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The effect of the COVID-19 pandemic on emergency department visits for serious cardiovascular conditions



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ABSTRACT

Objective: We examine how emergency department (ED) visits for serious cardiovascular conditions evolved in the coronavirus (COVID-19) pandemic over January–October 2020, compared to 2019, in a large sample of U.S. EDs.

Methods: We compared 2020 ED visits before and during the COVID-19 pandemic, relative to 2019 visits in 108 EDs in 18 states in 115,716 adult ED visits with diagnoses for five serious cardiovascular conditions: ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), ischemic stroke (IS), hemorrhagic stroke (HS), and heart failure (HF). We calculated weekly ratios of ED visits in 2020 to visits in 2019 in the pre-pandemic (Jan 1–March 10), early-pandemic (March 11–April 21), and later-pandemic (April 22–October 31) periods.

Results: ED visit ratios show that NSTEMI, IS, and HF visits dropped to lows of 56%, 64%, and 61% of 2019 levels, respectively, in the early-pandemic and gradually returned to 2019 levels over the next several months. HS visits also dropped early pandemic period to 60% of 2019 levels, but quickly rebounded. We find mixed evidence on whether STEMI visits fell, relative to pre-pandemic rates. Total adult ED visits nadired at 57% of 2019 volume during the early-pandemic period and have only partly recovered since, to approximately 84% of 2019 by the end of October 2020.

Conclusion: We confirm prior studies that ED visits for serious cardiovascular conditions declined early in the COVID-19 pandemic for NSTEMI, IS, HS, and HF, but not for STEMI. Delays or non-receipt in ED care may have led to worse outcomes.

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1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic spread across the United States in early 2020 with extensive publicity and lockdowns beginning in mid-March. One effect of the pandemic was a reduction in non-COVID-19 care in emergency departments (EDs) and other settings. Emergency care avoidance was driven by stay-at-home orders, concerns that the emergency care system would be overwhelmed by COVID-19 cases, and patient worries about becoming infected in healthcare settings. [1] U.S. ED visits declined precipitously, reaching a

low point in the second week of April at 58% of 2019 volume. [2–4] Anecdotal evidence indicates that since then, ED visits have partially recovered but remain substantially below 2019 levels. Other contributors to lower ED visits likely include less communicable disease other than COVID-19, and lower injury rates, due to social distancing, mask wearing, and school/business closures, and care shifts to other venues, including telemedicine. [5]

Prior work has reported considerable declines not only for lower acuity ED care, but also serious cardiovascular conditions, including acute myocardial infarction (AMI), stroke, and heart failure, where emergency care is clearly indicated and timely care can be lifesaving. Multiple studies have found lower ED visits for serious, life-threatening conditions, both in the U.S., [6–9] and internationally. [10–13] Declines in visits for these conditions likely reflect ED

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avoidance, rather than lower disease incidence. This is because these conditions are commonly caused by underlying medical risk, which should not be strongly affected by behavior change due to the pandemic. The underlying incidence of AMI and stroke may have increased among people who contract COVID-19 due to its pro-thrombotic nature. [14]

However, the early studies have notable limitations. For one, all investigate only a limited period following the mid-March onset of the pandemic. Some involve indirect evidence, rather than direct evidence obtainable from ED records. [7,8] Some grouped more and less serious conditions together. [6,10–12] For example, timely care is crucial for ST-segment elevation myocardial infarction (STEMI), hemorrhagic stroke (HS) and often for ischemic stroke (IS). [15] By contrast, immediate care can be less crucial for some non-ST-segment elevation myocardial infarction (NSTEMI), and for some cases of heart failure (HF). Some HF can be managed through telemedicine, use of which grew rapidly during the pandemic. [16,17]

We add to the evidence on ED avoidance by providing data on how ED visits for a broad group of serious cardiovascular conditions (STEMI, NSTEMI, IS, HS; HF) evolved during the COVID-19 pandemic as well as overall ED visits over a longer time period through October 2020 in a large, geographically diverse sample of U.S. academic and community EDs.

