Journal of the American Heart Association

ORIGINAL RESEARCH

Trends and Costs of US Telehealth Use Among Patients With Cardiovascular Disease Before and During the COVID-19 Pandemic

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BACKGROUND: The COVID-19 pandemic affected outpatient care delivery and patients' access to health care. However, no prior studies have documented telehealth use among patients with cardiovascular disease.

METHODS AND RESULTS: We documented the number of telehealth and in-person outpatient encounters per 100 patients with cardiovascular disease and the percentage of telehealth encounters from January 2019 to June 2021, and the average payments per telehealth and in-person encounters across a 12-month period (July 2020–June 2021) using the MarketScan commercial database. From February 2020 to April 2020, the number of in-person encounters per 100 patients with cardiovascular disease decreased from 304.2 to 147.7, whereas that of telehealth encounters increased from 0.29 to 25.3. The number of in-person outpatient encounters then increased to 280.7 in June 2020, fluctuated between 268.1 and 346.4 afterward, and ended at 268.1 in June 2021, lower than the prepandemic levels. The number of telehealth encounters dropped to 16.8 in June 2020, fluctuated between 8.8 and 16.6 afterward, and ended at 8.8 in June 2021, higher than the prepandemic levels. Patients who were aged 18 to 35 years, women, and living in urban areas had higher percentages of telehealth encounters than those who were aged 35 to 64 years, men, and living in rural areas, respectively. The mean (95% CI) telehealth and in-person outpatient encounter costs per visit were $112.8 (95% CI, $112.4–$113.2) and $161.4 (95% CI, $160.4– $162.4), respectively.

CONCLUSIONS: There were large fluctuations in telehealth and in-person outpatient encounters during the pandemic. Our results provide insight into increased telehealth use among patients with cardiovascular disease after telehealth policy changes were implemented during the pandemic.

Key Words: cardiovascular disease ■ heart disease ■ stroke ■ telehealth ■ telehealth outpatient cost

During the early COVID-19 pandemic period, many states in the United States mandated stay-at-home orders,[1] and patients with COVID-19 took priority for hospital beds and in-person visits.[2,3] As a result, many patients who needed medical care either delayed their doctor visits[4,5] or sought telehealth.[6] Because of the emergency need for telehealth, the Centers for Medicare and Medicaid Services relaxed telehealth restrictions by expanding coverage of services starting March 6, 2020.[7] For example, expanded telehealth flexibilities allowed for broader use of telehealth during the public health emergency, such as waiving geographic limitations in service provision and expanding the list of services eligible for reimbursement.[8] The Centers for Medicare and Medicaid Services encouraged private health insurers to cover telehealth services, and the US Department of Health and Human Services Office for Civil Rights waived the Health Insurance Portability and Accountability Act rules to facilitate telehealth use during the pandemic.[9] Several studies have documented increased telehealth use

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Supplemental Material is available at https://www.ahajournals.org/doi/suppl/10.1161/JAHA.122.028713

For Sources of Funding and Disclosures, see page 10.

JAHA is available at: www.ahajournals.org/journal/jaha

CLINICAL PERSPECTIVE

What Is New?

- Telehealth use increased significantly during the first 2 months of the pandemic among patients with cardiovascular disease and sub–cardiovascular diseases (eg, acute myocardial infarction, heart failure, ischemic heart disease, stroke, and atrial fibrillation).
- In a subsample of a commercial claims database, telehealth and in-person outpatient encounters among patients with cardiovascular disease changed significantly during the COVID-19 pandemic periods compared with the prepandemic period.
- Patients with cardiovascular disease who were younger, women, and living in urban areas had higher use of telehealth than those who were older, men, and living in rural areas, respectively, throughout the pandemic.

What Are the Clinical Implications?

- Because the temporary telehealth provisions put in place during the COVID-19 public health emergency remain, policymakers, health systems, health services researchers, and insurers may benefit from information about telehealth and in-person use among patients with cardiovascular disease for decisions about drivers of telehealth use and sustainability.
- Health care providers and health systems may attune the provision of care to the health needs of patients with cardiovascular disease–related diagnoses and continued interest in using telehealth services.
- Policymakers, researchers, and insurers benefit from monitoring ongoing trends of use and cost of telehealth services when developing protocols for coverage and treatment, and tracking population health.

Nonstandard Abbreviations and Acronyms

CCAE	Commercial Claims and Encounters
OOP	out-of-pocket

associated with these COVID-19–related policy changes.[10–14] However, no prior studies have documented telehealth use among patients diagnosed with cardiovascular disease (CVD).

CVD is prevalent and burdensome, with 931 558 deaths in 2020 attributed to CVD.[15] Nearly half of US adults (49.2%) have at least 1 type of CVD,[16] and 28% of all deaths of US adults are attributed to CVD.[15] Ideal care for chronic diseases often includes primary care, self-management strategies, and multiple touchpoints with the health care system.[17] Heath care access, particularly the role of telehealth during the pandemic, was relevant for patients with cardiovascular conditions because of the potentially increased risk for developing serious illnesses from COVID-19.[18] Although studies have examined overall trends in the use of telehealth at various time points throughout the pandemic,[19–21] no studies have documented telehealth use among patients diagnosed with CVD or those who have underlying and potentially undiagnosed CVD conditions. Documenting telehealth use among patients with cardiovascular conditions and the related costs could guide decisions about ongoing telehealth implementation among patients with CVD.

This study reports the trends in telehealth use and in-person outpatient visits among patients with CVD before and during the COVID-19 pandemic using commercial insurance claims data to examine health care use patterns that may have been associated with these policy changes (ie, mobility restrictions and expanded coverage of telehealth). Finally, we summarize the cost of telehealth and in-person visits for patients with CVD.

METHODS

Data

We used the IBM Watson Truven Health MarketScan Commercial Claims and Encounters (CCAE) database from January 1, 2019 to June 30, 2021.[22] MarketScan CCAE database are derived from administrative medical claims of a large subsample of enrollees and their dependents in employer-sponsored health insurance plans provided by >300 large employers covering 30 health plans and >500 hospitals in the United States, with 24.9 million enrollees in 2017 and 16.4 million enrollees in 2020. The data include inpatient, emergency department, outpatient, and pharmacy claims, information about patients' demographics such as age and sex, type of insurance plans (ie, capitated or noncapitated), and urban/rural status and Census region of patient residence, and allows tracking of patients over multiple periods. MarketScan data have been used in a wide range of studies, including those on health care use.[23–26] We accessed MarketScan data through Truven Health MarketScan Treatment Pathways, an online query tool that allows researchers to access data by identifying cohorts of patients based on the *International Classification of Diseases, Tenth Revision, Clinical Modification* (*ICD-10-CM*) diagnosis code, procedure modifiers, and place and date of service. All MarketScan patient data are deidentified and comply with the Health Insurance Portability

and Accountability Act, so our study is not subject to institutional review board approval from the Centers for Disease Control and Prevention. The authors cannot make the MarketScan data publicly available because of the data use agreement. The program codes used for the study will be available upon request to the corresponding author.

Identification of Patients With CVD

Figure 1 shows the study sample selection to identify patients diagnosed with CVD. We first selected patients who appeared in 2017 to 2018 MarketScan commercial data, aged 18 to 64 years as of June 30, 2021, and continuously enrolled from January 2017 to June 2021. We excluded patients aged ≥65 years, because they might also have coverage through Medicare, which would not be captured in the CCAE database. We based our definition of patients with CVD on *ICD-10-CM* codes I00-I09 and I16-I78, defined after excluding hypertension diagnosis (*ICD-10-CM* code I10-I15) from CVD diagnosis (*ICD-10-CM* code I00-I78). We excluded patients with hypertension only because more than half of the patients with CVD diagnosis had only hypertension diagnosis, which we would like to study differently from other CVD diagnoses, as suggested by a subject matter expert in our institution. Patients with CVD were identifi ed if there was at least 1 CVD diagnosis (*ICD-10-CM* codes I00-I09 and I16-I78) from inpatient or emergency department encounters, or 2 diagnoses of CVD from outpatient encounters at least 30 days apart from January 2017 to December 2018. We used *ICD-10-CM* code Z3A to exclude patients with pregnancy diagnoses from January 2017 to June 2021.

Identification of Patients With Sub-CVD Diseases

We used the same algorithms to identify patients with sub-CVD diseases as we did to identify patients with CVD. We classified the following conditions as sub-CVD diseases: acute myocardial infarction (*ICD-10-CM* codes I21–I22), heart failure (*ICD-10-CM* codes I09.81, I50.1–I50.4, I50.8–I50.9), ischemic heart disease (*ICD-10-CM* codes I20–I25), stroke (*ICD-10-CM* codes I60–I69), and atrial fibrillation (*ICD-10-CM* code I48).[27] The sub-CVD diseases are particular subgroups of interest within the CVD sample population.

