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Medicare Beneficiaries In Disadvantaged Neighborhoods Increased Telemedicine Use During The COVID-19 Pandemic

DOI: 10.1377/hlthaff.2021.01706
HEALTH AFFAIRS 41,
NO. 5 (2022): 635–642

ABSTRACT **Anticipating a growing need for health care during the COVID-19 pandemic, the Centers for Medicare and Medicaid Services expanded telemedicine coverage in the United States on March 6, 2020. In this study we used roughly thirty million Medicare fee-for-service claims to quantify outpatient telemedicine use before and after the Medicare telemedicine coverage waiver and to examine the association of telemedicine use with the Area Deprivation Index, a comprehensive measure of neighborhood socioeconomic disadvantage. Before the waiver, 0.42 percent of patients had at least one outpatient telemedicine visit, with no significant differences between people residing in the most versus the least disadvantaged neighborhoods. With the waiver, 9.97 percent of patients had at least one outpatient telemedicine visit, with the highest odds of utilization seen for people residing in the most disadvantaged neighborhoods. After adjustment, our data suggest that the coverage waiver increased access to telemedicine for all Medicare populations, including people residing in the most disadvantaged neighborhoods, although the odds of use were persistently lower with increasing age. Overall, these findings are encouraging, but they illuminate a need for targeted interventions to improve telemedicine access further.**

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Socioeconomic disparities in a variety of medical and surgical outcomes have been well documented.[1,2] In the past decade, increasing access to government-funded health care through Medicaid expansion and the Affordable Care Act has been associated with significant reductions in mortality, particularly among people living in more socioeconomically deprived areas.[3,4] As such, there is growing interest in enhancing health care accessibility through government programs across the United States.

Telemedicine is one means by which access to health care may be improved.[5] The utility of telemedicine has become particularly evident during the COVID-19 pandemic, as remote consulting and triaging allow patients to maintain adequate physical distancing and avoid overburdening hospitals.[6] Accordingly, on March 6, 2020, five days before the World Health Organization declared COVID-19 a global pandemic, the Centers for Medicare and Medicaid Services (CMS) expanded telemedicine coverage to include all Medicare beneficiaries in the United States.[5] Although federal law has historically restricted Medicare reimbursement for telehealth to designated rural areas and certain medical facilities, the Department of Health and Human Services determined that a nationwide public health emergency existed in the US, allowing Congress to exercise additional statutory authorities, including a waiver for enhanced telemedicine ser-

vices.[7] With the waiver, all restrictions for telemedicine use based on geographic location were eliminated, and providers were permitted to bill for virtual visits at the same rate as in-person visits. They were also allowed to reduce or waive the standard Medicare coinsurance and deductibles for these services.[5]

Despite this effort to broaden access to health care, studies on telemedicine use in the US during the COVID-19 pandemic since March 2020 have consistently reported disparities in its use by race and ethnicity; geographic location; and individual markers of socioeconomic status, such as insurance payer type and median household income.[8,9] However, no studies to our knowledge have assessed the association of a comprehensive marker of socioeconomic status with telemedicine use.

The Area Deprivation Index (ADI) is a validated composite metric incorporating household income, education, employment, and housing quality at the census block group level to provide a more holistic assessment of geographical socioeconomic disadvantage than individual socioeconomic status markers can provide.[1,10] In both the medical and surgical literature, increasing ADI has previously been associated with poor outcomes,[11,12] but the relationship of ADI with telemedicine use has not been demonstrated.

In this article we aim to describe the demographic characteristics of Medicare beneficiaries using telemedicine during the COVID-19 pandemic in the US and to quantify the trends in telemedicine use among people who reside in the most disadvantaged neighborhoods (as measured by ADI) both before and after the Medicare telemedicine coverage waiver took effect March 6, 2020. We hypothesized that telemedicine has been underused by people residing in the most disadvantaged neighborhoods and that the Medicare coverage waiver might not have adequately reached this population.