2. Methods

2.1. Study design and setting

We used data from a national emergency medicine group to perform a retrospective longitudinal study of adult ED visits (age 18 and older). We compared ED visit rates from January–October 2020 to the same time period in 2019, across 108 EDs in 18 states continuously staffed by the emergency medicine group. Our dataset has been described elsewhere in detail, and includes granular patient-level information on demographics, diagnoses, and disposition. [18] Data elements are extracted directly from electronic health records at each ED site and analyzed centrally for operational and billing purposes. Diagnoses are assigned by trained coders, and regular quality assurance is performed to ensure data integrity. ED location as large central metro, large fringe metro/medium metro, or small metro and non-metro was defined using the National Center for Health Statistics Urban-Rural Classification Scheme for Counties. [19] This study was approved by the Institutional Review Board at Allegheny Health Network.

2.2. Serious cardiovascular conditions

The primary analysis included five serious cardiovascular conditions, STEMI, NSTEMI, IS, HS, and HF, identified using the primary International Classification of Diseases, Tenth Revision (ICD-10), diagnosis codes (see appendix for coding details). STEMI, NSTEMI, HS, and IS were chosen because they represent common, time-sensitive conditions where ED and hospital care improves outcomes. HF was also included as a serious, debilitating condition where some exacerbations can be life-threatening, but some are treatable without an ED visit. We also studied total adult ED visits across all sites for comparison purposes. All visits with a primary or secondary diagnosis of COVID-19 (ICD-10 of U07.1 or B97.29) were excluded from all analyses.

2.3. Methods of measurement and data analysis

Using data from January–October 2019 and January–October 2020, we aggregated patient-level visit data to the ED-week level and calculated, for each ED, 3-week moving averages of visit counts in 2020 and the corresponding 3-week periods in 2019. We then calculated the overall weekly means of the moving averages across all EDs, using 2019 total ED visit volumes as weights, and computed a 2020/2019

ratio of the moving averages. These ratios can be interpreted as fractional changes from 2019 to 2020 (e.g., a ratio of 0.80 would indicate a 20% drop in ED visits in 2020 relative to 2019).

We rely principally on graphs of the weekly ratios, but also divided the sample period into three subperiods: a pre-pandemic period (weeks beginning January 1 – March 4, 2020), an early-pandemic period (weeks beginning March 11–April 15), and a later pandemic period (weeks beginning April 22 or later). Extensive COVID-19 publicity began mid-March, with a national emergency order issued on March 13. Given the use of a 3-week rolling averages, the week of March 11 begins to capture pandemic effects, but they are not fully captured until the week of March 25. We chose the dividing line between the early and later period based on total ED visits for all causes, which nadired during the week of April 15, and then began to recover.

We also computed the change in the 2020/2019 visit ratio from the pre-pandemic period to the early and the later pandemic period. We also studied total ED visits by age category and gender, and studied cardiovascular conditions by ED location (large central metro; large fringe/medium metro; small metro/non-metro), ED size based on 2019 visit volume (<30,000 visits, 30,000–59,999 visits, and > 60,000 visits), and academic versus community hospital. Stata version 16.1 was used for all analyses (College Station, TX).

3. Results

We included 2,511,783 ED visits in 2020 and 3,055,151 ED visits in 2019 across study sites. Of those, there were 55,842 visits in 2020 (2.2%) with any of the five serious cardiovascular conditions and 59,874 (2.0%) visits in 2019. Of the 115,716 visits for serious cardiovascular conditions in both years, 53,960 (47%) were for HF, 26,944 were for IS (23%), 17,802 were for NSTEMI (15%), 9310 for STEMI (8%), and 7700 for HS (7%).

3.1. Pre-pandemic period (January 1–March 11, 2020)

During the pre-pandemic period, total ED visits in 2020 were similar to 2019 (2020/2019 ratio = 1.01), but slightly higher for patients age 65 and older and for small EDs (2020/2019 ratios = 1.03). The 2020/2019 ratios for the five serious conditions together were more variable, with HS and HF differing the most (2020/2019 ratios = 0.91 and 1.08) (Table 1). The ratios also fluctuated during the pre-pandemic period; for example, the STEMI ratio averaged 0.96 but ranged from a low of 0.80 to a high of 1.10.

