Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Clinical Outcomes of Telehealth in Patients With Coronary Artery Disease and Heart Failure During the COVID-19 Pandemic

Pauline Woo, MD\textsuperscript{a,\textasteriskcentered}, Joanie Chung, MPH\textsuperscript{b}, Jiaxiao M. Shi, PhD\textsuperscript{b}, Stephanie Tovar, MS\textsuperscript{b}, Ming-Sum Lee, MD, PhD\textsuperscript{c}, and Annette L. Adams, PhD\textsuperscript{b}

The COVID-19 pandemic necessitated a rapid adoption of telehealth (TH); however, its safety in subspecialty clinical practice remains uncertain. To assess the clinical outcomes associated with TH use in patients with coronary artery disease and/or heart failure during the initial phase of the COVID-19 pandemic, eligible adult patients who saw cardiologists from March 1, 2020, to August 31, 2020 (TH period) were identified. Patients were divided into two 3-month subcohorts (TH1, TH2) and compared with corresponding 2019 prepandemic subcohorts. The primary outcome was cardiovascular (CV) events within 3 months after index visits. Secondary analysis was CV events in patients aged ≥75 years within 3-month follow-up associated with TH use. Multivariable logistic regression was used to evaluate the association between TH use and CV outcomes. The study cohort included 6,485 TH and 7,557 prepandemic patients. The mean age was 70 years, with 40% of patients aged ≥75 years and 35% women. TH visits accounted for 0% of visits during the prepandemic period, compared with 68% during the TH period. Telephone visits comprised ≥92% of all TH encounters. Compared with the prepandemic period, patients seen during the TH period had fewer overall CV events (adjusted odds ratio 0.78, 95% confidence interval 0.67 to 0.90). Patients aged ≥75 years had similar findings (adjusted odds ratio 0.70, 95% confidence interval 0.55 to 0.89). Additional analysis of CV outcome events within 6 months after index visits showed similar findings. In conclusion, TH largely by way of telephone encounters can be safely incorporated into the ambulatory cardiology practice regardless of age. © 2022 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/) (Am J Cardiol 2023;187:171–178)

The COVID-19 pandemic has altered medical practice dramatically, forcing the adoption of telehealth (TH) at an unprecedented pace.\textsuperscript{1} Patients with cardiovascular (CV) disease are especially vulnerable to COVID-19 infections and have increased mortality risks, yet they are also at increased risk for CV events if routine clinical assessments are suboptimal.\textsuperscript{2} Early research suggested the potential benefits of telehealth in increasing care access, patient satisfaction, and cost savings,\textsuperscript{3} in addition to preserving personal protective equipment and mitigating infections.\textsuperscript{4,−6} Despite new guidance from cardiology publications on how to perform TH visits,\textsuperscript{7,−9} residual hesitancy among patients\textsuperscript{10} and providers\textsuperscript{11} in adopting TH stems from the paucity of evidence evaluating its impact on clinical outcomes compared with in-person visits. In this study, we sought to investigate the clinical outcomes of patients with coronary artery disease (CAD) and/or heart failure (HF) who were evaluated in cardiology clinics through TH visits during the first 6 months of the 2020 COVID-19 pandemic in comparison with prepandemic (PP) patients seen in the first 6 months of 2019. Our primary objective was to compare overall CV outcome events occurring within 3 months after patients’ index visits for the TH and PP cohorts. The secondary objective was to apply the same comparisons on patients with advanced age (≥75 years) to assess whether TH use adversely affects the clinical outcomes for this vulnerable subgroup. Additional analysis extending the follow-up period to 6 months after index visits was performed to assess the impact of TH care over a longer term.