Study Data And Methods

DATA SOURCES AND STUDY POPULATION In this retrospective cohort study, we used Medicare fee-for-service claims data to identify adult patients ages eighteen and older with at least one outpatient visit between January 1, 2019, and March 31, 2021, based on Current Procedural Terminology codes 99201–99215. Claims that were invalid, duplicated, or missing demographic information or ZIP code were excluded (see online appendix exhibit A1).[13] This study was reviewed and approved by the Johns Hopkins Medicine Institutional Review Board.

PATIENT FACTORS Patient visits were stratified by whether they were conducted via telemedicine or in person. Telemedicine visits were distinguished from other outpatient visits by Place of Service Code 02.[14] Patient-level ADI rankings were obtained from the University of Wisconsin's Neighborhood Atlas and calculated using a nine-digit ZIP code.[10] ADI was originally designed as a measure of socioeconomic status using a continuous scale from 0 to 100 for national percentile ranking. For the purpose of this analysis, patients were categorized on the basis of their national ADI quartile, as described by Amy Kind and colleagues,[1] where 85 percent of the general population was classified as ADI-1 (least deprived) and the most disadvantaged 15 percent were evenly spread over ADI-2, ADI-3, and ADI-4. Other patient demographic factors assessed included age, sex, race and ethnicity (White, Asian, Hispanic, Black, and other or unknown), and ZIP code (obtained from the Medicare Master Beneficiary Summary File).[15] Beneficiaries' ZIP codes were used to identify population density of residence (metropolitan versus rural) and geographical region (Northeast, Midwest, South, West, and other).[16] We also reviewed each patient's inpatient, outpatient, and carrier claims one year before the first outpatient visit date to determine their Charlson Comorbidity Index score. To define a comorbidity, we required at least one diagnosis from inpatient claims or at least two diagnoses recorded greater than thirty days apart from outpatient and carrier claims.[17]

OUTCOMES The primary outcome was telemedicine use, assessed as a proportion of outpatient visit claims. We explored trends in telemedicine use over time and evaluated the association of the Medicare telemedicine coverage waiver with telemedicine use overall and by ADI quartile. We also evaluated other patient characteristics associated with telemedicine use before and after the waiver took effect.

STATISTICAL ANALYSIS We used an interrupted time series analysis to estimate the association of the Medicare telemedicine coverage waiver with telemedicine use. We treated the weekly rate of telemedicine visits per 100 outpatient visits as a time series and the week of the waiver announcement as a possible interruption in the time series. The weekly rate of telemedicine use was divided into two segments: before and after the Medicare telemedicine coverage waiver took effect (for brevity, this is described as pre- and postwaiver). Negative binomial regression was used to model the time series and calculate the weekly rate of telemedicine visits rate ratios by ADI quartile. Multivariable logistic regression was then used to determine demographic and clinical factors associated with telemedicine use in the prewaiver (January 1, 2019–March 5,

Our data suggest large swings in access to telemedicine across the United States for all populations.

2020) and postwaiver (March 7, 2020–March 31, 2021) periods separately. Model 1 adjusted for age, sex, and race and ethnicity. Model 2 adjusted for all covariates in model 1, as well as Charlson Comorbidity Index score, residence population density, geographical region, and ADI quartile. Statistical significance was defined as $p < 0.05$. Analyses were performed using SAS Enterprise, version 7.1, and Stata, version 17.

