Telemedicine Familiarity and Post-Disaster Utilization of Emergency and Hospital Services for Ambulatory Care Sensitive Conditions

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Introduction: In this study, we examined the association between telemedicine use before a disaster and utilization of emergency or hospital services for ambulatory care sensitive conditions post-disaster.

Methods: Difference-in-differences analyses were conducted in 2020–2021 to assess pre- to post-fire changes in emergency or hospital utilization for 5 ambulatory care sensitive conditions: asthma, diabetes, hypertension, coronary artery disease, and heart failure across all Kaiser Permanente Santa Rosa patients (N=108,113) based on telemedicine utilization before the 2017 Tubbs wildfire. Inverse probability of treatment weighting was employed for cohort balancing across telemedicine familiar status.

Results: Utilization for any ambulatory care sensitive condition increased from 9.03% pre-fire to 9.45% post-fire across the full cohort. Telemedicine familiarity (ref: not familiar) was associated with decreased absolute risk in pre- to post-fire inpatient and emergency department utilization for 4 conditions: asthma (absolute risk= −1.59%, 95% CI= −2.02%, −1.16%), diabetes (absolute risk= −0.68%, 95% CI= −0.89%, −0.47%), hypertension (absolute risk= −2.07%, 95% CI= −2.44%, −1.71%), and coronary artery disease (absolute risk= −0.43%, 95% CI= −0.61%, −0.24%). Telemedicine familiarity was associated with decreased relative change in pre- to post-fire utilization for 5 conditions: asthma (RRR=0.70, 95% CI=0.64, 0.75), diabetes (RRR=0.54, 95% CI=0.47, 0.63), hypertension (RRR=0.57, 95% CI=0.52, 0.62), heart failure (RRR=0.64, 95% CI=0.50, 0.82), and coronary artery disease (RRR=0.56, 95% CI=0.47, 0.67). Similar results were seen among patients residing in evacuation zones.

Conclusions: Telemedicine familiarity pre-fire was associated with decreased inpatient and emergency department utilization for certain ambulatory care sensitive conditions for 1-year post-fire. These results suggest a role for telemedicine in preventing unnecessary emergency and hospital utilization following disasters.

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following disasters and can experience longer delays regaining access to care.1−7

With the increasing incidence of severe weather events, it is critical that the healthcare community explores how to accommodate the volume and variety of patient needs following disruption.1−3 Previous literature has shown that in the wake of a disaster, many patients request care and medications for pre-existing conditions rather than for acute needs, and medical personnel often do not have the supplies or training to meet this demand.2−5,8,9 Telemedicine is recognized as a resource to manage short-term surge capacity in certain disasters and has played a role in the response to the coronavirus disease 2019 (COVID-19) pandemic.2,6−10

The Tubbs fire was part of a complex of wildfires that swept through Sonoma County, California, in October 2017. The Tubbs fire is the second most destructive fire in California history, destroying 5,636 structures and causing 22 deaths.11 The fire burned from October 8 to 31, 2017, and forced 2 of 3 local hospitals to close. At the Kaiser Permanente Santa Rosa Medical Center, 73 physicians and approximately 225 nonphysician staff lost their homes, and facilities in Santa Rosa were closed for up to 3 weeks. Even after ambulatory care services were restored, office visit access was limited by the large number of physicians who had themselves lost their homes and were displaced.

In this study, we assessed the impact of the Tubbs fire on inpatient and emergency department (ED) utilization for ambulatory care sensitive conditions (ACSCs): asthma, diabetes, hypertension, heart failure, and coronary artery disease (CAD).12 A quasi-experimental difference-in-differences methodology was used to examine associations between patients’ pre-existing familiarity with telemedicine and changes in pre-to post-fire ED and hospital utilization for these conditions. The hypothesis is that pre-fire familiarity with telemedicine is associated with decreased post-fire ED and hospital utilization for ACSCs as compared to no familiarity with telemedicine.