Identification of Telehealth Versus In-Person Outpatient Encounters

We defined telehealth outpatient encounters as those in which the place of service was telehealth or the procedure modifiers were telehealth-related (procedure modifiers 95, GO, GQ, and GT).[22] In-person outpatient encounters were all the remaining outpatient encounters.

Trends of Telehealth and In-Person Outpatient Encounters

We calculated the number of telehealth and in-person outpatient encounters per 100 patients with CVD and the percentage of telehealth encounters monthly during January 2019 to June 2021. The prepandemic period is defined from January 2019 to February 2020, and the pandemic period is determined to be from March 2020 to June 2021. We calculated the numbers of telehealth and in-person outpatient encounters per 100 patients by dividing the total numbers of telehealth and in-person outpatient encounters in a month by the total number of patients with CVD, respectively, then multiplying by 100. We calculated the percentage of telehealth outpatient encounters by dividing the total number of telehealth outpatient encounters in a month by the total number of all (both telehealth and in-person) outpatient encounters for the month among patients with CVD, then multiplying by 100. Results were stratified by the subgroups of age group (aged 18–34 years versus 35–64 years), sex, urban/rural status of patient residence, Census region of patient residence, and sub-CVD diseases. We compared the changes in the numbers of telehealth and in-person encounters per 100 patients before and during the pandemic for all and for subgroups.

Statistical Analysis

The month-to-month changes in the numbers of telehealth and in-person encounters per 100 patients from February 2020 (the month before the pandemic) to June 2020 and the differences in the monthly estimates between February 2020 and June 2021 were tested using a Welch 2-tailed *t* test for all and the subgroups. For both telehealth and in-person outpatient encounters, the differences in the monthly estimates of the numbers per 100 patients with CVD between subgroups of age group, sex, and urbanicity were tested using a Welch 2-tailed *t* test, and the differences among subgroups of Census region and sub-CVD diseases were tested using a 1-way ANOVA by each month to test the differences in the monthly estimates by subgroups. A P value <0.05 indicates statistical significance.

Trends in the Proportion of Telehealth to Total Outpatient Encounters

We calculated the proportion of telehealth to total outpatient encounters among all patients with CVD and by subgroups (age group, sex, urbanicity, 4 Census regions, and sub-CVD diseases). The proportions

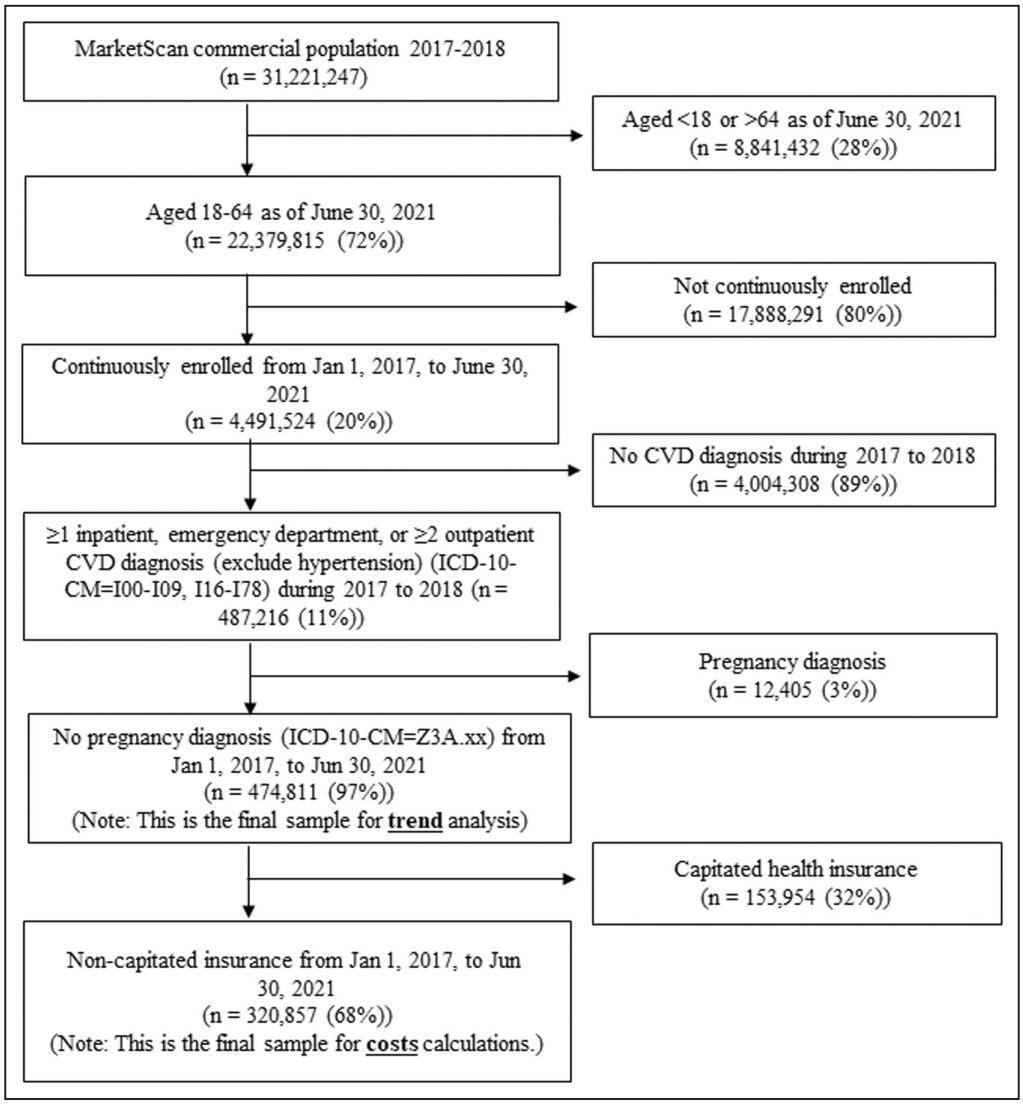

Figure 1. Study sample selection of patients diagnosed with cardiovascular disease (CVD), MarketScan Commercial Claims and Encounters database, January 2017 to June 2021.
The MarketScan Commercial Claims and Encounters database from January 1, 2017 to June 30, 2021 was used. Inpatient, outpatient, and emergency department visits were identified using *International Classification of Diseases, Tenth Revision, Clinical Modification* (*ICD-10-CM*) codes. *ICD-10-CM* codes of I00–I09 and I16–I78 were used to define the diagnosis of cardiovascular disease (CVD) (*ICD-10-CM* codes I00–I09, I16–I78), defined after excluding hypertension diagnosis alone (*ICD-10-CM* codes I10–I15) from CVD (*ICD-10-CM* codes I00–I78). *ICD-10-CM* code Z3A was used to exclude patients with pregnancy diagnoses. Patients with CVD were identified if inpatient or emergency department encounters contained at least 1 diagnosis of CVD, or at least 2 outpatient encounters contained the diagnosis of CVD with at least a 30-day interval during the 2 years of lookback periods from January 1, 2017 to December 31, 2018. For the patients with CVD with capitated and noncapitated health insurance, the trend analysis was performed from January 1, 2019 to June 30, 2021. Patients were restricted with noncapitated health insurance for the cost calculations because of inaccurate payment information in capitated health insurance.

were calculated by dividing the total number of telehealth outpatient encounters by the total number of outpatient encounters. The month-to-month changes in the proportions from February 2020 (the month before the pandemic) to June 2020 and the differences in the monthly estimates between February 2020 and June 2021 were tested using a Welch 2-tailed *t* test for all and the subgroups. The differences in the monthly estimates of the proportions of telehealth encounters between subgroups of age group, sex, and urbanicity were tested using a Welch 2-tailed *t* test, and the differences among subgroups of Census region and sub-CVD diseases were tested using 1-way ANOVA. A *P* value <0.05 indicates statistical significance.

Costs Associated With Telehealth and In-Person Outpatient Encounters

Cost calculations were restricted to patients with CVD who were covered by noncapitated health insurance plans, because capitated health insurance plans had incomplete payment information (Figure 1). We reported total payments per encounter, patient out-of-pocket (OOP) payments per encounter, and share of patient OOP payments to total payments per encounter among patients with CVD for both telehealth and in-person outpatient encounters, respectively, during the 12-month study period of July 1, 2020 to June 30, 2021. Total payments include insurer's payments, coordination of benefits, and patient OOP payments. Patient OOP payments include copayment, coinsurance, and deductible. We reported the values and the bias-corrected and accelerated bootstrap 95% CI of the variables.

