients used telehealth consultations at least once during their SNF stay. During the pandemic, telehealth visits allowed SNF patients to receive medical care without facing the risk of increased exposure to the virus inherent in a transfer to the hospital. In this study, SNF patients who received at least one telehealth encounter during their SNF stay had a significantly lower hospitalization rate than those who did not have a telehealth visit.

Additionally, the CCI score was higher for those that received telehealth in all six clinical groups. This indicates that the illness burden in the telehealth group was higher than in the non-telehealth group. The age distribution was similar between telehealth and non-telehealth populations, with more than 45% of patients older than 80 years of age. This suggests that with an equally elderly yet sicker population, telemedicine interventions may have decreased the hospitalization rate.

Table 3. Illness burden in telehealth and non-telehealth patients

| Clinical Category | Charlson Comorbidity Index | | | | |
	TH (mean)	TH (SD)	Non-TH (mean)	Non-TH (SD)	*P*-value
Cardiovascular	8.53	3.52	8.27	3.58	1.13254E-47
Dementia	7.38	3.30	7.28	3.25	1.58376E-02
Diabetes	8.96	3.32	8.67	3.39	1.45499E-15
Neurological	8.28	3.59	7.95	3.66	2.58109E-28
Orthopedic	8.32	3.60	7.88	3.64	2.26524E-32
Other	8.42	3.80	8.19	3.96	5.46924E-03

Non-TH: non-telehealth; SD: standard deviation; TH: telehealth.

Table 4. Patient distribution by the number of telehealth visits per 30 days

TH Visits	Patients (*n*)	Patients (%)
1	38,989	40.1
2	18,417	18.9
3	9,200	9.5
4	6,568	6.8
5	4,429	4.6
6	3,561	3.7
7	2,811	2.9
8	2,231	2.3
9	1,813	1.9
10+	9,185	9.4

TH: telehealth.

Table 5. Hospitalizations in telehealth and non-telehealth patients

Clinical Category	Non-TH Patients (*n*)	Non-TH Hospitalization (*n*)	Rate (%)	TH Patients (*n*)	TH Hospitalizations (*n*)	Rate (%)	95% Confidence Interval	Relative Rates of Decline (%)
Cardiovascular	347,933	26,626	7.65	56,705	3,398	5.99	0.755 to 0.811	22
Dementia	66,754	2,549	3.82	13,724	353	2.57	0.599 to 0.749	33
Diabetes	85,894	5,479	6.38	15,248	729	4.78	0.692 to 0.807	25
Neurological	165,787	11,969	7.22	27,731	1,547	5.58	0.732 to 0.814	23
Orthopedic	110,586	7,672	6.94	17,532	889	5.07	0.680 to 0.782	27
Other	26,312	1,664	6.32	5,133	249	4.85	0.665 to 0.869	23
All Groups	**803,266**	**55,959**	**6.97**	**136,073**	**7,165**	**5.27**	**0.737 to 0.774**	**24**