**METHODS**

**Study Population**

This observational, quasi-experimental study used difference-in-differences methodology to assess pre- to post-fire differences in utilization, by telemedicine familiarity. Telemedicine is defined as telephone or video appointments or a secure patient message to physicians. The setting for this study was Kaiser Permanente Northern California (KPNC), a large, integrated healthcare system that acts as both insurer and healthcare provider to its patients.13 Because the structure of KPNC is not reliant on fee-for-service payments, all KPNC patients have access to free telephone appointments and secure messaging with physicians regardless of insurance type.

The index date for this study was October 8, 2017, the first day of the Tubbs fire. The study sample comprised all adult KPNC patients with a home address within the Kaiser Permanente Santa Rosa catchment area during the fire. All members of the study sample were aged 18−89 years as of the index date and were required to have had continuous active KPNC insurance from 1 year before 1 year after the fire. Baseline characteristics and pre-fire utilization were identified as of the index date with a lookback period of 1 year before index (October 8, 2016−October 7, 2017). Post-fire outcomes were identified from the index date to 1 year after (October 8, 2017−October 7, 2018). This study was approved by the KPNC IRB with waiver of consent.

**Measures**

Variables including patient demographics, clinical characteristics, and inpatient and ED utilization were obtained using the KPNC Electronic Health Record. Utilization outside KPNC was identified using claims data. Patient addresses were geocoded to obtain latitude and longitude, which was used for subsequent spatial analysis. Variables related to fire exposure were obtained from the California Department of Forestry and Fire Protection, which identified homes and other buildings evacuated and destroyed during the Tubbs fire.14 GIS data on evacuation zones and fire perimeter extent were obtained directly from Napa and Sonoma County governments.

All KPNC patients have access to telemedicine encounters. Telemedicine encounters in the year before index (October 8, 2016−October 7, 2017) were extracted from KPNC encounter databases and were categorized as scheduled phone visit, video visit, and secure message. Univariate statistics were produced on each category of telemedicine encounter. Patients having greater than the median number of encounters for ≥1 telemedicine visit types were classified as telemedicine familiar. Patients with ≥2 scheduled telephone visits, ≥1 video visit, or ≥6 secure messages were classified as telemedicine familiar; patients having <2 scheduled telephone visits, 0 video visits, and <6 secure messages were classified as not telemedicine familiar. Telemedicine utilization was quantified during the lookback period only because the investigators aimed to assess the impact of comfort with telemedicine services at the time of the wildfire.

Inpatient and ED encounters between October 8, 2016, and October 7, 2018, that included a diagnosis for the following ACSCs were included: asthma, chronic obstructive pulmonary disease, or other respiratory condition; diabetes; heart failure; CAD; or hypertension. Inpatient and ED utilization within the KPNC system was extracted from the electronic health record, and inpatient and ED utilization outside KPNC was identified using claims data. Encounters occurring October 8, 2016−October 7, 2017 were classified as pre-fire utilization, and those occurring October 8, 2017−October 7, 2018 comprised post-fire utilization. Utilization was quantified as counts per month, and binomial variables reflecting any utilization for each diagnosis during the pre- and post-fire time periods were produced.

Because the Tubbs fire was so widespread, all the patients in the KPNC Santa Rosa catchment area were considered to have been impacted by the fire and to have experienced disruption in day-to-day life and medical care. Patient addresses as of October 8,
2017, were linked to publicly available California Department of Forestry and Fire Protection data, which included variables indicating, by building, homes that were damaged or destroyed by the fire. GIS data on evacuation zones and burn areas were incorporated, allowing for the creation of a binomial variable reflecting evacuation status.

Patient date of birth, sex, race, and ethnicity were extracted from the patient demographic data. Median census block-level income was obtained from the 2010 census data geocoded and matched to the KPNC population. All the patients were insured by KPNC; therefore, insurance type was not included as a covariate. Preferred spoken language was extracted from the electronic health record; where the preferred primary language was not English, the patient was considered to have limited English proficiency. The Charlson Comorbidity Score was used as a proxy for overall disease burden and was calculated by extracting diagnosis and procedure information for comorbid conditions for the look-back year.15

**Statistical Analysis**

Counts of inpatient and ED encounters by month were plotted graphically, with trends descriptively shown using linear regression lines. Bivariate statistics were conducted using the chi-square test where variables were binomial. The Fisher’s exact test with bootstrap correction for multiple comparisons was used when the variables were categorical, and the t-test was employed for continuous variables.