3.2. Early-pandemic period (March 11–April 21, 2020)

During the early-pandemic period, the total ED visit 2020/2019 ratio fell sharply, and averaged 0.67 during this period, with greater reductions for adults 65 and older (average ratio = 0.62) and females (average ratio = 0.62). Visits for serious conditions also declined significantly during the early pandemic period (average ratio = 0.70 for all five conditions together). Of the five serious conditions, visits for NSTEMI dropped the most (average ratio = 0.66), followed by HF (average ratio = 0.68). IS and HS also fell significantly (average ratios = 0.71 and 0.78, respectively). STEMI visits declined less sharply (average ratio = 0.84) and were similar to the average for the last three pre-pandemic weeks (average for these three weeks = 0.89).

The weekly 2020/2019 ratios are presented graphically in Fig. 1A (STEMI and NSTEMI), 1B (HS and IS) and 1C (HF), together with 95% confidence intervals (CIs). Each figure also includes the 2020/2019 ratio for all visits, for comparison. Total ED visit ratios fell sharply in the early pandemic and nadired at 57% of 2019 volume in the third week of April. The five serious cardiovascular conditions together nadired at an average of 63%. The lows by condition were 56% for NSTEMI, 64% for IS, 60% for HF and HS, and 77% for STEMI. HS demonstrated a rapid decline to 60% of 2019 volume in the week of April 1,

Table 1
Change in Emergency Care 2020/2019 Visit Ratios from the Prepandemic Period (January 1 to March 10) to Two Pandemic Periods (March 11 to April 21 and April 22 to October 27)