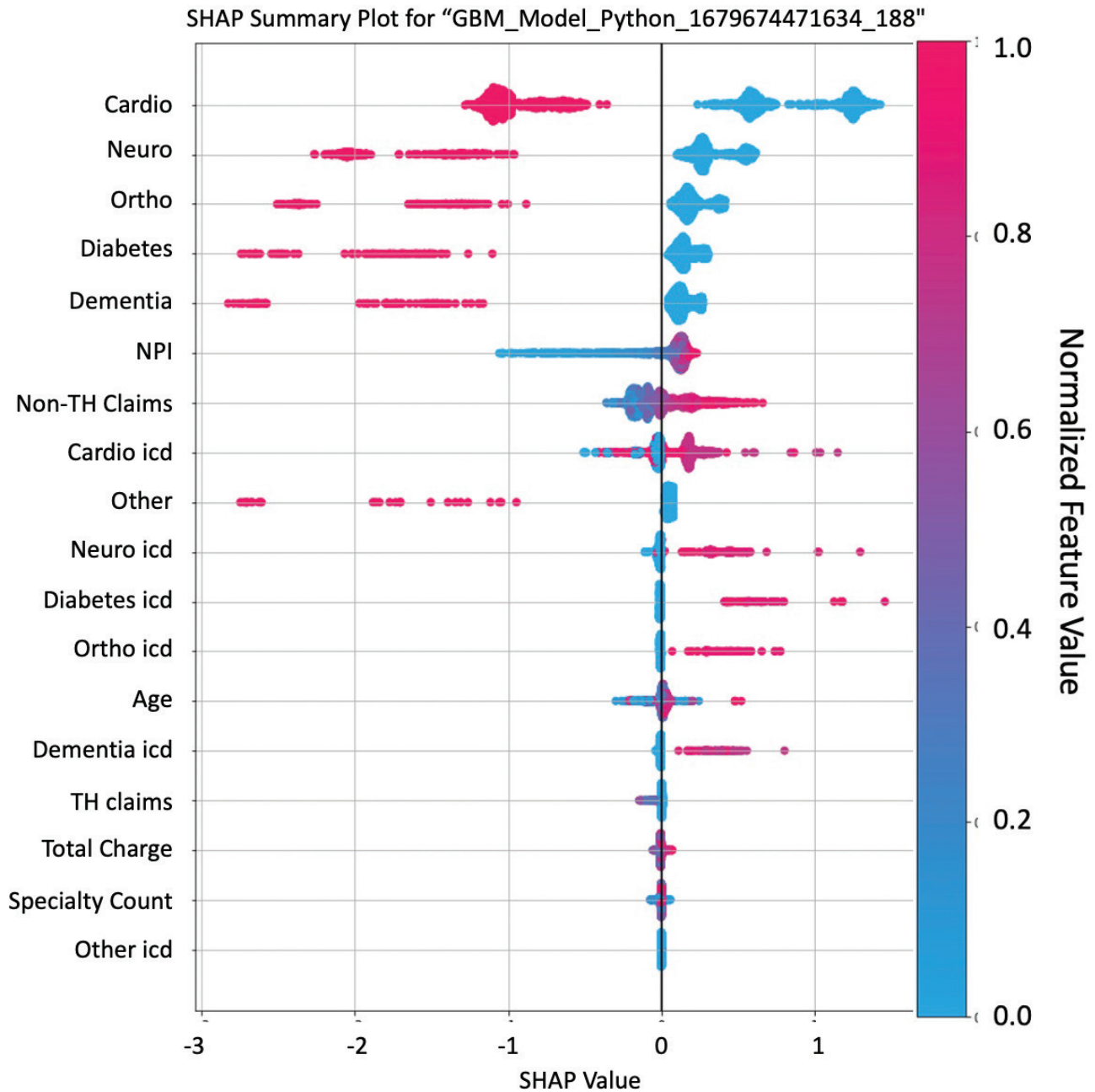Non-TH: non-telehealth; SD: standard deviation; TH: telehealth.

Fig. 2. Beeswarm plot of SHAP (SHapley Additive exPlanations) values. Cardio: cardiology; CI: confidence index; GBM: Gradient Boosting Machine; icd: International Classification of Diseases/ICD-10-CM; Neuro: neurology; Non-TH: non-telehealth; NPI: National Provider Identifier; Ortho: orthopedics; SD: standard deviation; TH: telehealth.

We would like to know with certainty that telehealth was the single intervention that led to lower hospitalization, but we cannot make this conclusion based on observational data alone. The Beeswarm SHAP summary plot is a complex and information-rich display of SHAP values that reveals the relative importance of features and their relationships with the predicted outcome. The plot verifies the complexity of our research problem: SNF patients had multiple diseases and thus belonged to more

than one disease category, resulting in multi-collinearity. The result is that conclusions are ambiguous when looking at only one of many clinical conditions a patient has in isolation.

The SHAP summary plot helps us understand the feature contributions to the linear regression. Feature importance is displayed in descending order, with the Cardiology category having the highest importance in predicting no hospitalization. Although having a telehealth claim (TH claim)

ranked lower in feature importance, the use of telemedicine visits has a negative effect on hospitalizations. Furthermore, the higher use of regular, non-telehealth (Non-TH) visits increases the chances of hospitalization.

The SHAP analysis also revealed that the lower number of providers a patient sees (npi_count; National Provider Index) is associated with a lower probability of hospitalization. This is consistent with an assumption that healthier patients require less medical attention and are less likely to be hospitalized.