Difference-in-differences models were employed to assess the association between telemedicine familiarity and pre- to post-fire differences in utilization by chronic condition diagnosis by year.16 For difference-in-differences models, outcomes were dichotomized (inpatient or ED utilization, yes/no). The magnitude of pre- and post-fire change in utilization was assessed using absolute risk (AR) values reported as percentages for utilization associated with each chronic condition diagnosis. RRRs for the interaction between pre- and post-fire time periods and telemedicine familiarity were produced to quantify the association between telemedicine familiarity and relative change in utilization. Inverse probability of treatment weighting was employed for cohort balancing across telemedicine familiar status with respect to patient characteristics.17 Propensity scores adjusting for differences between the telemedicine familiar and not telemedicine familiar groups were created for each patient using age, sex, race/ethnicity, limited English proficiency, median census block-level household income, and the Charlson Comorbidity Score; inverse probability of treatment weights were calculated based on propensity scores. Univariate distributions of propensity scores and inverse probability of treatment weights were examined to assess the adequacy of the propensity score model. In addition, as a sensitivity analysis, ARs and RRRs for difference-in-differences models employing inverse probability of treatment weights were compared with identical difference-in-differences models not employing inverse probability of treatment weights. AR values and RRRs from this sensitivity analysis did not markedly differ across weighted and unweighted difference-in-differences models. Difference-in-differences models were produced for the full cohort of KPNC Santa Rosa members and for a subgroup whose homes were located within fire evacuation zones.

The map of the study cohort, fire extent, and fire evacuation areas was produced by aggregating the geocoded patient points to a 1,500 m hexagonal grid. Statistical analyses were performed using R, version 9.4. Mapping was conducted using R, version 3.6.1, and ArcGIS Pro, version 2.7.18,19 This study was funded by the KPNC Community Benefit Program.

**RESULTS**

There were 108,113 KPNC Santa Rosa members meeting study inclusion criteria; of these, 21,269 lived in homes within the fire evacuation zones. A map showing the study population distribution by pre-fire home address, the KPNC Santa Rosa medical office buildings, fire evacuation zones, and extent of the Tubbs fire is shown in Figure 1.

Of the 108,113 members, 48,654 (45.0%) were familiar to telemedicine and 59,459 (55.0%) were not telemedicine familiar before the fire. Bivariate results by telemedicine familiarity are shown in Table 1. Patients who were familiar to telemedicine were older (aged 55.9 years vs 46.8 years, p<0.001) and had slightly higher Census block-level household income ($67,539.59 vs $67,069.31, p<0.001) than patients who were not telemedicine familiar. Female patients were more likely to be telemedicine familiar than male patients (52.5% vs 36.6%, p<0.001). Patients having limited English proficiency were less likely to be telemedicine familiar than those proficient in English (23.1% vs 46.8%, p<0.001). In comparisons across race/ethnicity, White patients were more likely to be telemedicine familiar (49.2%) than Black patients (44.8%), Asian patients (36.5%), Hispanic patients (34.0%), and those of unknown or other race/ethnicity (25.6%). Paired comparisons by race/ethnicity were significant at p<0.010 for all comparisons.

Figure 2 shows inpatient and ED utilization associated with chronic condition diagnoses over time, by telemedicine familiarity. Monthly counts of inpatient and ED encounters for November 2016–September 2018 are shown stratified by telemedicine familiar status. Utilization trends for each group are shown descriptively using linear regression lines.