Methods

This retrospective observational cohort study included adult (aged ≥18 years) patients with documented diagnoses of CAD and/or HF who were seen by cardiologists in clinics during the 6-month periods in March 2019 to August 2019 and March 2020 to August 2020 at 3 Kaiser Permanente Southern California (KPSC) medical centers which collectively served a patient population of approximately 889,000 members with median household income between $50,000 to $75,000. Eligible patients were identified from the KPSC region-wide electronic health record using the
International Classification of Diseases, tenth edition (ICD-10) diagnosis codes. The index visit for each subject was defined as the first clinic encounter during the study periods. Patients were excluded from the study if they were seen solely for device checks, on hemodialysis, pregnant, enrolled in hospice or palliative care, terminated KPSC membership, or tested positive for COVID-19 within 6 months of their index clinic visits. Nonclinical telephone encounters lasting ≤10 minutes to discuss test results were also excluded.

Patients who had at least 1 index visit in the period from March 1 to August 31 in both the 2020 TH and 2019 PP periods were counted and compared for baseline characteristics such as age, gender, race, and body mass index (BMI). The overall co-morbid burden was quantified using the Charlson Co-morbidity Index (CCI) score with the associated chronic conditions identified in the 12 months before each patient's index visit. Co-morbid medical conditions known to be associated with CV events such as hypertension, diabetes mellitus, stroke (CV accident [CVA]), chronic kidney disease (CKD 3 to 5), anemia, pulmonary disease, and the presence of implantable cardioverter defibrillator (AICD) were also compared. In-person visit types included return and consultation encounters. TH visit types were telephone and video encounters which included both consultations and return visits. As the “stay at home” order was lifted in the latter part of the TH study period, the proportion of TH use also shifted, although TH visits still accounted for the majority of clinic encounters. To address the potential difference in outcomes because of this shift in TH use, our TH cohort in 2020 was divided into two 3-month subcohorts: TH1 (from March 1 to May 31) and TH2 (from June 1 to August 31) and compared with the two same 3-month subcohorts (PP1 and PP2) in 2019 when patients were seen exclusively in person.

CV outcome events were identified using the principal or primary discharge diagnoses with ICD-10 codes corresponding to CVA, transient ischemic attack, myocardial infarction, angina, HF exacerbations, or cardiac arrest. CV death was identified by ICD-10 codes in death registries and/or by chart review by a cardiologist (Supplementary Appendix 1). CV outcome events were determined by tracking emergency department (ED) visits, urgent care visits, hospitalizations, and CV deaths that occurred at least 24 hours after and within 3 and 6 months from index visits. Patients with more than 1 clinic visit spanning both 3-month study periods in 2019 or 2020 would have their qualifying outcome events count toward the first index visit. ED visits leading to CV hospitalization were counted as hospitalization encounters.

This study was approved by the KPSC Institutional Review Board and was internally funded by the KPSC Regional Research Committee. Informed consent was waived for this retrospective study utilizing existing clinical data.

Categorical variables were described using counts and proportions. Continuous variables were summarized using means and SDs. Comparison of the distributions of demographic, baseline clinical variables, and visit types between PP and TH cohorts were performed using chi-square for categorical variables and Kruskal–Wallis tests for continuous variables. Logistic regression analyses were performed to compare the outcome events between PP and TH cohorts. The multivariable models were adjusted for age, gender, race/ethnicity, BMI, and baseline medical co-morbidities. All analyses were two-sided and performed using SAS version 9.4 (Cary, North Carolina). A p <0.05 was considered statistically significant.

Results

A total of 8,816 patients in the 2020 TH periods and 8,490 patients in the 2019 PP periods were initially identified. After applying all exclusion criteria, 6,485 TH and 7,557 PP patient encounters were included in the final analysis (Figure 1). Since 875 patients in TH and 1,038 patients in PP cohorts were seen in both 3-month study periods, 5,610 patients in TH and 6,519 patients in PP periods were identified for baseline comparisons after eliminating duplicate encounters. Among the TH cohort, 2,659 patients (46%) were also seen in the PP period. There was no apparent increase in clinic encounters in TH2 after heavy TH use in the TH1 period as the proportion of patients who were seen in both 3-month study periods in PP and TH was identical at 16%. There was no apparent increase in total clinic encounters in TH periods, even after accounting for the 372 patients who were excluded because of COVID-19 infections.