We used Stata MP statistical software version 14.2 (StataCorp, College Station, TX) for the trend and cost calculations. We performed the data analysis in 2021 to 2022.

RESULTS

Trends in the Number of Telehealth and In-Person Outpatient Encounters per 100 Patients With CVD

From January 1, 2017 to June 30, 2021, a total of 474 811 patients with CVD met the inclusion criteria (Figure 1). The number of telehealth encounters per 100 patients with CVD was 0.30 in February 2020 and peaked at 25.4 in April 2020, fluctuated between 9.0 and 16.8 afterward, and ended at 9.0 in June 2021, higher than the prepandemic levels (Figure 2A). The trend patterns were similar for all subgroups by age group, sex, urbanicity, and Census region, where the peak was in April 2020 (Figure 2 and Table S1). For both telehealth and in-person outpatient encounters, the month-to-month changes in the numbers per 100 patients with CVD from February 2020 to June 2020 were statistically significant for all and the subgroups (age group, sex, urbanicity, and Census region) (Tables S1 and S2). Those with CVD who were aged 18 to 34 years (versus 35–64 years), women (versus men), and living in urban areas (versus rural areas) had statistically significantly higher numbers of telehealth outpatient encounters per 100 patients with CVD from March 2020 to June 2021, with peak differences observed in April 2020.

The average number of in-person outpatient encounters per 100 patients with CVD in February 2020 was 298.0.9, whereas the number was 145.7 in April 2020 (Figure 2A). The average numbers increased to 276.5 in June 2020, fluctuated between 263.2 and 340.0 afterward, and ended at 263.2 in June 2021, lower than the prepandemic levels (Table S2).

Trends in the Number of Telehealth and In-Person Outpatient Encounters per 100 Patients With Sub-CVD Diseases

Of the 474 811 patients with CVD (Figure 1), there were 12 571 patients with acute myocardial infarction, 20 327 patients with heart failure, 81 082 patients with ischemic heart disease, 28 395 patients with stroke, and 32 599 patients with atrial fibrillation. For both telehealth and in-person outpatient encounters, the month-to-month changes in the numbers per 100 patients from February 2020 to June 2020 were statistically significant for each of the sub-CVD diseases (acute myocardial infarction, heart failure, ischemic heart disease, stroke, and atrial fibrillation) (Tables S1 and S2). The differences between sub-CVD diseases in the numbers of telehealth and in-person outpatient encounters per 100 patients were statistically significantly different from March 2020 to June 2021 (Figure 2F and Tables S1 and S2).

Trends in the Proportion of Telehealth to Total Outpatient Encounters

The proportion of telehealth (to total outpatient) encounters among patients with CVD was 0.10% in February 2020 and peaked at 14.83% in April 2020 (Figure 3A and Table S3). The month-to-month changes in the proportions from February 2020 to June 2020 were statistically significant for all and the subgroups (by age group, sex, urbanicity, Census region, and sub-CVD diseases) (Table S3). The proportions of telehealth encounters among patients with CVD peaked in April 2020 for all subgroups, where the proportion was statistically significantly higher for patients aged 18 to 34 years than for those aged 35 to 64 years (20.94% versus 14.24%, $P<0.001$), for women than men (17.09% versus 12.29%, $P<0.001$), and for those living in urban rather than in rural areas (15.61% versus 9.92%, $P<0.001$). The differences in the proportions by subgroups remained statistically different throughout the pandemic, from March 2020 to June 2021 (Table S3).

Costs of Telehealth and In-Person Outpatient Encounters

A total of 320 857 out of 474 811 patients with CVD had noncapitated insurance from January 1, 2017 to June 30, 2021, and were included for cost calculations (Figure 1). Of the 320 857 patients, 119 689 patients had at least 1 telehealth outpatient encounter, and 308 130 patients had at least 1 in-person encounter from July 2020 to June 2021 (Table).

The mean (95% CI) number of telehealth encounters per patient with CVD was 4.2 (95% CI, 4.16–4.25) during the 12-month study period, whereas the mean (95% CI) number of in-person encounters per patient with CVD was 37.5 (95% CI, 37.3–37.7). The mean (95% CI) of total payments per telehealth encounter was $113.1 (95% CI, $112.8–$113.5), whereas the mean (95% CI) of total payments per in-person encounter was $160.9 (95% CI, $159.8–$161.8). The mean (95% CI) of patient OOP payments per telehealth encounter

Figure 2. Numbers of telehealth and in-person outpatient encounters per 100 patients with cardiovascular disease and by age, sex, urbanicity, and Census region, sub-CVD disease, MarketScan Commercial Claims and Encounters database, January 2019 to June 2021.

A, All samples. **B**, By age group. **C**, By sex. **D**, By urbanicity. **E**, By Census region. **F**, By sub-CVD disease. On the *y*-axis, we report the number of outpatient encounters per 100 patients diagnosed with CVD (*ICD-10-CM* code I00–I09, I16–I78) (**A** through **E**) and respective sub-CVD diseases (**F**). Patients with CVD were defined if inpatient or emergency department encounters contained at least 1 diagnosis of CVD, or at least 2 outpatient encounters contained the diagnosis of CVD with at least a 30-day interval during the 2 years of lookback periods from January 1, 2017 to December 31, 2018. CVD was defined after excluding hypertension alone (*ICD-10-CM* code I10-I15) from CVD (*ICD-10-CM* code I00–I78). Out of 474 811 patients with CVD (Figure 1), 35 863 patients were aged 18 to 34 y, and 426 428 were aged 35 to 64 y; 234 107 patients were men, and 240 704 were women; 410 911 patients lived in urban regions, and 63 900 lived in rural regions; 72 859 patients lived in the Northeast; 244 384 patients lived in the South; 109 464 patients lived in the Midwest; and 47 176 patients lived in the West. There were 12 571 patients with acute myocardial infarction, 20 327 patients with heart failure, 81 082 patients with ischemic heart disease, 28 395 patients with strokes, and 32 599 patients with atrial fibrillation. For both telehealth and in-person outpatient encounters, the differences in the monthly estimates of the numbers per 100 patients with CVD between subgroups of age group, sex, and urbanicity were tested using a Welch 2-tailed *t* test, and the differences among subgroups of Census region and sub-CVD diseases were tested using 1-way ANOVA by each month to test the differences in the monthly estimates by subgroups. The corresponding numbers of telehealth and in-person outpatient encounters per 100 patients with CVD and the test results are shown in Tables S1 and S2. CVD indicates cardiovascular disease; and *ICD-10-CM*, *International Classification of Diseases, Tenth Revision, Clinical Modification*.

was $23.8 (95% CI, $23.6–$24.0), whereas the mean (95% CI) of patient OOP payments per in-person encounter was $32.7 (95% CI, $32.5–$32.8). The mean share of patient OOP payments to total payments per telehealth encounter was 23.2% (95% CI, 23.1%–23.4%), whereas the mean share of patient OOP payments to total payments per in-person encounter was 27.6% (95% CI, 27.5%–27.7%).

DISCUSSION

We documented the trends of telehealth use among patients with CVD before and during the pandemic from January 2019 to June 2021 using the MarketScan CCAE database. The number of telehealth encounters increased by >80 times from February 2020 to April 2020, whereas the number of in-person outpatient encounters decreased by about half during the same time 2-month period. During the same time period, the proportion of telehealth to total outpatient encounters increased from 0.1% to 14.8%. The increased number of telehealth encounters only partially offset the reduction in in-person outpatient encounters. By June 2020, 3 months after after the pandemic was declared a national emergency, the number of in-person outpatient encounters quickly rebounded afterward, although it was still about 6% lower than the prepandemic levels, and the proportion of telehealth to total outpatient encounters went down to 5.8% in June 2020 and fluctuated 3% to 5.4% afterward. Patients who were younger, women, and living in urban areas had higher use of telehealth than those who were older, men, and living in rural areas, respectively, throughout the pandemic. Overall, surveillance of telehealth use since the start of the COVID-19 pandemic shows higher rates in urban areas,[19,20] and the findings from our study affirm a similar trend for patients with CVD. Additionally, our study shows that women and younger patients with CVD tended to use telehealth more frequently, which is consistent with trends for non–disease-specific telehealth use.[21] The cost of outpatient encounters and patient OOP payments were higher for in-person encounters than telehealth encounters, whereas the number of in-person encounters was higher than the number of telehealth encounters. The findings of higher costs of in-person than telehealth were consistent with a prior study on a different disease.[28] Costs of telehealth may be moderated by the expanded provisions and reimbursement for telehealth allowed by the Coronavirus Aid, Relief, and Economic Security Act.[29]

Telehealth use trends for patients with CVD described in this study correspond with broader trends in telehealth during the same period[20,21] and align with timing of the initial community spread of COVID-19 in the United States, the Centers for Medicare and Medicaid Services waivers for the use of telehealth,[30] and implementation of the Coronavirus Aid, Relief, and Economic Security Act.[21,29] Fluctuations in the use of telehealth among patients with CVD during the COVID-19 pandemic may reflect patients adjusting their need for health care access and clinical care, and health systems adapting to patients' changing needs for care and using enhanced policy provisions for telehealth.