	Jan 1 - Mar 10		Mar 11 - Apr 21		Apr 22 -Oct 27		Change from Jan 1 - Mar 10 to:			
							Mar 11 - Apr 21		Apr 22 -Oct 27	
	Ratio	(95% CI)	Ratio	(95% CI)	Ratio	(95% CI)	Diff.	(95% CI)	Diff.	(95% CI)
ED Visit Ratios										
All ED Visits	1.01	(1.00, 1.02)	0.67	(0.65, 0.68)	0.78	(0.77, 0.80)	-0.34	(-0.35, -0.33)	-0.22	(-0.24, -0.21)
Ages										
18–44 y	1.00	(0.99, 1.01)	0.69	(0.68, 0.71)	0.78	(0.76, 0.79)	-0.31	(-0.33, -0.30)	-0.23	(-0.25, -0.21)
45–64 y	0.99	(0.98, 1.00)	0.67	(0.65, 0.69)	0.78	(0.77, 0.80)	-0.32	(-0.34, -0.30)	-0.21	(-0.23, -0.19)
65+ y	1.03	(1.01, 1.04)	0.62	(0.61, 0.63)	0.79	(0.78, 0.81)	-0.41	(-0.42, -0.39)	-0.23	(-0.25, -0.22)
Gender										
Male	1.02	(1.01, 1.03)	0.73	(0.71, 0.75)	0.82	(0.81, 0.84)	-0.29	(-0.31, -0.28)	-0.20	(-0.22, -0.18)
Female	1.00	(0.99, 1.00)	0.62	(0.61, 0.63)	0.75	(0.74, 0.77)	-0.38	(-0.39, -0.36)	-0.24	(-0.26, -0.23)
Facility Characteristics										
ED Location										
Small metro and non-metro (N = 28)	0.99	(0.97, 1.01)	0.67	(0.65, 0.70)	0.80	(0.77, 0.82)	-0.32	(-0.34, -0.30)	-0.20	(-0.21, -0.18)
Medium metro (N = 54)	1.01	(0.99, 1.02)	0.67	(0.65, 0.69)	0.80	(0.77, 0.82)	-0.34	(-0.36, -0.32)	-0.21	(-0.23, -0.19)
Large central metro (N = 26)	1.01	(1.00, 1.02)	0.66	(0.64, 0.69)	0.76	(0.73, 0.78)	-0.35	(-0.38, -0.33)	-0.26	(-0.28, -0.23)
ED Size										
Small (<30,000 visits/y, N = 36)	1.03	(1.01, 1.04)	0.67	(0.64, 0.69)	0.84	(0.81, 0.87)	-0.36	(-0.39, -0.34)	-0.19	(-0.21, -0.17)
Medium (30,000–59,999 visits/y, N = 57)	0.99	(0.95, 1.02)	0.65	(0.63, 0.68)	0.76	(0.74, 0.79)	-0.33	(-0.35, -0.31)	-0.22	(-0.24, -0.20)
Large (60,000 visits/y, N = 18)	0.98	(0.96, 1.01)	0.65	(0.63, 0.68)	0.76	(0.73, 0.79)	-0.33	(-0.35, -0.31)	-0.22	(-0.25, -0.19)
Type										
Community hospital (N = 101)	1.01	(1.00, 1.02)	0.66	(0.65, 0.68)	0.78	(0.76, 0.80)	-0.34	(-0.36, -0.33)	-0.23	(-0.24, -0.21)
Academic Hospital (N = 7)	1.01	(0.99, 1.02)	0.69	(0.63, 0.74)	0.80	(0.76, 0.84)	-0.32	(-0.37, -0.27)	-0.21	(-0.25, -0.16)
Visit Ratios for Serious Cardiac Conditions										
STEMI	0.96	(0.87, 1.06)	0.84	(0.74, 0.94)	0.91	(0.85, 0.96)	-0.13	(-0.26, 0.00)	-0.06	(-0.17, 0.05)
NSTEMI	1.09	(0.98, 1.19)	0.66	(0.57, 0.76)	0.87	(0.81, 0.93)	-0.42	(-0.58, -0.26)	-0.22	(-0.33, -0.10)
Ischemic Stroke	0.99	(0.91, 1.07)	0.71	(0.65, 0.78)	0.90	(0.85, 0.94)	-0.28	(-0.35, -0.21)	-0.09	(-0.16, -0.02)
Hemorrhagic Stroke	0.91	(0.83, 0.99)	0.78	(0.67, 0.90)	0.95	(0.89, 1.01)	-0.13	(-0.28, 0.02)	0.04	(-0.06, 0.13)
Heart Failure	1.08	(1.00, 1.15)	0.68	(0.63, 0.73)	0.98	(0.92, 1.03)	-0.40	(-0.46, -0.34)	-0.10	(-0.18, -0.02)
Any serious cardiac condition	1.04	(0.99, 1.09)	0.70	(0.67, 0.74)	0.93	(0.90, 0.96)	-0.34	(-0.38, -0.29)	-0.11	(-0.16, -0.06)

Notes: Facility means used to calculate ratios (available in the Appendix) are weighted by 2019 adult ED volume and have standard errors clustered by facility.

but rapidly recovered to pre-pandemic levels by the week of April 22. STEMI first rose and then fell, with the nadir for STEMI (77% in the week of April 15) barely below the 80% level in the pre-pandemic week of Feb 26. Examination of temporal trends by ED location (large central metro, large fringe metro/medium metro, and small metro/non-metro), size (small, medium, and large EDs), and type (community vs. academic hospital) did not demonstrate clear differences across locations, sizes, and types (see Appendix).

3.3. Later-pandemic period (April 22 – August 31, 2020)

Total ED visits gradually recovered but remained depressed during the later-pandemic period (average 2020/2019 ratio = 0.78), with a somewhat larger decline among females (average ratio = 0.75). Visits for serious cardiovascular conditions during the later-pandemic period recovered to near 2019 levels (average ratio = 0.93). There was a moderate recovery for NSTEMI (average ratio = 0.87), IS (average ratio = 0.90), and effectively complete recovery in visit rates for HF (average ratio = 0.98), STEMI (average ratio = 0.91, comparable to immediate pre-pandemic weeks) and HS (average ratio = 0.95, not meaningfully difference than the pre-pandemic ratio average ratio of 0.91).