Baseline characteristics comparisons between the entire PP and TH cohorts showed similar distributions of age, gender, race, BMI, and CCI scores. The mean patient age at index visit was 70 years, with 40% of each cohort aged ≥75 years. The mean BMI was 30 kg/m², 35% were women, and 64% had a CCI score of ≥3. Approximately 37% were Hispanic patients, while 17% and 15% were Asian and Black patients, respectively. Among the medical co-morbidities, patients with hypertension and diabetes had proportionally fewer encounters while patients with AICD and CVA had more clinic encounters in the TH than the PP periods. (Table 1). Baseline characteristics in the subcohort comparisons showed similar distributions of age, gender, race, BMI, CCI score ≥3, and encounter proportions for patients with hypertension, diabetes, and AICD (Table 2).

Clinic encounters were exclusively in person in the PP periods. Consultations comprised 11% of all PP1 and 12% of all PP2 encounters, thus 89% of all PP1 and 88% of all PP2 encounters were return visits. Clinic encounters in TH periods were mostly done by way of telephone which comprised 76.1% of all TH1 and 53% of all TH2 encounters. Video visits comprised only 1% of all TH1 and 4.8% of all TH2 encounters. In-person consultations decreased in TH periods to 3.1% of all TH1 (a 73% decrease from PP1) and 6.6% of all TH2 encounters. In-person return visits also decreased to 19.8% of all TH1 (a 78% decrease from PP1) and 35.6% of all TH2 encounters (Table 2).

Patients aged ≥75 were seen in TH periods mostly by telephone which comprised 78.0% of all TH1 and 55.4% of all TH2 encounters. Video encounters comprised 0.6% of all TH1 and 3.2% of all TH2 encounters. A larger decrease in the proportions of in-person consultations and return visits were noted in TH1 for this group which comprised 2% (vs 8.8% in PP1) and 19.4% (vs 91.2% in PP1) of all
encounters respectively. By the TH2 period, the proportional decrease in both in-person consultations and return visits for patients aged \( \geq 75 \) was like the total cohort at 48% and 60% respectively when compared with the PP2 period (Table 2).

Outcome comparisons for all study cohorts showed no increase in overall CV outcome events including all ED and urgent care visits and hospitalizations between the TH and PP periods (part A of Table 3). After adjustments for age, gender, race/ethnicity, BMI, and medical co-morbid conditions, overall event rates were lower in TH1 \( \text{aOR} 0.75, 95\% \text{CI} 0.62 \text{ to } 0.91 \) and TH2 \( \text{aOR} 0.78, 95\% \text{CI} 0.62 \text{ to } 0.98 \) periods when compared with PP1 and PP2 subcohorts. CV hospitalization rates were significantly lower in TH1 \( \text{aOR} 0.66, 95\% \text{CI} 0.45 \text{ to } 0.95 \) and trended lower in TH2 \( \text{aOR} 0.65, 95\% \text{CI} 0.41 \text{ to } 1.02 \). ED visits trended lower in TH1 \( \text{aOR} 0.65, 95\% \text{CI} 0.39 \text{ to } 1.09 \) and in TH2 \( \text{aOR} 0.53, 95\% \text{CI} 0.28 \text{ to } 1.0 \). Again, the volumes of urgent care visits and CV deaths were too low for meaningful comparisons.

The multivariable logistic regression model was used to further analyze how study cohorts, patient characteristics, and medical co-morbid conditions were associated with overall CV outcomes within 3 months after index visits. For all study patients, the TH cohort was less likely \( \text{aOR} 0.78, 95\% \text{CI} 0.67 \text{ to } 0.90, p = 0.001 \) than the PP cohort to have outcome events (Figure 2). Black patients had a much higher likelihood of outcome events \( \text{aOR} 1.54, 95\% \text{CI} 1.23 \text{ to } 1.92, p < 0.001 \) while outcome events for Hispanic patients \( \text{aOR} 1.20, 95\% \text{CI} 0.99 \text{ to } 1.44, p = 0.06 \) trended higher than White patients. Among the medical co-morbidities, patients with CKD 3 to 5 had a 26% higher likelihood of outcome events \( \text{aOR} 1.26, 95\% \text{CI} 1.04 \text{ to } 1.54, p = 0.019 \). Applying the same analysis model to patients aged \( \geq 75 \) years showed similar results (Figure 3). The TH cohort was less likely to have outcome events \( \text{aOR} 0.70, 95\% \text{CI} 0.55 \text{ to } 0.89, p = 0.003 \), and Black patients had a