To assess the association between telemedicine familiarity and the pre- to post-fire relative change in inpatient and ED utilization for each condition (asthma, diabetes, hypertension, heart failure, and CAD), difference-in-differences models with inverse probability of treatment weighting accounting for differences across telemedicine familiar status with respect to age, sex, race/ethnicity, limited English proficiency, median Census block-level household income, and the Charlson Comorbidity Score were employed. Results of difference-in-differences
analyses are shown in Table 2. Results for unweighted models are shown in Appendix Table 1 (available online).

The proportion of patients having any ED or inpatient utilization for any of the 5 conditions increased from 9.03% (n=9,764) pre-fire to 9.45% (n=10,217) post-fire in the full cohort and from 9.60% (n=2,042) to 10.34% (n=2,200) among patients having homes in evacuation zones. Utilization for all conditions increased for the full cohort across the pre- to post-fire time periods. Utilization increased for the not telemedicine familiar group for all 5 conditions; for the telemedicine familiar group, pre- to post-fire utilization decreased for 3 conditions (asthma:

![Map of 2017 Tubbs fire and study population distribution.](https://example.com/map.png)

**Figure 1.** Map of 2017 Tubbs fire and study population distribution.

N, North.
Table 1. Patient Characteristics, by Telemedicine Familiarity, All KPNC Santa Rosa Members (N=108,113)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Telemedicine familiar, n=48,654 (45.0)</th>
<th>Not telemedicine familiar, n=59,459 (55.0)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years, mean ± SD: 50.9 ± 17.8</td>
<td>55.9 ± 17.1</td>
<td>46.8 ± 17.4</td>
<td>&lt;0.001a</td>
</tr>
<tr>
<td>Sex, n (%)</td>
<td></td>
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<tr>
<td>Female, n=57,082 (52.8)</td>
<td>29,982 (52.5)</td>
<td>27,100 (47.5)</td>
<td>&lt;0.001b</td>
</tr>
<tr>
<td>Male, n=51,031 (47.2)</td>
<td>18,672 (36.6)</td>
<td>32,359 (63.4)</td>
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<tr>
<td>Limited English proficiency</td>
<td></td>
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<tr>
<td>Yes, n=8,036 (7.4)</td>
<td>1,853 (23.1)</td>
<td>6,183 (76.9)</td>
<td>&lt;0.001b</td>
</tr>
<tr>
<td>No, n=100,077 (92.6)</td>
<td>46,801 (46.8)</td>
<td>53,276 (53.2)</td>
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<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Asian, n=5,235 (4.8)</td>
<td>1,908 (36.5)</td>
<td>3,327 (63.5)</td>
<td>&lt;0.010c</td>
</tr>
<tr>
<td>Black, n=1,758 (1.6)</td>
<td>787 (44.8)</td>
<td>971 (55.2)</td>
<td></td>
</tr>
<tr>
<td>Hispanic, n=17,587 (16.3)</td>
<td>5,972 (34.0)</td>
<td>11,615 (66.0)</td>
<td></td>
</tr>
<tr>
<td>White, n=78,943 (73.0)</td>
<td>38,813 (49.2)</td>
<td>40,130 (50.8)</td>
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</tr>
<tr>
<td>Unknown/other, n=4,590 (4.3)</td>
<td>1,174 (25.6)</td>
<td>3,416 (74.4)</td>
<td></td>
</tr>
<tr>
<td>Median Census block-level household income, in dollars, mean ± SD: 67,280.99 ± 24,368.60</td>
<td>67,539.59 ± 24,458.89</td>
<td>67,069.31 ± 24,292.61</td>
<td>&lt;0.001c</td>
</tr>
<tr>
<td>Charlson comorbidity score</td>
<td></td>
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</tr>
<tr>
<td>≥1, n=32,681 (30.2)</td>
<td>23,148 (70.8)</td>
<td>9,533 (29.2)</td>
<td>&lt;0.001b</td>
</tr>
<tr>
<td>0, n=75,432 (69.8)</td>
<td>25,506 (33.8)</td>
<td>49,926 (66.2)</td>
<td></td>
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<tr>
<td>Resided in evacuation zone</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Yes, n=21,269 (19.7)</td>
<td>10,097 (47.5)</td>
<td>11,172 (52.5)</td>
<td>&lt;0.001b</td>
</tr>
<tr>
<td>No, n=86,844 (80.3)</td>
<td>38,557 (44.4)</td>
<td>48,287 (55.6)</td>
<td></td>
</tr>
</tbody>
</table>