LIMITATIONS There were limitations to this retrospective study. Our analysis was limited to general trends in the pre– and post–Medicare telemedicine coverage waiver periods, and we were unable to comment on specific applications of telemedicine use. Because data were collected from an administrative database, they came with the inherent risk of misclassification bias. Our findings are also specific to Medicare patients, and it is possible that the trends we report are not reproducible for those covered by private payers or individual health systems, or without any insurance coverage. This is especially true for Medicare patients younger than age sixty-five. We also were unable to account for any supplemental initiatives by hospitals and clinics that accompanied the coverage waiver and changed over time (such as efforts to raise awareness of telemedicine in communities) or for whether the option to waive the copay or deductible for patients was embraced. Also, we could not assess technology ownership, which has been closely linked to health care provider communication in the past.[18] Despite these limitations, our study represents a very large sample of claims, use of contemporary national-level data, and application of a comprehensive marker of socioeconomic status, using patient ZIP code data to assess trends in telemedicine use by neighborhood socioeconomic deprivation status.

Study Results

STUDY POPULATION There were 30,488,891 patients with at least one outpatient visit claim to Medicare in the period before the telemedicine coverage waiver, of which 129,114 (0.42 percent) had at least one visit conducted via telemedicine. In the study period after the waiver took effect, there were 28,038,684 patients with at least one outpatient visit claim, of whom 2,795,242 (9.97 percent) had at least one visit conducted via telemedicine ($p < 0.001$). Baseline demographic and clinical cohort characteristics of patients with outpatient visit claims in the pre- and postwaiver periods are presented in exhibit 1.

TRENDS IN TELEMEDICINE USE In the prewaiver period, the weekly rate of telemedicine use was relatively stable over time, both overall and within each ADI quartile (exhibit 2). During the week after the Medicare telemedicine coverage waiver was announced, telemedicine use increased significantly across all groups, with people residing in the least disadvantaged neighborhoods (ADI-1) experiencing a 56.0-fold (95% confidence interval: 12.3, 253.7) increase in telemedicine use and people residing in the most disadvantaged neighborhoods (ADI-4) experiencing a 28.9-fold (95% CI: 10.4, 79.9) increase in use (all $p < 0.001$).

The largest absolute increase in telemedicine use after the telemedicine coverage waiver took effect was observed in ADI-4, followed by ADI-3, ADI-1, and ADI-2 (exhibit 2). After the initial surge during the week after the waiver took effect, there was a similar, steady decline in telemedicine use across all ADI quartiles (incidence rate ratio: 0.97; 95% CI: 0.96, 0.98; $p < 0.001$).

FACTORS ASSOCIATED WITH TELEMEDICINE USE

▶ **BEFORE THE WAIVER:** In the prewaiver period, higher ADI quartile (greater deprivation) was associated with higher odds of telemedicine use (ADI-4 versus ADI-1, OR: 2.01; 95% CI: 1.95, 2.08) (exhibit 3, unadjusted data). Older age and Asian race were associated with lower odds of telemedicine use, whereas Black and Hispanic race and ethnicity, increasing Charlson Comorbidity Index score, and rural location were associated with higher odds (appendix exhibit A2, unadjusted model).[13]

After demographic variables (exhibit 3, model 1), comorbidities, and region and residency factors (model 2) were adjusted for, no statistical significance was found in the association of ADI quartile with telemedicine use: People residing in the most disadvantaged neighborhoods had similar odds of telemedicine use compared with people residing in the least disadvantaged neighborhoods (ADI-4 versus ADI-1, OR: 0.97; 95% CI: 0.94, 1.01) exhibit 3, model 2). In the fully adjusted model (model 2), increasing age and Black race were associated with lower odds of telemedicine use, whereas female sex, increasing Charlson Comorbidity Index score, and rural location were associated with higher odds (ap-

EXHIBIT 1

Baseline demographic and clinical characteristics of US Medicare patients with at least one outpatient visit claim, before and after the Medicare telemedicine coverage waiver took effect, 2019–21