Figure 1. Cardiology patients and adverse cardiovascular clinical event identification flow diagram: prepandemic 2019 versus 2020 telehealth cohorts.
higher outcome event likelihood (aOR 1.53, 95% CI 1.09 to 2.15, p = 0.013). Different than the larger cohort, Asian patients trended lower in likelihood for outcome events (aOR 0.66, 95% CI 0.44 to 1.0, p = 0.049) while patients with the pulmonary disease were associated with higher outcome event likelihood (aOR 1.55, 95% CI 1.02 to 2.35, p = 0.039).

Extending the analysis of CV outcome events to 6 months after index visits showed similar findings. The overall adverse event rates in both study periods roughly doubled the 3-month rates for all subcohorts with a similar decrease in overall CV adverse events, ED visits, and hospitalizations for all TH subcohorts (Supplementary Table 1). Patients aged ≥75 years had no increase in event rates as well (Supplementary Table 1) when compared with the PP subcohorts. The lower likelihood for overall CV event rates was again seen for the entire TH cohort (aOR 0.77, 95% CI 0.68 to 0.87, p <0.0001) and for patients aged ≥75 years (aOR 0.74, 95% CI 0.62 to 0.89, p = 0.001) when compared with the PP cohort using the same multivariable logistic regression model for analysis.

Discussion

This study is novel in analyzing clinical outcomes of a high-risk cardiology patient group with CAD and/or HF after TH was adopted for a sustained period of 6 months during the early phase of the COVID-19 pandemic. Despite the continuous effort to promote video visits, TH visits were mostly conducted by telephone which comprised ≥92% of all TH encounters in this study. Overall CV outcome event counts from ED visits, urgent care visits, and hospitalizations were tracked for up to 6 months after patients’ index visits. The TH and PP cohorts had similar baseline patient characteristics, demographics, and co-morbidity burdens. Almost half (46%) of the TH patients were also seen in the PP period. Subcohort analyses were performed to address the potential outcome differences as the proportions of TH, and in-person visits shifted during the second half of our study period. The safety of TH use for advanced age (≥75 years) patients who were known to be challenged by TH visits was also studied.

Our results showed that TH care primarily by way of telephone encounters did not lead to any excess CV outcome events within 3 or 6 months after index visits, even when 77% of all encounters were conducted by way of TH visits during the first 3 months of the COVID-19 pandemic shutdown. No apparent increase in follow-up clinic encounters because of TH use was detected since the total clinic encounter counts were not increased in the TH period, and the proportion of patients (16%) who were seen in both 3-month subcohorts in the TH period was identical to that of the PP period. There was no outcome difference as the proportion of TH use shifted to 58% of all encounters in the second half of our TH study period. Those who were aged ≥75 years also had no excess outcome events utilizing TH largely by way of telephone contacts like the larger cohort. The favorable outcome in our TH cohorts that persisted over a 6-month study period from March 2020 and a follow-up period of up to 6 months could not be solely influenced by patients’ avoidance of medical care. The similar volume of patients who were seen in both TH and PP cohorts supports the potential benefit of TH in maintaining care access and reducing healthcare disparities for vulnerable patients as suggested by other investigators.

As described in other studies, patients of Black and Hispanic ethnicity tend to have an increased likelihood of CV outcome events compared with White patients. Patients aged ≥75 years as a group were less willing to be seen in person during the early phase of the pandemic shutdown. Inequities in telemedicine use were a challenge to our cohorts who were older and had difficulties with video encounters during the TH periods. Lack of digital literacy and Internet access were potential factors limiting the adoption of video encounters to no more than 8% of our TH visits.