KPNC, Kaiser Permanente Northern California.
aComparisons performed using the t-test.
bComparisons performed using the chi-square test.
cA series of paired Fisher’s exact tests with bootstrap correction for multiple comparisons were performed to assess differences in telemedicine familiarity across race/ethnic groups. Significant differences were found across all paired comparisons at p<0.010 for all comparisons.

9.64%—9.33%, diabetes: 3.84%—3.76%, and hypertension: 8.67%—8.25%). Telemedicine familiarity (ref: not familiar) was associated with decreased AR in pre- to post-fire inpatient and ED utilization for 4 conditions: asthma (AR=−1.59%, 95% CI=−2.02%, −1.16%), diabetes (AR=−0.68%, 95% CI=−0.89%, −0.47%), hypertension (−2.07%, 95% CI=−2.44%, −1.71%), and CAD (AR=−0.43%, 95% CI=−0.61%, −0.24%). Telemedicine familiarity was associated with decreased relative change in pre- to post-fire utilization for all 5 conditions: asthma (RRR=0.70, 95% CI=0.64, 0.75), diabetes (RRR=0.54, 95% CI=0.47, 0.63), hypertension (RRR=0.57, 95% CI=0.52, 0.62), heart failure (RRR=0.64, 95% CI=0.50, 0.82), and CAD (RRR=0.56, 95% CI=0.47, 0.67). Among patients having homes in evacuation zones, telemedicine familiarity was associated with a decreased pre- to post-fire AR for utilization for 4 conditions as well as decreased relative change in utilization for all 5 conditions.

DISCUSSION

A small increase in ACSC-associated ED and hospital utilization was detected for the entire cohort up to 12 months post-fire compared with the previous year. Only 19.7% of the cohort was evacuated from their homes, suggesting that the entire community experienced prolonged negative health effects after the fire, not just those who were evacuated or lost their homes. These results are concordant with previous studies indicating that short-term disruptions because of disaster are associated with persistent health consequences.20,21

Telemedicine familiarity was associated with a significantly reduced RRR for post-fire hospital and ED utilization for all 5 ACSCs, and a significant AR reduction for 4 conditions. Although the number of ED and inpatient admissions during the study period was small, a reduction in something as financially and personally costly as hospital use is noteworthy. The protective effect of telemedicine familiarity against post-fire utilization persisted after adjusting for between-group differences using inverse probability of treatment weights.

In previous studies, researchers have affirmed the importance of telemedicine in the aftermath of a disaster domestically and internationally, particularly during short-term recovery efforts.7,10,22,23 Telemedicine has been shown to impact healthcare utilization patterns: patients with multiple chronic conditions who used a secure message portal to communicate with their care...
team showed decreased ED use and preventable hospital stays. These results support this finding and suggest that accessing medical care through telemedicine may offer continuity of care, particularly when in-person care is inaccessible. Telemedicine aptitude and access, especially during the first few critical weeks of recovery, may keep patients from experiencing increasing ill health and preventable hospitalization following a disaster. This has important implications for health equity in disaster settings, especially given that telephone visits were commonly utilized by members of the telemedicine familiar group during the study timeframe. Although video visits and other forms of telehealth requiring broadband access may widen gaps in access among medically underserved patients, telephone visits have been demonstrated to offer high efficacy and patient satisfaction in routine preventive care and chronic disease management and may reduce barriers to accessing care.