	Prewaiver		Postwaiver	
Characteristics	**Number**	**Percent**	**Number**	**Percent**
Total sample	30,488,891	—[a]	28,038,684	—[a]
National Area Deprivation Index (ADI) quartile				
ADI-1 (least deprived)	28,457,412	93.34	26,296,700	93.79
ADI-2	881,886	2.89	768,052	2.74
ADI-3	674,663	2.21	577,932	2.06
ADI-4 (most deprived)	474,930	1.56	396,000	1.41
Age, years				
18–64	4,235,107	13.89	3,513,597	12.53
65–69	7,522,529	24.67	6,971,373	24.86
70–74	6,850,294	22.47	6,582,844	23.48
75–79	4,936,838	16.19	4,635,483	16.53
80–84	3,379,477	11.08	3,157,496	11.26
85+	3,564,646	11.69	3,177,891	11.33
Sex				
Male	13,388,944	43.91	12,349,567	44.04
Female	17,099,947	56.09	15,689,117	55.96
Race and ethnicity				
White	25,269,180	82.88	23,400,369	83.46
Asian	625,367	2.05	558,228	1.99
Hispanic	603,624	1.98	516,711	1.84
Black	2,652,372	8.70	2,287,400	8.16
Other or unknown	1,338,348	4.39	1,275,976	4.55
Charlson Comorbidity Index score				
0	18,061,801	59.24	17,788,349	63.44
1–2	8,318,554	27.28	7,116,374	25.38
3–4	2,729,867	8.95	2,180,884	7.78
5–6	813,185	2.67	580,715	2.07
7+	565,484	1.85	372,362	1.33
Metropolitan status				
Rural	6,222,658	20.41	5,607,342	20.00
Metropolitan	24,266,233	79.59	22,431,342	80.00
Geographic region				
Northeast	5,512,111	18.08	5,079,131	18.11
Midwest	6,897,749	22.62	6,222,522	22.19
South	12,177,138	39.94	11,283,016	40.24
West	5,857,878	19.21	5,419,074	19.33
Other	44,015	0.14	34,941	0.12
At least one telemedicine visit				
No	30,359,777	99.58	25,243,442	90.03
Yes	129,114	0.42	2,795,242	9.97

SOURCE Authors' analysis of Medicare fee-for-service claims. **NOTES** The period before the waiver was January 1, 2019–March 5, 2020. The period after the waiver took effect was March 7, 2020–March 31, 2021. [a]Not applicable.

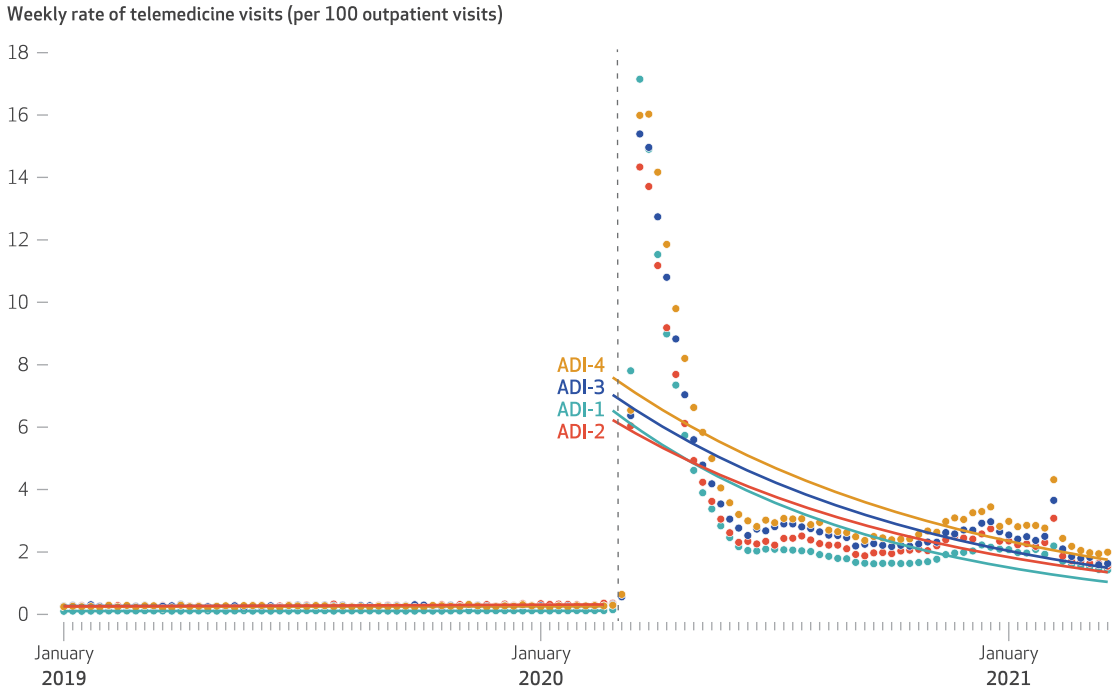
pendix exhibit A2, model 2).[13]