This study is different from previous reports in several respects. We focused on clinical outcomes in a high-risk subspecialty patient group associated with TH use. Our patient population is drawn from a large, community-based integrated-care health system that serves a diverse population with an overall household median income of $<75,000, where Hispanic patients were the most prevalent ethnicity. Our non-fee-for-service reimbursement structure provided for a significantly larger percentage of telephone encounters being conducted than other studies, thus potentially narrowing the gap in TH inequity. This may be an important factor contributing to the favorable outcome seen in our older patient subgroup (≥75 years) who were able to
access care by telephone despite the pandemic shutdown. By establishing a longer study and follow-up period of 6 months, the question of the clinical safety of TH can be better verified.19,20

The remaining challenge for TH is to devise evidence-based metrics to triage the appropriate patient demographics, disease diagnoses, and clinic visit types for TH care.23 As observed in our study, triage decisions for TH were subjective and likely based upon cardiologists’ clinical judgment that physical assessment was needed and/or patients’ desire to be seen in person. Evidence from this study showed that other patient characteristics such as Black ethnicity, diagnoses such as CKD 3 to 5 for the total cohort, and pulmonary disease among patients aged ≥75 years were associated with a higher likelihood for outcome events which can be factored into future triage decisions for TH use. Despite reimbursement policies favoring the use of video encounters,24 this digital platform could not be easily adopted by our older cardiology cohort. Further clinical outcome studies comparing the use of different TH modalities will be important since many vulnerable digitally challenged patient subgroups can potentially increase their access to care if telephone TH is economically incentivized by reimbursement policy.

This study has some potential limitations. We have excluded patients diagnosed with COVID-19 which comprised 4% of the TH cohort, and patients on hemodialysis because of a potential increase in CV outcomes associated with noncardiac factors. Owing to the significant surge in COVID-19 cases during our TH study periods, we did not compare the groups regarding all-cause mortality.25 Direct comparison of CV outcome among the different clinic and TH visit types was not performed because of the constraints

Table 2
Baseline characteristics of cardiology subcohorts seen in prepandemic (2019) and telehealth (2020) periods