This is the first study to demonstrate a protective effect of telemedicine against ED and hospitalization for 5 different ACSCs. A strength of this study is that the entirety of KPNC membership has equal access to telemedicine services in their insurance plans. KPNC membership is large and diverse and is generally representative of the population residing within the catchment area. The quasi-experimental study design and difference-in-differences analytical methods allowed the authors to assess the absolute as well as relative change in pre- to post-fire utilization with respect to telemedicine familiarity. Furthermore, the use of inverse probability of treatment weighting to perform cohort balancing with respect to

Figure 2. Inpatient and ED utilization for ambulatory care sensitive conditions, pre and post Tubbs fire, by telemedicine familiarity. Of N=108,113 in the study population, 48,654 (45.0%) were telemedicine familiar and 59,459 (55%) were not telemedicine familiar. Trends shown descriptively using linear regression lines, by telemedicine familiarity.
<table>
<thead>
<tr>
<th>Ambulatory care sensitive condition</th>
<th>Overall utilization for this condition pre- to post-fire, %</th>
<th>Telemedicine familiar, percent utilization for this condition pre-to post-fire, %</th>
<th>Not telemedicine familiar, percent utilization for this condition pre- to post-fire, %</th>
<th>Pre- to post-fire change in utilization, telemedicine familiar (ref: not familiar) Absolute risk, % (95% CI)&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Pre- to post-fire relative change in utilization, telemedicine familiar (ref: not familiar) RRR (95% CI)&lt;sup&gt;b&lt;/sup&gt;</th>
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<tbody>
<tr>
<td><strong>Asthma</strong></td>
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<tr>
<td>Full cohort (N=108,113)</td>
<td>5.63−6.01</td>
<td>9.64−9.33</td>
<td>2.35−3.29</td>
<td>−1.59 (−2.02, −1.16)</td>
<td>0.70 (0.64, 0.75)</td>
</tr>
<tr>
<td>Evacuated (n=21,269)</td>
<td>5.73−6.47</td>
<td>9.69−10.10</td>
<td>2.16−3.20</td>
<td>−1.53 (−2.49, −0.56)</td>
<td>0.66 (0.55, 0.79)</td>
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<tr>
<td><strong>Diabetes</strong></td>
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<tr>
<td>Full cohort (N=108,113)</td>
<td>1.95−2.11</td>
<td>3.84−3.76</td>
<td>0.39−0.76</td>
<td>−0.68 (−0.89, −0.47)</td>
<td>0.54 (0.47, 0.63)</td>
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<tr>
<td>Evacuated (n=21,269)</td>
<td>2.08−2.20</td>
<td>3.99−3.78</td>
<td>0.35−0.77</td>
<td>−1.07 (−1.16, −0.59)</td>
<td>0.40 (0.28, 0.58)</td>
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<td><strong>Hypertension</strong></td>
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<tr>
<td>Full cohort (N=108,113)</td>
<td>4.66−5.00</td>
<td>8.67−8.25</td>
<td>1.38−2.34</td>
<td>−2.07 (−2.44, −1.71)</td>
<td>0.57 (0.52, 0.62)</td>
</tr>
<tr>
<td>Evacuated (n=21,269)</td>
<td>5.21−5.75</td>
<td>9.52−9.20</td>
<td>1.32−2.63</td>
<td>−2.94 (−3.80, −2.09)</td>
<td>0.46 (0.38, 0.56)</td>
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<tr>
<td><strong>Heart failure</strong></td>
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<tr>
<td>Full cohort (N=108,113)</td>
<td>0.58−0.74</td>
<td>1.12−1.35</td>
<td>0.13−0.25</td>
<td>−0.11 (−0.03, 0.00)</td>
<td>0.64 (0.50, 0.82)</td>
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<tr>
<td>Evacuated (n=21,269)</td>
<td>0.66−0.88</td>
<td>1.28−1.59</td>
<td>0.10−0.23</td>
<td>−0.15 (−0.45, 0.15)</td>
<td>0.47 (0.26, 0.86)</td>
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<td><strong>Coronary artery disease</strong></td>
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<tr>
<td>Full cohort (N=108,113)</td>
<td>1.13−1.41</td>
<td>2.20−2.42</td>
<td>0.27−0.58</td>
<td>−0.43 (−0.61, −0.24)</td>
<td>0.56 (0.47, 0.67)</td>
</tr>
<tr>
<td>Evacuated (n=21,269)</td>
<td>1.29−1.63</td>
<td>2.49−2.69</td>
<td>0.21−0.67</td>
<td>−0.71 (−1.15, −0.27)</td>
<td>0.40 (0.26, 0.62)</td>
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<tr>
<td><strong>Any ACSC</strong></td>
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<tr>
<td>Full cohort (N=108,133)</td>
<td>9.03−9.45</td>
<td>15.94−14.68</td>
<td>3.38−5.17</td>
<td>−3.45 (−3.95, −2.95)</td>
<td>0.62 (0.59, 0.66)</td>
</tr>
<tr>
<td>Evacuated (n=21,269)</td>
<td>9.60−10.34</td>
<td>16.77−15.90</td>
<td>3.12−5.33</td>
<td>−4.08 (−5.22, −2.94)</td>
<td>0.56 (0.49, 0.64)</td>
</tr>
</tbody>
</table>