The Community Preventive Services Task Force recommends the use of telehealth to help address the needs of patients with CVD.[31] Furthermore, a 2017 policy statement from the American Heart Association recommended leveraging the use of evidence-based strategies, such as remote patient monitoring and telestroke, to support the needs of patients with CVD.[32] As a result of these recommendations and the widespread use of telehealth during the COVID-19 pandemic, more patients with CVD are receiving their care virtually than ever before. More work is required to understand the role and impact of telehealth on the nation's leading causes

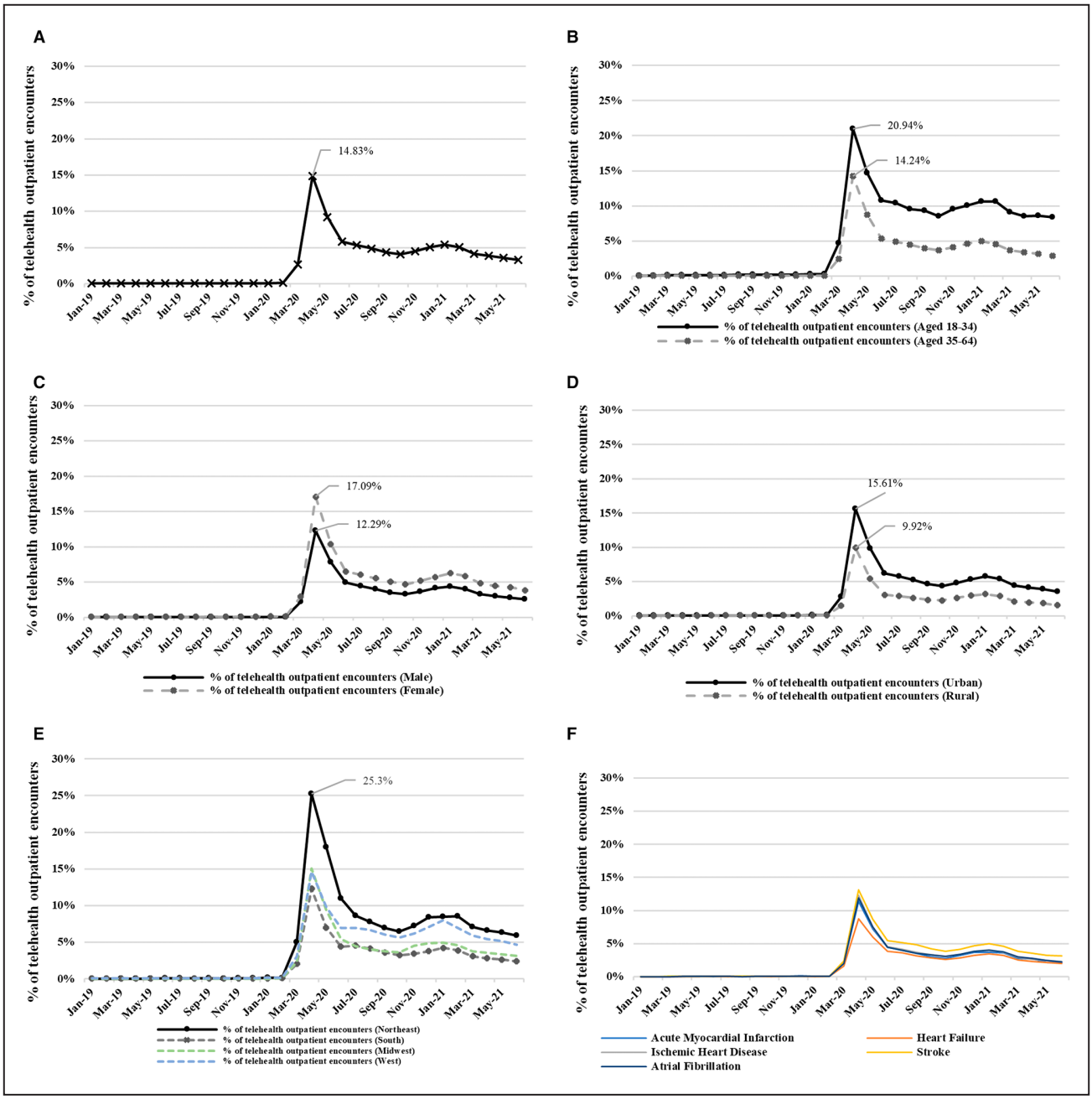

Figure 3. The proportion of telehealth outpatient encounters among patients with CVD by all subgroups: age, sex, urbanicity, Census region, and sub-CVD disease during January 2019 to June 2021 using the MarketScan Commercial Claims and Encounters database.

A, All samples. **B**, By age group. **C**, By sex. **D**, By urbanicity. **E**, By Census region. **F**, By sub-CVD disease. On the *y*-axis, we report the percent of telehealth outpatient encounters among patients with CVD (ie, the total number of telehealth outpatient encounters divided by the total number of outpatient encounters, then multiplied by 100). Out of 474 811 patients with CVD (Figure 1), 35 863 patients were aged 18 to 34 y, and 426 428 were aged 35 to 64 y; 234 107 patients were men, and 240 704 were women; 410 911 patients lived in urban regions, and 63 900 lived in rural regions; 72 859 patients lived in the Northeast; 244 384 patients lived in the South; 109 464 patients lived in the Midwest; and 47 176 patients lived in the West. There were 12 571 patients with acute myocardial infarction, 20 327 patients with heart failure, 81 082 patients with ischemic heart disease, 28 395 patients with all strokes, and 32 599 patients with atrial fibrillation. For both telehealth and in-person outpatient encounters, the differences in the monthly estimates of the numbers per 100 patients with CVD between subgroups of age, sex, and urbanicity were tested using a Welch 2-tailed *t* test, and the differences among subgroups of Census region and sub-CVD diseases were tested using 1-way ANOVA by each month to test the differences in the monthly estimates by subgroups. The test results are shown in Table S3. CVD indicates cardiovascular disease.

Table. Outpatient Visits and Payments for Telehealth and In-Person Outpatient Encounters Among Patients With Cardiovascular Disease, MarketScan Commercial Claims and Encounters Database, July 2020 to June 2021

Encounters	Mean (95% CI)
Telehealth encounters	
No. of telehealth encounters per patient	4.2 (4.16–4.25)
Total payments per encounter	$113.1 ($112.8–$113.5)
Patient OOP payments per encounter	$23.8 ($23.6–$24.0)
Share of patient OOP payments to total payments per encounter	23.2 (23.1–23.4)
Sample size, n	119689
In-person encounters	
No. of in-person encounters per patient	37.5 (37.3–37.7)
Total payments per encounter	$160.9 ($159.8–$161.8)
Patient OOP payments per encounter	$32.7 ($32.5–$32.8)
Share of patient OOP payments to total payments per encounter	27.6 (27.5–27.7)
Sample size, n	308130