Fig. 1A-C shows the rebound in visits by condition type. The timing of the return to pre-pandemic levels for STEMI, HS, and HF varied across these conditions. STEMI visit rates never really fell; HS visits recovered by late April and HF visits recovered by late July. Total adult ED visits increased gradually to a 2020/2019 ratio of around 0.81 by late June but then leveled off.

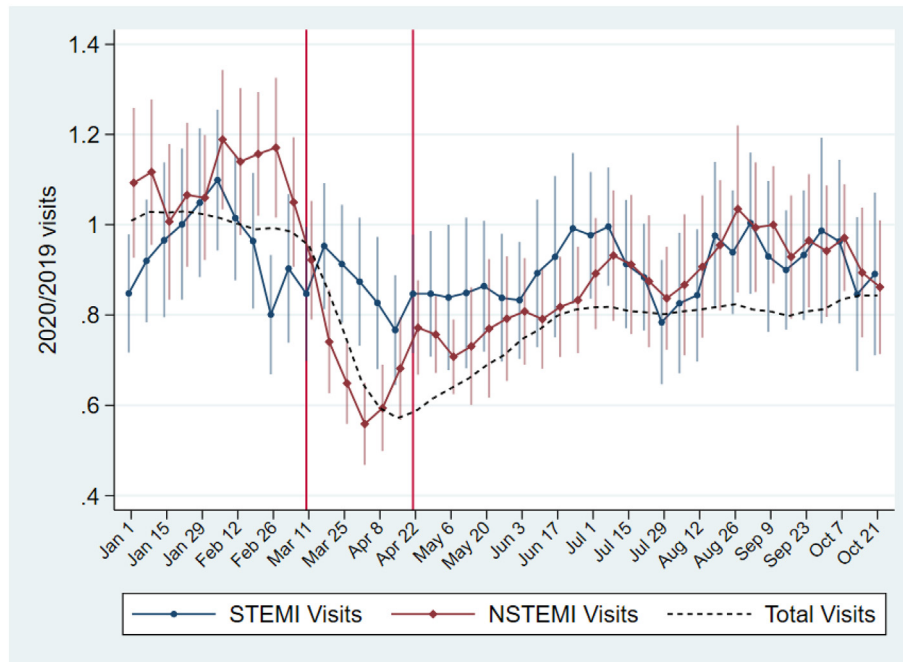
4. Discussion

Understanding the extent of both initial and continuing ED avoidance for serious cardiovascular conditions is vital, particularly in 2021 as high COVID-19 case levels lead to public health restrictions similar

to the early pandemic periods, and stories about hospital overcrowding emerge in the US. In our study, we demonstrate that visits for serious cardiovascular conditions declined in the early-pandemic period, with significant declines for all conditions except STEMI, for which the evidence for a decline is mixed. This occurred contemporaneously with large increases in COVID-19 cases in the United States. Based on 2020/2019 visit ratios, there were approximately 459 fewer NSTEMI, 563 fewer IS, 124 fewer HS, and 1335 fewer HF visits across the 108 EDs in the 6-week long early pandemic period. Given the clear benefits of hospital-based care for these conditions, the early pandemic declines likely worsened outcomes for many patients and led to avoidable deaths outside the hospital because ED care was not sought, and perhaps also for persons who delayed obtaining care but eventually arrived to the ED. Further study will be required to account for the pandemic's “collateral” effects on excess morbidity and mortality for non-COVID-19 conditions. [9] However, estimates of excess mortality for cardiovascular conditions from the Centers for Disease Control and Prevention (CDC) as of mid-January 2021 place this number at 15,574 excess U.S. deaths for ischemic heart disease, 12,253 for cerebrovascular disease, and 4447 for heart failure since February 1, 2020. [20] The ED avoidance we observe in our study likely contributed to these excess deaths, along with AMI events triggered by COVID infection and subsequent deaths. [21]