▶ **AFTER THE WAIVER:** In the postwaiver period, higher ADI quartile (greater deprivation) was associated with higher odds of telemedicine use based on univariable analysis (ADI-4 versus ADI-1 OR: 1.16, 95% CI: 1.15, 1.17) (exhibit 3, unadjusted data). Increasing age and rural location were associated with lower odds of telemedicine use, whereas female sex and non-White race and ethnicity were associated with higher odds (appendix exhibit A3, unadjusted data).[13]

After demographic variables (exhibit 3, model 1), comorbidities, and region and residency factors (model 2) were adjusted for, increasing ADI quartile was persistently associated with higher odds of telemedicine use; unlike in the prewaiver period, people residing in the most disadvantaged neighborhoods (ADI-4) had the highest odds of using telemedicine relative to people residing in the least disadvantaged neighborhoods (ADI-1) after adjustment (ADI-4 versus ADI-1, OR: 1.14; 95% CI: 1.12, 1.15) (exhibit 3, model 2). In the fully adjusted model (model 2), increasing age and rural location were still asso-

EXHIBIT 2

Interrupted time series analysis of the weekly rate of telemedicine visits per 100 outpatient visits in the US before and after the Medicare telemedicine coverage waiver took effect, by national Area Deprivation Index (ADI) quartile, 2019–21



SOURCE Authors' analysis of Medicare fee-for-service claims. **NOTES** Dots represent weekly rates of telemedicine visits, with solid lines depicting the line of best fit for each group. ADI-1 represents the least deprivation, and ADI-4 the most. The period before the waiver was January 1, 2019–March 5, 2020. The period after the waiver took effect was March 7, 2020–March 31, 2021.

ciated with lower odds of telemedicine use, whereas female sex, Asian and Hispanic race and ethnicity, and increasing Charlson Comorbidity Index score were associated with higher odds (appendix exhibit A3, model 2).[13]

Discussion

The COVID-19 pandemic has highlighted disparities in health care access in the United States.[19,20] As physical distancing and a reduction in nonessential medical care were encouraged, tele-

EXHIBIT 3

Association of Area Deprivation Index (ADI) quartile with telemedicine use in the US before and after the Medicare telemedicine coverage waiver took effect, 2019–21

	Unadjusted model		Model 1		Model 2	
National ADI quartile	**OR**	**95% CI**	**Adjusted OR**	**95% CI**	**Adjusted OR**	**95% CI**
PREWAIVER						
ADI-1 (least deprived)	Ref[a]		Ref		Ref	
ADI-2	2.352	2.300, 2.406	1.864	1.822, 1.907	1.073	1.048, 1.098
ADI-3	2.136	2.079, 2.194	1.673	1.628, 1.719	1.027	0.999, 1.056
ADI-4 (most deprived)	2.010	1.945, 2.077	1.469	1.421, 1.519	0.972	0.940, 1.005
POSTWAIVER						
ADI-1 (least deprived)	Ref		Ref		Ref	
ADI-2	0.959	0.952, 0.967	0.888	0.881, 0.895	1.029	1.021, 1.037
ADI-3	1.083	1.074, 1.092	0.982	0.974, 0.990	1.112	1.102, 1.122
ADI-4 (most deprived)	1.158	1.146, 1.169	0.992	0.982, 1.002	1.135	1.123, 1.146