Cardiovascular disease (CVD) was defined after excluding hypertension diagnosis alone (*ICD-10-CM* codes I10–I15) from CVD (*ICD-10-CM* codes I00-I78). Patients with CVD (*ICD-10-CM* codes I00–I09, I16–I78) were defined if inpatient or emergency department encounters contained at least 1 diagnosis of CVD, or at least 2 outpatient encounters contained the diagnosis of CVD with at least a 30-day interval during the 2 years of lookback periods from January 1, 2017 to December 31, 2018. Of the 320857 patients with CVD (Figure 1), 308130 (or 96.0%) patients had at least 1 in-person outpatient encounter, 119689 (or 37.3%) patients had at least 1 telehealth encounter, 309590 (or 96.5%) patients had at least 1 in-person or telehealth encounter, 118229 (or 36.8%) patients had both an in-person and telehealth encounter, 1460 (or 0.5%) patients had only a telehealth outpatient encounter, 189901 (or 59.2%) patients had only an in-person outpatient encounter, and 11267 (or 3.5%) patients did not have any in-person or telehealth outpatient encounters during July 1, 2020 to June 30, 2021. Patients with telehealth outpatient encounters were defined in the following way: the place of service is equal to 2 in MarketScan data for telehealth; and procedure modifiers are equal to 95 for synchronous telemedicine service rendered via real-time interactive audio and visual telecommunication system; equal to GO for telehealth services for diagnosis, evaluation, or treatment of symptoms of acute stroke; equal to GQ for telehealth service rendered via an asynchronous telecommunications system; and equal to GT for telehealth service rendered via interactive audio and video telecommunication systems. If outpatient encounters contained any of the above telehealth places of service or procedure modifiers from July 1, 2020 to June 30, 2021, we defined them as telehealth outpatient encounters. The cost calculation for in-person outpatient encounters was defined by taking differences between total outpatient costs and total telehealth outpatient costs. Outpatient encounters were defined if settings contained nonphysician office visits, other outpatient office visits, specialty office visits, primary care physician office visits, or other outpatient (ie, all encounters excluding inpatient, emergency department, laboratory test, and pharmacy). Total payments for in-person and telehealth were defined by the average payment per outpatient encounter for in-person and telehealth encounters, respectively. The OOP payment share was the ratio of patients' OOP payments and total payments. The 95% CIs are the bias-corrected and accelerated bootstrap 95% CIs with 1000 replications. *ICD-10-CM* indicates *International Classification of Diseases, Tenth Revision, Clinical Modification*; and OOP, out-of-pocket.

of morbidity and mortality; this study is a first step. Future studies may focus on either inpatient or outpatient settings, because the use and delivery of telehealth may differ substantially in each setting. Additional next steps include assessing the costs and use of telehealth services for condition-specific and actionable cardiovascular issues, for example, hypertension, which is prevalent, costly, and manageable in an outpatient setting.[33,34] Further studies may also examine disparities in telehealth use by race and ethnicity, income, and other characteristics to better understand the equitability of access, use, cost, and outcomes related to telehealth. Finally, future work may examine health system, payer, or patient costs to document the economic impact of expanded telehealth use.

This study has 5 limitations. First, the MarketScan CCAE is a large convenient subsample of the employees and their dependents with employer-sponsored private health insurance and is not representative of the privately insured population, while also excluding both those with public insurance (eg, through Medicare or Medicaid) and the uninsured. Second, recording errors may occur in claims data. If providers are less familiar with telehealth-related coding, telehealth outpatient encounters might be over- or underestimated. Third, the study sample is limited to patients who had any outpatient, emergency department, or inpatient claim (regardless of reason for the encounter) and who reported having a CVD-related diagnosis. Therefore, the outpatient encounters included in the analysis may not be to address CVD but to treat/manage entirely unrelated conditions. Fourth, the period of our cost calculations (July 1, 2020–June 30, 2021) occurred during the time in the pandemic when the Centers for Medicare and Medicaid Services telehealth waivers[30] and Coronavirus Aid, Relief, and Economic Security Act[29] temporarily institutionalized flexibilities for billing of telehealth visits and for copays and other costs incurred by patients. As a result, this analysis reflects the costs of telehealth services only during the public health emergency and does not summarize historical costs or project future costs for telehealth visits for patients with CVD. Fifth, we restricted our analysis to patients who have been continuously covered by insurance before and during the pandemic. Consequently, our results do not capture those who lost coverage because of disruptions in their jobs, stay-at-home orders, or other causes. Future studies may address these limitations by exploring trends and use among publicly insured patients or by examining trends and use of telehealth for patients with CVD for encounters related to managing their condition.

CONCLUSIONS

Telehealth use among a large sample of privately insured patients diagnosed with CVD increased rapidly during the first 2 months of the COVID-19 pandemic, increasing from <0.1% to 14.8% of all outpatient encounters between February 2020 and April 2020. However, the share of telehealth use dropped as rapidly to 5.8% by June 2020 and fluctuated in a range of 3% to 5.4% over the remaining 12 months, which is slightly higher compared with the prepandemic period.

Telehealth encounters had a lower average cost compared with in-person encounters in July 2020 to June 2021. The temporary telehealth provisions put in place during the COVID-19 public health emergency remain, and policymakers, health systems, health services researchers, and insurers may benefit from information about telehealth use and costs among patients with CVD for decisions about drivers of telehealth use and sustainability.

ARTICLE INFORMATION

Received December 8, 2022; accepted January 17, 2023.

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Acknowledgments

The authors are genuinely grateful to F. Loustalot, X. Tong, Q. Yang, and S. L. Jackson (Centers for Disease Control and Prevention) for their guidance, suggestions, and article review. The authors appreciate F. Coronado, K. Roy, K. E. MacLeod, and R. Schwartz (Centers for Disease Control and Prevention) for their thorough review and meaningful advice to improve the quality of the article. Thank you K. Miller (Merative) for your technical guidance and support. The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention. Use of trade names and commercial sources is for identification only and does not imply endorsement by the US Department of Health and Human Services.

Sources of Funding

None.

Disclosures

None.

Supplemental Material

Tables S1–S3

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Table S1. The numbers of telehealth outpatient encounters per 100 patients with CVD by all and subsamples from January 2019 to June 2021 using the MarketScan® Commercial Claims and Encounters Database.

	The number of telehealth outpatient encounters per 100 patients									
		Age Group			Sex			Urbanicity		
Month	All	Aged 18-34	Aged 35-64	P-value	Male	Female	P-value	Urban	Rural	P-value
19-Jan	0.14	0.22	0.13	p=0.0093	0.10	0.18	p<0.001	0.15	0.10	p=0.0065
19-Feb	0.13	0.21	0.12	p=0.005	0.09	0.18	p<0.001	0.14	0.07	p<0.001
19-Mar	0.14	0.24	0.12	p<0.001	0.10	0.18	p<0.001	0.14	0.10	p=0.0154
19-Apr	0.15	0.31	0.14	p<0.001	0.10	0.21	p<0.001	0.16	0.10	p=0.0049
19-May	0.14	0.28	0.13	p<0.001	0.09	0.20	p<0.001	0.15	0.09	p=0.0014
19-Jun	0.16	0.32	0.14	p<0.001	0.11	0.21	p<0.001	0.16	0.17	p=0.6303
19-Jul	0.18	0.40	0.16	p<0.001	0.12	0.25	p<0.001	0.19	0.17	p=0.5354
19-Aug	0.18	0.42	0.16	p<0.001	0.12	0.24	p<0.001	0.18	0.18	p=0.9523
19-Sep	0.20	0.42	0.17	p<0.001	0.12	0.28	p<0.001	0.20	0.21	p=0.5760
19-Oct	0.21	0.43	0.18	p<0.001	0.13	0.28	p<0.001	0.20	0.21	p=0.8572
19-Nov	0.21	0.43	0.19	p<0.001	0.13	0.29	p<0.001	0.21	0.22	p=0.2481
19-Dec	0.23	0.39	0.22	p<0.001	0.16	0.30	p<0.001	0.24	0.21	p=0.3460
20-Jan	0.30	0.65	0.26	p<0.001	0.18	0.41	p<0.001	0.30	0.24	p=0.0295
20-Feb	0.30	0.52	0.27	p<0.001	0.19	0.40	p<0.001	0.31	0.23	p=0.0046
20-Mar	6.71	8.88	6.47	p<0.001	5.15	8.22	p<0.001	7.17	3.70	p<0.001
20-Apr	25.38	28.95	24.99	p<0.001	20.02	30.59	p<0.001	26.66	17.18	p<0.001
20-May	20.64	24.91	20.14	p<0.001	16.15	25.00	p<0.001	21.90	12.56	p<0.001
20-Jun	16.98	22.70	16.28	p<0.001	12.83	21.02	p<0.001	18.19	9.19	p<0.001
20-Jul	16.16	23.02	15.39	p<0.001	12.00	20.20	p<0.001	17.30	8.79	p<0.001
20-Aug	14.47	20.61	13.78	p<0.001	10.73	18.10	p<0.001	15.50	7.85	p<0.001
20-Sep	14.06	21.24	13.27	p<0.001	10.19	17.82	p<0.001	15.11	7.28	p<0.001
20-Oct	13.95	20.89	13.16	p<0.001	10.06	17.73	p<0.001	14.93	7.64	p<0.001
20-Nov	14.00	20.56	13.25	p<0.001	10.15	17.75	p<0.001	14.91	8.16	p<0.001
20-Dec	16.77	23.08	16.04	p<0.001	12.53	20.90	p<0.001	17.86	9.80	p<0.001
21-Jan	15.83	22.56	15.03	p<0.001	11.57	19.97	p<0.001	16.85	9.24	p<0.001
21-Feb	14.44	21.52	13.60	p<0.001	10.47	18.30	p<0.001	15.41	8.17	p<0.001
21-Mar	14.57	22.41	13.63	p<0.001	10.40	18.63	p<0.001	15.68	7.44	p<0.001
21-Apr	12.57	20.19	11.69	p<0.001	9.01	16.03	p<0.001	13.53	6.38	p<0.001
21-May	10.51	17.35	9.70	p<0.001	7.37	13.56	p<0.001	11.30	5.41	p<0.001
21-Jun	8.95	15.20	8.25	p<0.001	6.20	11.62	p<0.001	9.68	4.20	p<0.001