|                  | PP 1 (n = 3970) | TH 1 (n = 3508) | p-Value* | PP 2 (n = 3587) | TH 2 (n = 2977) | p-Value* |
|------------------|-----------------|-----------------|----------|-----------------|-----------------|----------|
| Hospital         |                 |                 |          |                 |                 |          |
| Baldwin Park     | 1244 (31.3%)    | 977 (27.9%)     | 0.004    | 1149 (32%)      | 1110 (37.3%)    | <0.001   |
| Downey           | 1531 (38.6%)    | 1431 (40.8%)    |          | 1353 (37.7%)    | 948 (31.8%)     |          |
| South Bay        | 1195 (30.1%)    | 1100 (31.4%)    |          | 1085 (30.2%)    | 919 (30.9%)     |          |
| Age mean (SD)    | 70.4 (12.05)    | 70.1 (12.60)    | 0.45     | 70.6 (12.07)    | 70.4 (12.36)    | 0.63     |
| Age ≥75          | 1576 (39.7%)    | 1380 (39.3%)    | 0.75     | 1446 (40.3%)    | 1197 (40.2%)    | 0.93     |
| Gender F         | 1395 (35.1%)    | 1242 (35.4%)    | 0.81     | 1291 (36%)      | 1030 (34.6%)    | 0.24     |
| Race/ethnicity   |                 |                 | 0.25     |                 |                 | 0.21     |
| White            | 1151 (29%)      | 1053 (30%)      |          | 1046 (29.2%)    | 932 (31.3%)     |          |
| Asian            | 664 (16.7%)     | 547 (15.6%)     |          | 634 (17.7%)     | 506 (17%)       |          |
| Black            | 584 (14.7%)     | 565 (16.1%)     |          | 525 (14.6%)     | 392 (13.2%)     |          |
| Hispanic         | 1512 (38.1%)    | 1290 (36.8%)    |          | 1340 (37.4%)    | 1107 (37.2%)    |          |
| Other/unknown    | 59 (1.5%)       | 53 (1.5%)       | 0.25     |                 |                 |          |
| BMI mean (SD)    | 29.7 (6.45)     | 30.0 (6.79)     | 0.29     | 29.6 (6.54)     | 29.7 (6.53)     | 0.95     |
| BMI ≥30          | 1626 (41%)      | 1495 (42.7%)    | 0.13     | 1446 (40.3%)    | 1196 (40.2%)    | 0.93     |
| Charlson co-morbidity score | 0.32        |                 |          |                 |                 |          |
| 0                | 194 (4.9%)      | 185 (5.3%)      |          | 203 (5.7%)      | 186 (6.2%)      |          |
| 1-2              | 1212 (30.5%)    | 1019 (29%)      |          | 1023 (28.5%)    | 887 (29.8%)     |          |
| 3+               | 2564 (64.6%)    | 2304 (65.7%)    |          | 2361 (65.8%)    | 1904 (64%)      |          |
| Coronary artery disease | 2826 (71.2%) | 2399 (68.4%)    | 0.009    | 2495 (69.6%)    | 2020 (67.9%)    | 0.14     |
| Heart failure    | 2033 (51.2%)    | 1921 (54.8%)    | 0.002    | 1879 (52.4%)    | 1612 (54.1%)    | 0.15     |
| Anemia           | 73 (1.8%)       | 66 (1.9%)       | 0.89     | 49 (1.4%)       | 67 (2.3%)       | 0.007    |
| Chronic kidney disease 3-5 | 727 (18.3%) | 548 (15.6%)    | 0.002    | 577 (16.1%)    | 555 (18.6%)     | 0.006    |
| Stroke           | 25 (0.6%)       | 33 (0.9%)       | 0.13     | 27 (0.8%)       | 34 (1.1%)       | 0.10     |
| Diabetes         | 1475 (37.2%)    | 1143 (32.6%)    | <0.001   | 1302 (36.3%)    | 1031 (34.6%)    | 0.16     |
| Hypertension     | 2751 (69.3%)    | 2126 (60.6%)    | <0.001   | 2417 (67.4%)    | 1909 (64.1%)    | 0.006    |
| Presence of AICD | 217 (5.5%)      | 277 (7.9%)      | <0.001   | 209 (5.8%)      | 231 (7.8%)      | 0.002    |
| Pulmonary disease | 188 (4.7%)     | 176 (5%)       | 0.57     | 129 (3.6%)      | 147 (4.9%)      | 0.007    |
| Index visit type (All) |               |                 | <0.001   |                 |                 | <0.001   |
| Consult in person | 449 (11.3%)     | 109 (3.1%)      |          | 449 (12.5%)     | 195 (6.6%)      |          |
| Return in person  | 3521 (88.7%)   | 695 (19.8%)     |          | 3137 (87.5%)    | 1060 (35.6%)    |          |
| Telephone        | 0 (0%)          | 2670 (76.1%)    |          | 1 (0%)          | 1578 (53%)      |          |
| Video            | 0 (0%)          | 34 (1%)         |          | 0 (0%)          | 144 (4.8%)      |          |
| Index visit type Age≥75 |               |                 | <0.001   |                 |                 | <0.001   |
| Consult in person | 139 (8.8%)      | 27 (2.0%)       |          | 143 (9.9%)      | 61 (5.1%)       |          |
| Return in person  | 1437 (91.2%)   | 268 (19.4%)     |          | 1302 (90.0%)    | 435 (36.3%)     |          |
| Telephone        | 0               | 1077 (78%)      |          | 1 (0.1%)        | 663 (55.4%)     |          |
| Video            | 0               | 8 (0.6%)        |          | 0               | 38 (3.2%)       |          |

* Chi-Square for categorical variables and Kruskal–Wallis for continuous variables.
AICD = implantable cardioverter defibrillator; BMI = body mass index; PP1 = prepandemic 1; PP2 = prepandemic 2; TH 1 = telehealth 1; TH 2 = telehealth 2.
Event outcome comparisons beyond 6 months after index visits were not analyzed because of the significant decrease in the proportion of TH visits and the increase in in-person clinic visits among our study cohort during the latter part of 2020 to 2021.