ED visit declines for the serious conditions nadired at different levels and at different times. While the cause for these differences is unclear, the sharper drops for HF, and for NSTEMI relative to STEMI, likely reflect less severe clinical presentations of these conditions for some patients. For example, NSTEMI can be debilitating and clinically apparent in many cases (i.e. crushing chest pain). Yet, in other cases the clinical presentations may be more subtle with atypical symptoms – such as shortness of breath/generalized weakness, which patients may ignore and not seek care. [22,23] Visits for HF dipped the most of all the serious conditions, likely because many cases of non-critical HF are less

A



B

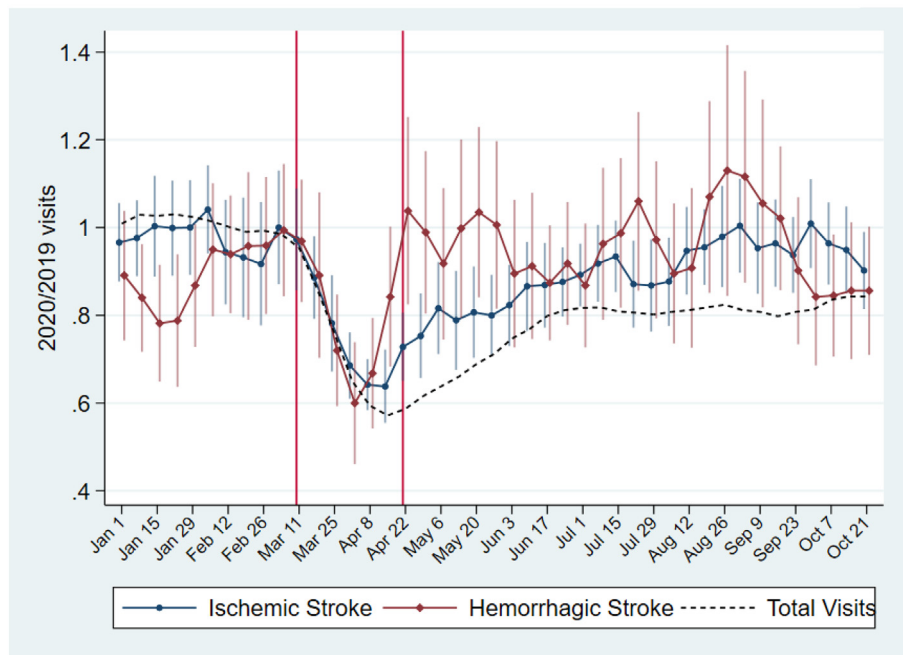


Fig. 1. Average Facility-Week Ratios for Serious Cardiac Conditions (using 3-week moving averages) in a Sample of 108 emergency departments through the COVID-19 pandemic, Fig. 1a. STEMI and NSTEMI, Fig. 1b. Ischemic and Hemorrhagic Stroke (using 3-week moving averages), Fig. 1c. Heart Failure and Any Serious Cardiac Condition (using 3-week moving averages). Notes: Facility-week means used to calculate ratios are weighted by 2019 adult ED volume and use a three-week moving average, vertical bars represent 95% confidence intervals. STEMI = ST segment elevation myocardial infarction; NSTEMI = non-ST segment elevation myocardial infarction; Any serious cardiac conditions = STEMI + NSTEMI + ischemic stroke + hemorrhagic stroke + heart failure visits

immediately debilitating and might be manageable outside of the hospital. For example, adjusting medication through telemedicine can be achieved when oral medication management changes are the sole intervention for volume overload or dehydration. One of the key

interventions by the Centers for Medicare and Medicaid Services during the pandemic was to broadly expand providers' ability to bill for telehealth, which may have increased access to care for people who feared or avoided in-person care. [24]