Test difference between Feb-20 and Mar-20	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
Test difference between Mar-20 and Apr-20	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
Test difference between Apr-20 and May-20	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
Test difference between May-20 and Jun-20	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
Test difference between Feb-20 and Jun-21	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
	Census regions					Sub-CVD Diseases					
Month	Northeast	South	Midwest	West	P-value	AMI	HF	IHD	Stroke	AF	P-value
19-Jan	0.13	0.13	0.13	0.23	p=0.0068	0.09	0.10	0.11	0.12	0.12	p=0.9248
19-Feb	0.12	0.13	0.11	0.21	p=0.0179	0.08	0.09	0.08	0.12	0.10	p=0.6502
19-Mar	0.11	0.14	0.10	0.24	p<0.001	0.10	0.11	0.09	0.14	0.11	p=0.5189
19-Apr	0.11	0.15	0.10	0.35	p<0.001	0.10	0.11	0.12	0.18	0.14	p=0.6045
19-May	0.11	0.14	0.09	0.33	p<0.001	0.20	0.12	0.12	0.14	0.16	p=0.4969
19-Jun	0.17	0.17	0.09	0.27	p<0.001	0.11	0.19	0.11	0.18	0.17	p=0.2207
19-Jul	0.19	0.19	0.11	0.29	p<0.001	0.14	0.16	0.13	0.18	0.19	p=0.5181
19-Aug	0.17	0.20	0.11	0.27	p<0.001	0.13	0.20	0.12	0.21	0.12	p=0.0451
19-Sep	0.22	0.22	0.11	0.25	p<0.001	0.13	0.19	0.13	0.24	0.17	p=0.0439
19-Oct	0.18	0.22	0.13	0.36	p<0.001	0.17	0.18	0.14	0.20	0.21	p=0.3470
19-Nov	0.22	0.24	0.11	0.31	p<0.001	0.22	0.20	0.18	0.19	0.14	p=0.5365
19-Dec	0.28	0.25	0.11	0.38	p<0.001	0.46	0.36	0.20	0.23	0.15	p=0.0294
20-Jan	0.41	0.27	0.16	0.57	p<0.001	0.17	0.16	0.21	0.35	0.23	p=0.2163
20-Feb	0.37	0.29	0.17	0.53	p<0.001	0.18	0.25	0.22	0.28	0.19	p=0.1887
20-Mar	11.90	5.40	5.92	7.34	p<0.001	6.22	7.87	6.36	7.85	6.25	p<0.001
20-Apr	36.93	22.50	23.98	26.01	p<0.001	25.92	34.08	26.20	31.25	25.98	p<0.001
20-May	33.66	16.76	20.30	21.56	p<0.001	20.25	27.05	20.43	25.73	21.17	p<0.001
20-Jun	28.89	13.43	16.22	18.90	p<0.001	15.13	20.64	15.71	20.91	16.14	p<0.001
20-Jul	24.67	14.03	13.86	19.52	p<0.001	13.98	19.74	14.87	19.84	14.68	p<0.001
20-Aug	21.71	12.51	12.48	18.10	p<0.001	11.99	16.95	13.04	18.13	13.13	p<0.001
20-Sep	22.07	11.66	12.46	17.89	p<0.001	11.31	16.44	12.38	17.20	12.99	p<0.001
20-Oct	22.27	11.20	12.87	17.94	p<0.001	11.02	15.54	12.21	16.78	12.82	p<0.001
20-Nov	22.06	10.80	14.20	17.73	p<0.001	11.57	15.17	12.05	16.12	12.74	p<0.001
20-Dec	26.43	13.04	16.58	21.75	p<0.001	14.26	18.33	14.94	19.30	16.06	p<0.001

21-Jan	24.85	12.51	14.95	21.24	p<0.001	12.46	18.00	14.06	18.00	14.43	p<0.001
21-Feb	23.66	11.21	13.71	18.67	p<0.001	12.12	16.54	12.54	16.65	13.13	p<0.001
21-Mar	25.21	10.97	13.73	18.83	p<0.001	11.04	15.59	12.08	16.80	12.66	p<0.001
21-Apr	21.72	9.27	12.29	16.27	p<0.001	9.93	13.22	10.17	14.49	10.88	p<0.001
21-May	18.30	7.95	9.89	13.21	p<0.001	7.51	11.47	8.60	11.83	8.83	p<0.001
21-Jun	15.65	6.96	8.23	10.70	p<0.001	6.64	9.30	7.32	10.67	7.37	p<0.001
Test difference between Feb-20 and Mar-20	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	
Test difference between Mar-20 and Apr-20	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	
Test difference between Apr-20 and May-20	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	
Test difference between May-20 and Jun-20	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	
Test difference between Feb-20 and Jun-21	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	

Abbreviation: CVD, cardiovascular disease; AMI, acute myocardial infarction; HF, heart failure; IHD, ischemic heart disease; AF, atrial fibrillation

Note: The numbers are the corresponding estimates for Figure 2. For age groups, sex, and urbanicity, the differences between the subgroups in the numbers of telehealth outpatient encounters were tested using Welch's 2-tail t-test by each month. For census regions (Northeast, South, Midwest, and West) and sub-CVD diseases (AMI, HF, IHD, stroke, and AF), the differences between the subgroups were tested using one-way ANOVA by each month. The corresponding p-values for the test statistics were reported on the columes right to the comparison groups. The month-to-month changes from February 2020 (the month before the pandemic) to June 2020, and the changes between February 2020 and June 2021 were tested using Welch's 2-tail t-test for all and the subgroups. The corresponding p-values for the test statistics were reported at the bottom of each panel.

Table S2. The numbers of in-person outpatient encounters per 100 patients with CVD by all and subsamples from January 2019 to June 2021 using the MarketScan® Commercial Claims and Encounters Database.

	The number of in-person outpatient encounters per 100 patients									
		Age Group			Sex			Urbanicity		
Month	All	Aged 18-34	Aged 35-64	P-value	Male	Female	P-value	Urban	Rural	P-value
19-Jan	328.00	259.29	336.02	p<0.001	296.81	358.33	p<0.001	329.72	316.95	p<0.001
19-Feb	296.42	224.17	305.08	p<0.001	267.53	324.52	p<0.001	297.94	286.68	p<0.001
19-Mar	309.07	234.68	317.93	p<0.001	275.91	341.32	p<0.001	310.77	298.12	p<0.001
19-Apr	319.03	236.69	329.00	p<0.001	282.25	354.79	p<0.001	320.31	310.79	p=0.0013
19-May	319.36	239.71	328.92	p<0.001	284.14	353.60	p<0.001	320.78	310.17	p<0.001
19-Jun	295.38	219.63	304.06	p<0.001	260.05	329.75	p<0.001	296.44	288.61	p<0.0056
19-Jul	313.89	233.85	322.72	p<0.001	277.30	349.48	p<0.001	314.67	308.84	p=0.0383
19-Aug	314.53	233.26	323.43	p<0.001	282.23	345.95	p<0.001	314.79	312.87	p=0.5130
19-Sep	309.11	222.56	320.13	p<0.001	276.11	341.21	p<0.001	310.37	301.02	p<0.001
19-Oct	364.29	255.91	377.60	p<0.001	323.01	404.44	p<0.001	365.11	359.00	p=0.0029
19-Nov	316.99	225.00	328.17	p<0.001	281.79	351.23	p<0.001	318.11	309.83	p<0.001
19-Dec	330.53	226.51	342.82	p<0.001	298.64	361.55	p<0.001	330.94	327.90	p=0.3098
20-Jan	322.67	236.51	333.04	p<0.001	291.11	353.38	p<0.001	323.70	316.10	p=0.0075
20-Feb	298.90	214.36	309.46	p<0.001	269.40	327.59	p<0.001	300.17	290.74	p<0.001
20-Mar	248.45	180.21	256.94	p<0.001	229.29	267.09	p<0.001	248.38	248.91	p=0.8348
20-Apr	145.73	109.35	150.51	p<0.001	142.96	148.42	p<0.001	144.12	156.04	p<0.001
20-May	203.47	144.78	210.78	p<0.001	190.37	216.22	p<0.001	200.77	220.87	p<0.001
20-Jun	276.49	187.74	286.73	p<0.001	249.27	302.95	p<0.001	274.51	289.23	p<0.001
20-Jul	286.50	197.71	296.51	p<0.001	258.11	314.11	p<0.001	285.11	295.39	p<0.001
20-Aug	282.99	195.68	293.30	p<0.001	256.26	308.98	p<0.001	281.42	293.08	p<0.001
20-Sep	308.11	207.49	320.74	p<0.001	279.79	335.65	p<0.001	308.50	305.56	p=0.3071
20-Oct	332.16	224.19	345.80	p<0.001	299.84	363.59	p<0.001	331.82	334.33	p=0.4134
20-Nov	296.55	195.21	309.21	p<0.001	266.86	325.42	p<0.001	295.77	301.54	p=0.0483
20-Dec	317.92	206.21	331.37	p<0.001	289.72	345.35	p<0.001	317.24	322.31	p=0.0990
21-Jan	277.30	189.31	287.88	p<0.001	254.15	299.82	p<0.001	276.62	281.72	p=0.0648
21-Feb	272.73	181.06	284.33	p<0.001	250.56	294.29	p<0.001	272.50	274.16	p=0.5419
21-Mar	340.04	224.54	354.68	p<0.001	310.27	369.00	p<0.001	338.71	348.62	p=0.0022
21-Apr	317.01	215.99	330.01	p<0.001	289.95	343.32	p<0.001	316.49	320.31	p=0.1911
21-May	281.88	184.70	293.78	p<0.001	257.97	305.14	p<0.001	280.84	288.60	p=0.0065
21-Jun	263.24	165.54	275.05	p<0.001	234.62	291.08	p<0.001	262.19	270.01	p=0.0033