In conclusion, this study showed that incorporating TH largely by way of telephone encounter into the ambulatory cardiology clinical practice across all adult cardiology patients is clinically acceptable with no excess CV outcome events within 3 or 6 months after index visits. Since most cardiologists will still maintain TH as a fraction of their practice after COVID-19 and the hybrid model of TH care as a supplement to in-person visits will persist, this outcome study will help to support the use of TH in the cardiology clinics. Outcome events in association with patient characteristics, demographics, and co-morbid diagnoses were presented to potentially provide evidence for future triage decisions for TH care.
Disclosures

The authors have no conflicts of interest to declare.

Acknowledgment

The authors would like to acknowledge the invaluable contributions of our colleagues who reviewed our study plan, provided suggestions to strengthen the study and the final manuscript, and Timothy M. Cotter, MD, CPC; Martha I Mercado, MD; Ramin F Shadman, MD; Maria T Taitano, MD; Cheng-Wei Huang, MD; and Alejandra E Montano, who provided other forms of support for this project.

Supplementary materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.amjcard.2022.10.043.

1. Wosik J, Fudim M, Cameron B, Gellad ZF, Cho A, Phinney D, Curtis S, Roman M, Poon EG, Ferranti J, Katz JN, Tcheng J. Telehealth transformation: COVID-19 and the rise of virtual care. J Am Med Inform Assoc 2020;27:957–962.
2. Tessitore E, Carballo D, Poncelet A, Perrin N, Follonier C, Assouline B, Carballo S, Girardin F, Mach F. Mortality and high risk of major adverse events in patients with COVID-19 and history of cardiovascular disease. Open Heart 2021;8:e001526.
3. Oseran AS, Wasyliw JH. Early experiences with cardiology electronic consults: a systematic review. Am Heart J 2019;215:139–146.
4. Mehrotra A, Ray K, Brockmeyer DM, Barnett ML, Bender JA. Rapidly converting to “virtual practices”: outpatient care in the era of Covid-19. NEJM Catalyst. Available at: https://catalyst.nejm.org/doi/full/10.1056/CAT.20.0091. Accessed on April 1, 2020.
5. Koonin LM, Hoots B, Tsang CA, Leroy T, Farris K, Jolly T, Antall P, McCabe B, Zelisi CBR, Tong I, Harris AM. Trends in the use of telehealth During the emergence of the COVID-19 pandemic- United States, January-March 2020. MMWR Morb Mortal Wkly Rep 2020;69:1595–1599.
6. Hollander JE, Carr BG. Virtually perfect? Telemedicine for COVID-19. N Engl J Med 2020;382:1679–1681.
7. Gorodeski EZ, Goyal P, Cox ZL, Thibodeau JT, Reay RE, Rasmussen K, Rogers JG, Starling RC. Virtual visits for care of patients with heart failure in the era of Covid-19: A Statement from the Heart Failure Society of America. J Card Fail 2020;26:448–456.
8. Kelly SA, Schesing KB, Thibodeau JT, Ayers CR, Drazner MH. Feasibility of remote video assessment of jugular venous pressure and implications for telehealth. JAMA Cardiol 2020;5:1194–1195.
9. Bhatt AB, Nagale S. Telemedicine for cardiovascular disease care. In: Bhatt AB, ed. Healthcare Information Technology for Cardiovascular Medicine. Health Informatics. Cham: Springer; 2021:1–11.
10. Singh A, Mountjoy N, McElroy D, Mittal S, Al Hemyari B, Coffey N, Miller K, Gaines K. Patient perspectives with telehealth visits in cardiology During COVID-19: online patient survey study. JMIR Cardio 2021;5:e25074.