These findings are encouraging and add further evidence to the benefit of telehealth for the care of patients in SNF. Best practices for using telehealth in the SNF setting have begun to emerge from experience during the pandemic. Jen and colleagues reported on their use of the Plan-Do-Study-Act cycle for improving the use of telemedicine in an SNF facility.[9]

We encourage further investigation and sharing of experience related to innovations in care delivery for patients in SNFs. Research should focus on the impact of telehealth on both quality of care and costs of care. The potential to treat new problems early and avoid transfer to the hospital contribute to improved patient satisfaction and avoids complications. Cost savings from avoiding hospitalization in the range of 22% to 33% relative rates for clinical subgroups, as identified in this study, should become a motivating factor for future work.

Limitations

Despite the valuable insights gained, this study was limited in the data it received regarding the characteristics of the SNFs where patients resided. Specifically, we needed information on bed size, insurance profiles, technology maturity, or access to telehealth services.

Further profiling of the SNF where a patient resided could provide greater detail about how telemedicine was used in the facility or how accessible it was to patients. These details could give interesting insight and more predictive power when assessing patients who may be admitted to the hospital. A major limitation of the data is that it does not include the majority of Medicare and Medicaid indemnity claims.

Conclusions

Our findings indicate that the use of telehealth for the care of patients in SNFs was associated with significantly lower hospitalization rates during the COVID-19 pandemic. Telehealth likely enabled quicker triage, rapid diagnosis, and early treatment and intervention decisions. However, this study was limited as we only evaluated patients with private insurance claims. We could not collect facility-characteristic data and could not control for other factors that might impact the risk of hospitalization. Future research could consider replicating this study by including Medicare/Medicaid indemnity claims and additional features that could impact hospitalization and other quality outcomes in the post-pandemic time frame. Overall, telehealth can potentially improve care delivery and outcomes for patients receiving care in SNFs.

Conflict Statements
The authors report no conflicts of interest in developing or publishing this work. The opinions expressed herein are those of the authors and do not represent the views or policy positions of the workgroup member organizations.

Contributors
Francis X. Campion contributed to study design, data management and interpretation, and manuscript preparation. Aanchal Mathur contributed to data analysis and interpretation and manuscript preparation. Beata Konczewski contributed to study design, data management, analysis, and interpretation.

References
1. Sengupta M, Lendon J, Melekin A, Singh P. Post-acute and long-term care providers and services users in the United States, 2017–2018 [Internet]. National Center for Health Statistics; 2022. (Vital Health Stat). Report No.: 3(47). Available from: https://www.cdc.gov/nchs/fastats/nursing-home-care.htm
2. Lee ACW, Billings M. Telehealth implementation in a skilled nursing facility: case report for physical therapist practice in Washington. Phys Ther. 2016 Feb;96(2):252–9.
3. Joseph JW, Kennedy M, Nathanson LA, Wardlow L, Crowley C, Stuck A. Reducing emergency department transfers from skilled nursing facilities through an emergency physician telemedicine service. West J Emerg Med. 2020 Oct 8;21(6):205–9.

4. Campion F, Ommen S, Sweet H, Shah N, Rabson B, Dougherty N, et al. COVID-19 telehealth impact study: exploring one year of telehealth experimentation. Telehealth Med Today. 2021 Jul 30 [cited 2021 Aug 1]; Available from: https://telehealthandmedicinetoday.com/index.php/journal/article/view/280

5. Campion F, Duffy L, Burgman A, Rojas R, Sangaralingham L, Sylvester P. Trends in telehealth care for diabetes during the COVID-19 Pandemic. Telehealth Med Today [Internet]. 2022 Jan 31;7(1). Available from: https://telehealthandmedicinetoday.com/index.php/journal/article/view/311

6. Sweet H, Campion F, Bixler M, Sylvester P, Ghanem N. Rural tele-mental health use during the pandemic for adjustment disorders, anxiety, and depression. J Rural Ment Health. 2022;46:151–61.

7. Johnston MC, Marks A, Crilly MA, Prescott GJ, Robertson LM, Black C. Charlson index scores from administrative data and case-note review compared favourably in a renal disease cohort. Eur J Public Health. 2015 Jun 1;25(3):391–6.