ACSC, ambulatory care sensitive condition; ED, emergency department.

<sup>a</sup>Difference-in-differences models were employed to assess the association between telemedicine familiar (compared with not telemedicine familiar) and the pre- to post-fire change in inpatient and ED utilization for 5 conditions of interest. Models were weighted using inverse probability of treatment weighting adjusting for differences across telemedicine familiar status with respect to age, sex, race/ethnicity, limited English proficiency, median Census block-level household income, and Charlson Comorbidity Score.

<sup>b</sup>RRRs measure the association between telemedicine familiar (compared with not telemedicine familiar) and the pre- to post-fire relative change in inpatient and ED utilization for 5 conditions of interest. Difference-in-differences models were employed; models were weighted using inverse probability of treatment weighting as described above.
important demographic and clinical variables allowed this study to account for potential important confounders in this population. The nature of this integrated system allowed for complete follow-up of the population for the entire study period, including capturing ED or hospital visits that were not within the KPNC system. Telemedicine uptake among the cohort was high, allowing good statistical power to assess the effects of telemedicine over long periods.

Limitations
Despite the quasi-experimental design, this is an observational study. Telemedicine familiar patients in this study were more likely to be White, English-speaking, and wealthier. However, differences across study groups with respect to these important confounders were accounted for in the analysis using inverse probability of treatment weights. A limitation of propensity score methods is that there may have been unmeasured differences between the telemedicine familiar and not familiar groups, which could influence utilization patterns. Future studies could further clarify the relationship between population characteristics and patterns of post-disaster utilization. All the diagnoses associated with an ED or hospital encounter were counted; and therefore, it is possible that the ACSC was not the primary diagnosis for some ED encounters and hospitalizations. Finally, these findings may not be generalizable to systems that do not have a precedent of telemedicine use or to disasters that destroy the infrastructure used to deliver telemedicine. However, because electricity and telecommunications are a priority to restore, and much virtual care may be done via telephone (which does not require internet or smartphone access), telemedicine may still play an important role in the recovery phase of a disaster.

CONCLUSIONS
The increasing frequency of extreme weather events highlights the need for broader investment in versatile care delivery methods such as telemedicine and more streamlined national policies to facilitate its use across multiple healthcare settings.25,29 The results of this study suggest that telemedicine may play a key role in supporting the recovery of a community during the aftermath of a disaster, particularly where telemedicine is provided regardless of insurance product and at a low cost before a disaster. The expanded availability of telemedicine may mitigate the burden on the entire system by prioritizing in-person services for those who need them most.29 Supporting historically underserved populations to access telemedicine resources is needed to close health disparity gaps observed during and after disasters.30

In future studies, researchers might consider how systems may ensure that all patients, particularly those in historically marginalized populations and those living in areas prone to extreme weather events, have equitable access to innovations like telemedicine and investigate its effects on downstream health disparities.

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