SOURCE Authors' analysis of Medicare fee-for-service claims. **NOTES** The period before the waiver was January 1, 2019–March 5, 2020. The period after the waiver took effect was March 7, 2020–March 31, 2021. Model 1 is adjusted for age, sex, and race and ethnicity. Model 2 is adjusted for all covariates in model 1 as well as the Charlson Comorbidity Index score, residence population density, geographical region, and ADI quartile. Refer to appendix exhibits A2 and A3 for all patient characteristics that were analyzed (see note 13 in text). OR is odds ratio. [a]Reference value is 1.000.

medicine became more appealing to reduce the spread of COVID-19 infection across the country.[21] We sought to investigate trends in telemedicine use in the periods before and after the Medicare telemedicine coverage waiver took effect and to assess the association of socioeconomic status, as measured by the Area Deprivation Index, with telemedicine use before and after the waiver took effect. We found a significant increase in telemedicine use overall as well as across all ADI quartiles after the waiver took effect. In the prewaiver period, ADI was not significantly associated with telemedicine use. In contrast, in the postwaiver period, higher ADI (greater deprivation) was associated with higher telemedicine use. Overall, our data suggest large swings in access to telemedicine across the United States for all populations, including people living in the most disadvantaged neighborhoods.

Before the Medicare telemedicine coverage waiver took effect, telemedicine was covered only for patients in designated rural areas or in particular medical facilities.[5] This offers one explanation for why the odds of telemedicine use were more than four times higher in rural areas than in metropolitan areas in the prewaiver period, as those patients were generally the only ones eligible to use telemedicine. With the waiver, restrictions on geographic location for telemedicine use were eliminated, rendering patients in all residential areas across the US eligible for coverage.[5] This reversed the previous trend, resulting in patients who lived in rural areas having 22 percent lower odds of using telemedicine during the study period than patients who lived in metropolitan areas in our study. These data suggest that there was a substantial increase in accessibility to patients in metropolitan areas, who were previously ineligible for telemedicine coverage under Medicare.

In addition to expanding telemedicine coverage by location, the Medicare telemedicine coverage waiver permitted providers to bill for virtual patient visits at the same rate as in-person visits, regardless of whether visits were with video or audio only, and it also allowed providers to reduce or waive the standard Medicare coinsurance and deductible for all telemedicine services.[5] These measures were intended to reduce socioeconomic barriers, in addition to eliminating geographic restrictions, to improve health care accessibility as much as possible. In our study we found that the waiver was, in fact, associated with greater telemedicine use by nearly all populations after its implementation, not only in overall numbers but also when stratified by particular demographic characteristics.

A notable exception to this was that the odds of utilization continued to decrease with increasing age, with people ages eighty-five and older having the lowest odds of telemedicine use relative to their younger counterparts (younger than age sixty-five) in both the pre- and postwaiver periods. Compared with younger adults, older adults have been shown to be less likely to own devices such as smartphones, and technology ownership is closely associated with communication with health care providers.[22] Access to and usability and adoption of new technologies are inversely correlated with age, suggesting a major barrier to telemedicine care in the elderly.[23,24] Of note, people younger than age sixty-five only qualify for Medicare if they have particular conditions such as disability or end-stage renal disease, so this age group is likely not representative of the general population.[25]

People living in the most disadvantaged neighborhoods experienced the greatest increase in their odds of telemedicine use postwaiver.