8. Chawla NV, Bowyer KW, Hall LO, Kegelmeyer WP. SMOTE: synthetic minority over-sampling technique. J Artif Intell Res. 2002 Jun 1;16(1):321–57.

9. Jen SP, Bui A, Leonard SD. Maximizing efficiency of telemedicine in the skilled nursing facility during the coronavirus disease 2019 pandemic. J Am Med Dir Assoc. 2021 Jun;22(6):1146–8.e2.

Appendix

Appendix A: Classification Coefficients and test statistics.

Names	Coefficients				β
Intercept	1.5814994	0.0075354	209.8752865	0.0	-0.0886800
Age	0.0000984	0.0000369	2.6649968	0.0076989	0.0069558
TH claims	-0.0375598	0.0013034	-28.8161087	0.0000000	-0.0958970
Nonth Claims	0.0275067	0.0002420	113.6641733	0.0	0.4995222
Diabetes	-3.2182350	0.0264825	-121.5228925	0.0	-0.9484050
Ortho	-2.8818908	0.0266763	-108.0320271	0.0	-0.9546172
Other	-4.5923343	0.1160386	-39.5759303	0.0	-0.7467747
Neuro	-2.4946908	0.0186963	-133.4321688	0.0	-1.0052475
Cardio	-1.8442677	0.0099120	-186.0645636	0.0	-0.9218922
Dementia	-3.3845452	0.0318767	-106.1759977	0.0	-0.8873995
Diabetes icd	0.8038576	0.0213550	37.6425686	0.0000000	0.2943968
Ortho icd	0.4581630	0.0230699	19.8597928	0.0000000	0.1773622
Other icd	1.6444846	0.1111014	14.8016503	0.0000000	0.2790220
Neuro icd	0.2485002	0.0155092	16.0227330	0.0000000	0.1221955
Cardio icd	-0.0788960	0.0061615	-12.8047718	0.0000000	-0.0642114
Dementia icd	0.6287932	0.0260580	24.1305603	0.0000000	0.2012313
Total Charge	-0.0000005	0.0000003	-1.9494362	0.0512434	-0.0123898
NPI Count	0.0028656	0.0002870	9.9847552	0.0000000	0.0560907
Specialty Count	0.0270674	0.0009401	28.7932086	0.0000000	0.1593835

Cardio: cardiology; CI: confidence index; GBM: Gradient Boosting Machine; icd: International Classification of Diseases/ICD-10-CM; Neuro: Neurology; Nonth: non-telehealth; NPI: National Provider Identifier; Ortho: orthopedics; TH: telehealth.

Appendix B. Variable Importance.

Variable Importance: H2O Gradient Boosting Machine
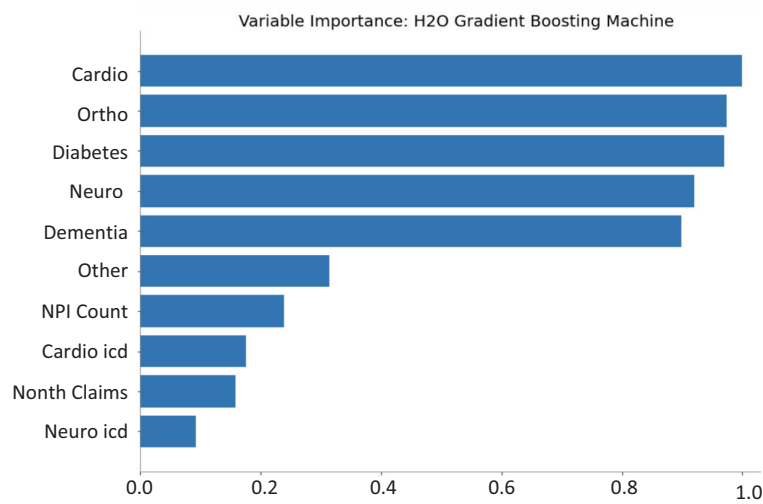
H2O Gradient Boosting Machine: An open-source machine learning platform that combines the predictions from multiple decision trees to generate final predictions. Cardio: cardiology; icd: International Classification of Diseases/ICD-10-CM; Neuro: neurology; Nonth: non-telehealth; NPI: National Provider Identifier; Ortho: orthopedics.