Test difference between Feb-20 and Mar-20	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
Test difference between Mar-20 and Apr-20	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
Test difference between Apr-20 and May-20	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
Test difference between May-20 and Jun-20	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
Test difference between Feb-20 and Jun-21	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
	Census regions					Sub-CVD Diseases					
Month	Northeast	South	Midwest	West	P-value	AMI	HF	IHD	Stroke	AF	P-value
19-Jan	330.91	327.66	332.15	317.08	p=0.0013	418.51	604.87	379.64	455.51	416.99	p<0.001
19-Feb	288.46	298.77	304.57	279.12	p<0.001	369.85	550.52	344.28	407.95	373.46	p<0.001
19-Mar	313.65	306.56	318.04	295.87	p<0.001	382.57	568.24	357.75	425.09	385.96	p<0.001
19-Apr	317.48	316.91	331.92	304.13	p<0.001	398.16	584.47	371.95	432.84	392.62	p<0.001
19-May	321.15	318.79	327.60	301.99	p<0.001	387.72	584.54	372.70	431.38	395.56	p<0.001
19-Jun	293.47	297.14	299.12	281.77	p<0.001	345.96	539.82	340.83	397.98	371.15	p<0.001
19-Jul	305.48	319.19	316.49	295.15	p<0.001	362.49	568.76	360.69	417.06	393.24	p<0.001
19-Aug	299.65	317.99	322.16	302.93	p<0.001	375.21	577.41	365.79	420.05	389.20	p<0.001
19-Sep	313.09	305.98	320.69	293.58	p<0.001	360.22	550.42	359.19	404.94	389.27	p<0.001
19-Oct	366.21	363.40	374.93	342.03	p<0.001	413.72	636.40	424.74	472.39	456.08	p<0.001
19-Nov	315.38	316.99	327.26	297.25	p<0.001	352.30	557.69	367.09	406.51	394.27	p<0.001
19-Dec	316.43	333.92	340.40	313.87	p<0.001	369.01	577.42	384.39	420.49	422.11	p<0.001
20-Jan	324.86	321.47	335.14	298.50	p<0.001	360.35	568.93	373.36	412.57	405.44	p<0.001
20-Feb	294.68	299.89	310.49	274.70	p<0.001	343.49	533.70	350.19	386.57	366.29	p<0.001
20-Mar	224.44	258.37	250.00	232.17	p<0.001	299.20	488.75	297.33	322.48	307.62	p<0.001
20-Apr	109.30	160.21	135.37	151.37	p<0.001	202.19	355.62	186.80	206.42	191.98	p<0.001
20-May	153.45	222.92	196.01	198.02	p<0.001	260.08	426.96	253.76	270.78	261.89	p<0.001
20-Jun	234.49	291.66	281.42	252.68	p<0.001	326.40	517.56	329.16	361.54	348.52	p<0.001
20-Jul	261.08	294.68	297.34	260.09	p<0.001	337.44	530.77	341.47	365.08	356.46	p<0.001
20-Aug	257.85	289.72	297.86	254.00	p<0.001	329.12	526.46	339.40	359.45	358.54	p<0.001
20-Sep	295.35	312.19	321.63	277.30	p<0.001	367.93	557.17	366.70	390.29	385.11	p<0.001
20-Oct	321.92	336.60	342.81	301.99	p<0.001	385.40	588.58	391.37	417.01	409.84	p<0.001
20-Nov	282.11	304.54	300.35	269.96	p<0.001	346.84	524.51	347.31	373.10	366.99	p<0.001

20-Dec	288.53	331.00	323.39	284.93	p<0.001	370.50	556.96	376.40	395.56	402.11	p<0.001
21-Jan	269.44	282.21	286.05	245.19	p<0.001	325.30	509.01	332.23	344.76	346.62	p<0.001
21-Feb	254.17	277.14	284.95	251.13	p<0.001	327.90	496.35	326.55	347.27	335.76	p<0.001
21-Mar	329.97	345.83	352.14	299.28	p<0.001	384.09	597.14	401.60	423.20	416.11	p<0.001
21-Apr	308.81	319.69	331.27	284.57	p<0.001	364.67	571.75	377.97	393.20	386.59	p<0.001
21-May	270.62	291.81	285.33	242.12	p<0.001	337.28	524.71	339.01	354.52	353.86	p<0.001
21-Jun	248.24	281.67	253.09	217.23	p<0.001	299.85	461.14	308.82	329.93	325.86	p<0.001
Test difference between Feb-20 and Mar-20	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	
Test difference between Mar-20 and Apr-20	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	
Test difference between Apr-20 and May-20	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	
Test difference between May-20 and Jun-20	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	
Test difference between Feb-20 and Jun-21	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	

Abbreviation: CVD, cardiovascular disease; AMI, acute myocardial infarction; HF, heart failure; IHD, ischemic heart disease; AF, atrial fibrillation
Note: The numbers are the corresponding estimates for Figure 2. For age groups, sex, and urbanicity, the differences between the subgroups in the numbers of in-person outpatient encounters were tested using Welch's 2-tail t-test by each month. For census regions (Northeast, South, Midwest, and West) and sub-CVD diseases (AMI, HF, IHD, stroke, and AF), the differences between the subgroups were tested using one-way ANOVA by each month. The corresponding p-values for the test statistics were reported on the columes right to the comparison groups. The month-to-month changes from February 2020 (the month before the pandemic) to June 2020, and the changes between February 2020 and June 2021 were tested using Welch's 2-tail t-test for all and the subgroups. The corresponding p-values for the test statistics were reported at the bottom of each panel.

Table S3. The proportion of telehealth to total outpatient encounters by all and subsamples from January 2019 to June 2021 using the MarketScan® Commercial Claims and Encounters Database.