We found a substantial change in the association of geographic socioeconomic deprivation (as determined by ADI) with telemedicine use after the Medicare telemedicine coverage waiver took effect. People living in the most disadvantaged neighborhoods (ADI-4) experienced the greatest increase in their odds of telemedicine use postwaiver. These findings were surprising, as prior studies have reported a consistent inverse association of socioeconomic status with telemedicine use during the COVID-19 pandemic. For example, Vivian Hsiao and colleagues demonstrated that rural status and self-pay or uninsured status were significantly negatively associated with having video visits in a single integrated academic health system.[9] Lauren Eberly and colleagues demonstrated an association of Medicaid insurance and lower household income with decreased telemedicine use and video use during telemedicine visits, respectively, also in a large academic health system.[18] Our

study is unique in that we used a comprehensive measure of socioeconomic status (ADI) to assess the association of socioeconomic deprivation with telemedicine use. We also used national Medicare claims data to assess trends in Medicare utilization during the COVID-19 pandemic nationwide, which is different from prior studies on this topic. The correlation shown by our data suggests that CMS was, in fact, successful in reaching even people in the most disadvantaged US neighborhoods with its telemedicine coverage waiver, at least among Medicare beneficiaries.

Several studies to date have highlighted concerns that increased telemedicine coverage is worsening preexisting racial disparities among certain populations during the COVID-19 pandemic.[9,18,26] Many investigators have emphasized an association with race and ethnicity and underuse of telemedicine in particular.[9,18,26,27] After Medicare telemedicine expansion, we found that telemedicine access was improved for all minority populations compared with White patients, with higher odds of telemedicine use noted after adjustment. Thus, our data suggest that the increase in telemedicine coverage has not worsened racial disparities in the Medicare population in the way some investigators feared.[9,18,26]

However, it is impossible to ignore that the greatest improvement in telemedicine use occurred in the week immediately after the announcement of the coverage waiver on March 6, 2020, and that by the next month (April 2020) there was already a sharp decline in the weekly rate of telemedicine visits for patients in all ADI quartiles. It is possible that visits peaked at the beginning because of acute fears of the COVID-19 pandemic that subsequently waned, but further research is warranted to understand the consistent postwaiver decline. Encouragingly, although patients living in the least deprived neighborhoods (ADI-1) experienced the largest increase in telemedicine use during the first week postwaiver, those living in the most deprived neighborhoods (ADI-4) had the highest rates of telemedicine use during the entire postwaiver period.

Overall, our findings are encouraging, as they suggest that the Medicare telemedicine coverage waiver could improve access to health care for people in the most disadvantaged US neighborhoods without worsening disparities. Since the Department of Health and Human Services first determined that a nationwide public health emergency existed in January 2020, the declaration has been renewed every three months. As of now, expanded telemedicine coverage continues to rely on this ongoing public health emergency.[28] Although we were unable to assess health-related patient outcomes in this study, other studies have shown that telemedicine is associated with similar or improved outcomes relative to regular care across numerous disciplines.[29] Together, these findings support the critical need for novel legislation that would allow continued telemedicine reimbursement outside of a national public health emergency, as well as targeted efforts to improve accessibility for all populations.

Conclusion

Given that patients with greater socioeconomic disadvantage are already more susceptible to poor outcomes in outpatient disease management,[2] efforts to expand the scope and quality of telemedicine for this high-risk population are essential during this pandemic and in the future. In this study we found that ADI, a comprehensive marker of socioeconomic status, was not significantly associated with outpatient telemedicine use among Medicare beneficiaries before March 6, 2020, when the Medicare telemedicine coverage waiver took effect. In contrast, people residing in the most disadvantaged neighborhoods were more likely to use telemedicine in the postwaiver period. Because of the ongoing, constantly evolving pandemic, it is imperative that research continue, to investigate factors associated with telemedicine access and use to ensure that timely health care is available to all patients who need it, both during and beyond the COVID-19 pandemic. ■

Christi Walsh and Caitlin Hicks (principal investigator) were supported by a grant from the Society of Bedside Medicine.

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