11. Lee M, Luna P, Lynch S, Nagpal S, Domínguez YC, Ahmed Z, Brice A, Arham A, Smolderen K, Hurtado CM. Telehealth provider perspectives during COVID-19: insights from an academic cardiology practice. J Am Coll Cardiol 2021;77:3212.
12. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 1992;45:613–619.
13. Eberly LA, Kallan MJ, Julien HM, Haynes N, Khatana SA, Nathan AS, Snider C, Chokshi NP, Eneanya ND, Takvorian SU, Anastas-Wallen RChaiyachati Kri, Ambrose M, O’Quinn R, Seigerman M, Goldberg LR, Leri D, Choi K, Gitelman Y, Kolansky DM, Cappola TP,
14. Kuehn BM. Telemedicine helps cardiologists extend their reach. *Circulation* 2016;134:1189–1191.
15. Poppas A, Rumsfeld JS, Wessler JD. Telehealth is having a moment: will it last? *J Am Coll Cardiol* 2020;75:2989–2991.
16. Yuan N, Pevnick JM, Botting PG, Elad Y, Miller SJ, Cheng S, Ebinger JE. Patient use and clinical practice patterns of remote cardiology clinic visits in the era of COVID-19. *JAMA Netw Open* 2021;4:e214157.
17. Lewey J, Choudhry NK. The current state of ethnic and racial disparities in cardiovascular care: lessons from the past and opportunities for the future. *Curr Cardiol Rep* 2014;16:530.
18. Sammour Y, Spertus JA, Austin BA, Magalski A, Gupta SK, Shatla I, Dean E, Kennedy KF, Jones PG, Nassif ME, Main ML, Sperry BW. Outpatient management of heart failure during the COVID-19 pandemic after adoption of a telehealth model. *JACC Heart Fail* 2021;9:916–924.
19. Sammour Y, Shatla I, Miller L, Dean E, Nassif M, Gupta S, Magalski A, Main M, Spertus J, Sperry B. Comparison of video and telephone virtual visits in outpatients with heart failure. *Am J Cardiol* 2021;158:153–156.
20. Rowe SJ, Paratz ED, Fahy L, Prior DL, MacIsaac AI. Telehealth in Australian cardiology: insight into factors predicting the use of telephone versus video during the COVID-19 pandemic. *Intern Med J* 2021;51:1229–1235.
21. Boriani G, Maisano A, Bonini N, Albini A, Imberti JF, Venturelli A, Menozzi M, Ziveri V, Morgante V, Camaioni G, Passatore M, De Mitri G, Nanni G, Girolami D, Fontanesi R, Siena V, Sgreccia D, Malavasi VL, Valenti AC, Vitolo M. Digital literacy as a potential barrier to implementation of cardiology tele-visits after COVID-19 pandemic: the INFO-COVID survey. *J Geriatr Cardiol* 2021;18:739–747.
22. Reed M, Huang J, Graetz I, Muelly E, Millman A, Lee C. Treatment and follow-up care associated with patient-scheduled primary care telemedicine and in-person visits in a large integrated health system. *JAMA Netw Open* 2021;4:e2132793.
23. Reeves JJ, Ayers JW, Longhurst CA. Telehealth in the COVID-19 era: a balancing act to avoid harm. *J Med Internet Res* 2021;23:e24785.
24. Medicare and Medicaid programs, basic health program, and exchanges; additional policy and regulatory revisions in response to the COVID-19 public health emergency and delay of certain reporting requirements for the skilled nursing facility quality reporting program. Federal Register. Available at: https://www.federalregister.gov/documents/2020/05/08/2020-09608/medicare-and-medicaid-programs-basic-health-program-and-exchanges-additional-policy-and-regulatory. Accessed on May 25, 2020.
25. Woolf SH, Chapman DA, Sabo RT, Zimmerman EB. Excess deaths From COVID-19 and other causes in the US, March 1, 2020, to January 2, 2021. *JAMA* 2021;325:1786–1789.
26. Hollander J, Sharma R. Telemedicine is mainstream care delivery. NEJM Catalyst Innovations in Care Delivery. Available at: https://catalyst.nejm.org/doi/full/10.1056/CAT.22.0176. Accessed on June 15, 2022.