	The proportion of telehealth to total outpatient encounters, %									
		Age Group			Sex			Urbanicity		
Month	All	Aged 18-34	Aged 35-64	P-value	Male	Female	P-value	Urban	Rural	P-value
19-Jan	0.04	0.09	0.04	p=0.0046	0.03	0.05	p=0.0198	0.05	0.03	p=0.0528
19-Feb	0.05	0.09	0.04	p=0.0003	0.03	0.06	p=0.0012	0.05	0.02	p=0.0170
19-Mar	0.04	0.10	0.04	p<0.001	0.03	0.05	p=0.0185	0.05	0.03	p=0.0588
19-Apr	0.05	0.13	0.04	p<0.001	0.03	0.06	p=0.0041	0.05	0.03	p=0.0062
19-May	0.05	0.12	0.04	p<0.001	0.03	0.06	p=0.0010	0.05	0.03	p=0.0834
19-Jun	0.05	0.14	0.05	p<0.001	0.04	0.06	p=0.0031	0.05	0.06	p=0.4145
19-Jul	0.06	0.17	0.05	p<0.001	0.04	0.07	p<0.001	0.06	0.06	p=0.7320
19-Aug	0.06	0.18	0.05	p<0.001	0.04	0.07	p=0.0017	0.06	0.06	p=0.6227
19-Sep	0.06	0.19	0.05	p<0.001	0.04	0.08	p<0.001	0.06	0.07	p=0.9390
19-Oct	0.06	0.17	0.05	p<0.001	0.04	0.07	p<0.001	0.06	0.06	p=0.1097
19-Nov	0.07	0.19	0.06	p<0.001	0.05	0.08	p<0.001	0.07	0.07	p=0.5923
19-Dec	0.07	0.17	0.06	p<0.001	0.05	0.08	p<0.001	0.07	0.06	p=0.3543
20-Jan	0.09	0.27	0.08	p<0.001	0.06	0.11	p<0.001	0.09	0.08	p=0.0516
20-Feb	0.10	0.24	0.09	p<0.001	0.07	0.12	p<0.001	0.10	0.08	p=0.1751
20-Mar	2.63	4.70	2.46	p<0.001	2.20	2.99	p<0.001	2.81	1.46	p<0.001
20-Apr	14.83	20.94	14.24	p<0.001	12.29	17.09	p<0.001	15.61	9.92	p<0.001
20-May	9.21	14.68	8.72	p<0.001	7.82	10.37	p<0.001	9.83	5.38	p<0.001
20-Jun	5.79	10.79	5.37	p<0.001	4.90	6.49	p<0.001	6.22	3.08	p<0.001
20-Jul	5.34	10.43	4.93	p<0.001	4.44	6.04	p<0.001	5.72	2.89	p<0.001
20-Aug	4.86	9.53	4.49	p<0.001	4.02	5.53	p<0.001	5.22	2.61	p<0.001
20-Sep	4.36	9.29	3.97	p<0.001	3.51	5.04	p<0.001	4.67	2.33	p<0.001
20-Oct	4.03	8.52	3.67	p<0.001	3.25	4.65	p<0.001	4.31	2.23	p<0.001
20-Nov	4.51	9.53	4.11	p<0.001	3.66	5.17	p<0.001	4.80	2.63	p<0.001
20-Dec	5.01	10.06	4.62	p<0.001	4.15	5.71	p<0.001	5.33	2.95	p<0.001
21-Jan	5.40	10.65	4.96	p<0.001	4.35	6.24	p<0.001	5.74	3.18	p<0.001
21-Feb	5.03	10.62	4.56	p<0.001	4.01	5.85	p<0.001	5.35	2.89	p<0.001
21-Mar	4.11	9.08	3.70	p<0.001	3.24	4.81	p<0.001	4.42	2.09	p<0.001
21-Apr	3.81	8.55	3.42	p<0.001	3.01	4.46	p<0.001	4.10	1.95	p<0.001
21-May	3.59	8.59	3.20	p<0.001	2.78	4.26	p<0.001	3.87	1.84	p<0.001
21-Jun	3.29	8.41	2.91	p<0.001	2.57	3.84	p<0.001	3.56	1.53	p<0.001

Test difference between Feb-20 and Mar-20	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
Test difference between Mar-20 and Apr-20	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
Test difference between Apr-20 and May-20	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
Test difference between May-20 and Jun-20	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
Test difference between Feb-20 and Jun-21	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001		p<0.001	p<0.001		
	Census regions					Sub-CVD Diseases					
Month	Northeast	South	Midwest	West	P-value	AMI	HF	IHD	Stroke	AF	P-value
19-Jan	0.04	0.04	0.04	0.07	p=0.0258	0.02	0.02	0.03	0.03	0.03	p=0.8582
19-Feb	0.04	0.04	0.04	0.08	p=0.0041	0.02	0.02	0.02	0.03	0.03	p=0.3495
19-Mar	0.04	0.05	0.03	0.08	p<0.001	0.02	0.02	0.03	0.03	0.03	p=0.2411
19-Apr	0.03	0.05	0.03	0.12	p<0.001	0.03	0.02	0.03	0.04	0.04	p=0.0574
19-May	0.04	0.04	0.03	0.11	p<0.001	0.05	0.02	0.03	0.03	0.04	p=0.9030
19-Jun	0.06	0.06	0.03	0.10	p<0.001	0.03	0.03	0.03	0.04	0.04	p=0.7946
19-Jul	0.06	0.06	0.04	0.10	p<0.001	0.04	0.03	0.04	0.04	0.05	p=0.7391
19-Aug	0.06	0.06	0.03	0.09	p<0.001	0.03	0.03	0.03	0.05	0.03	p=0.5067
19-Sep	0.07	0.07	0.03	0.09	p<0.001	0.04	0.03	0.04	0.06	0.04	p=0.3498
19-Oct	0.05	0.06	0.04	0.11	p<0.001	0.04	0.03	0.03	0.04	0.05	p=0.4107
19-Nov	0.07	0.08	0.03	0.10	p<0.001	0.06	0.04	0.05	0.05	0.04	p=0.4443
19-Dec	0.09	0.07	0.03	0.12	p<0.001	0.12	0.06	0.05	0.05	0.04	p=0.2298
20-Jan	0.13	0.08	0.05	0.19	p<0.001	0.05	0.03	0.06	0.09	0.06	p=0.8801
20-Feb	0.12	0.10	0.05	0.19	p<0.001	0.05	0.05	0.06	0.07	0.05	p=0.5142
20-Mar	5.04	2.05	2.31	3.06	p<0.001	2.04	1.58	2.09	2.38	1.99	p=0.0032
20-Apr	25.26	12.31	15.05	14.66	p<0.001	11.36	8.74	12.30	13.15	11.92	p<0.001
20-May	17.99	6.99	9.38	9.82	p<0.001	7.22	5.96	7.45	8.68	7.48	p<0.001
20-Jun	10.97	4.40	5.45	6.96	p<0.001	4.43	3.84	4.55	5.47	4.43	p<0.001
20-Jul	8.63	4.54	4.46	6.98	p<0.001	3.98	3.59	4.17	5.15	3.95	p<0.001
20-Aug	7.76	4.14	4.02	6.65	p<0.001	3.51	3.12	3.70	4.80	3.53	p<0.001
20-Sep	6.95	3.60	3.73	6.06	p<0.001	2.98	2.87	3.26	4.22	3.26	p<0.001
20-Oct	6.47	3.22	3.62	5.61	p<0.001	2.78	2.57	3.03	3.87	3.03	p<0.001
20-Nov	7.25	3.42	4.52	6.16	p<0.001	3.23	2.81	3.35	4.14	3.35	p<0.001
20-Dec	8.39	3.79	4.88	7.09	p<0.001	3.70	3.19	3.82	4.65	3.84	p<0.001

21-Jan	8.45	4.25	4.97	7.97	p<0.001	3.69	3.41	4.06	4.96	4.00	p<0.001
21-Feb	8.52	3.89	4.59	6.92	p<0.001	3.57	3.23	3.70	4.57	3.76	p<0.001
21-Mar	7.10	3.07	3.75	5.92	p<0.001	2.79	2.54	2.92	3.82	2.95	p<0.001
21-Apr	6.57	2.82	3.58	5.41	p<0.001	2.65	2.26	2.62	3.55	2.74	p<0.001
21-May	6.33	2.65	3.35	5.17	p<0.001	2.18	2.14	2.47	3.23	2.43	p<0.001
21-Jun	5.93	2.41	3.15	4.69	p<0.001	2.17	1.98	2.32	3.13	2.21	p<0.001
Test difference between Feb-20 and Mar-20	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	
Test difference between Mar-20 and Apr-20	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	
Test difference between Apr-20 and May-20	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	
Test difference between May-20 and Jun-20	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	
Test difference between Feb-20 and Jun-21	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	

Abbreviation: CVD, cardiovascular disease; AMI, acute myocardial infarction; HF, heart failure; IHD, ischemic heart disease; AF, atrial fibrillation
Note: The numbers are the corresponding estimates for Figure 3. For age groups, sex, and urbanicity, the differences between the subgroups in the proportions of telehealth to total outpatient encounters were tested using Welch's 2-tail t-test by each month. For census regions (Northeast, South, Midwest, and West) and sub-CVD diseases (AMI, HF, IHD, stroke, and AF), the differences between the subgroups were tested using one-way ANOVA by each month. The corresponding p-values for the test statistics were reported on the columes right to the comparison groups. The month-to-month changes from February 2020 (the month before the pandemic) to June 2020, and the changes between February 2020 and June 2021 were tested using Welch's 2-tail t-test for all and the subgroups. The corresponding p-values for the test statistics were reported at the bottom of each panel.