C

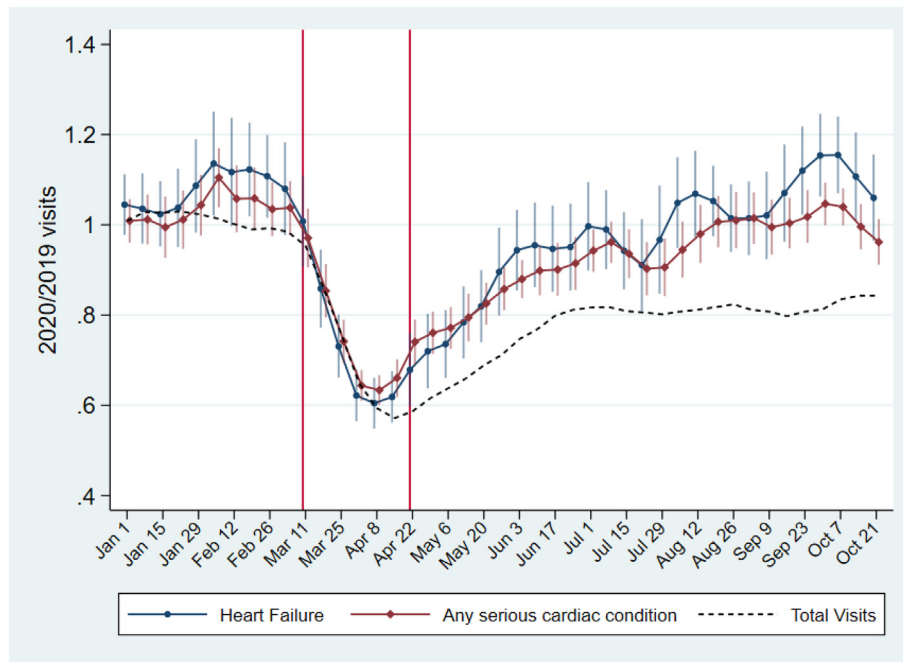


Fig. 1 (continued).

We did not find clear evidence for a decline in STEMI visits during the COVID-19 period compared to earlier in 2020. This differs from three other notable studies of the early-pandemic which reported large, relative declines compared to 2019. One reported a 38% decline in activations for STEMI in 9 large, academic cardiac catheterization laboratories, another reported a 40% decline in STEMI in Kaiser Permanente Northern California, and a multi-center European study found that STEMI fell 22% across 9 large EDs. [7,9,11] These same studies also reported a larger decrease in NSTEMI visits than STEMI, which we confirm. From these studies as well as ours, we can generalize that patients with more serious acute myocardial infarctions (i.e. STEMI) were less likely to avoid care. This is likely because the presentation of STEMI is often more clinically dramatic for patients, often with more severe chest pain and more associated symptoms. [25] We did not find clear patterns of care avoidance across specific types, sizes, and locations of EDs.

Starting in mid-May 2020 and continuing through the summer, there was a lifting in the U.S. of stay-at-home orders and a subsequent broad, but gradual re-opening of public places and easing restrictions on gathering sizes. This also correlated with the second spike in COVID-19 cases, which began to rise in May and peaked in mid-July. While HS visits rapidly recovered to baseline, it took several additional months for NSTEMI, IS, and HF to return to 2019 levels. This slow return highlights the importance of public health messaging to ensure that people with serious cardiovascular conditions seek care throughout 2021, before the vaccine is widely available and distributed. In some communities, interventions were redeployed to retain hospital capacity for COVID-19 care during the late 2020 / early 2021 surge. Ensuring people appropriately seek care may require a combination of general public health messages, messaging targeted at higher risk patients possibly through their physicians, and increased access to telemedicine for persons seeking to determine whether they need ED care. [26] To our knowledge, this is the first report to quantify the degree and pace of the rebound in ED visits for serious cardiovascular conditions following the initial pandemic period.

There are several limitations to our study. First, while the EDs in our sample encompass a broad geography (18 U.S. states), they only represent only approximately 2% of U.S. EDs nationally. Therefore, our results may not generalize to all U.S. EDs. Specifically, our study EDs were not located in the pandemic's early hotspots, including New York City, and only 7 teaching hospitals are included in our sample. Unlike previous studies, that covered principally academic medical centers, we are able to provide insights from community hospital EDs, where most Americans seek care.

We rely solely on data from ED visits and could not directly observe the actual underlying incidence of disease outside the ED, outcomes for patients who avoided or delayed care (i.e. deaths at home or worse outcomes from delaying care), specific symptoms that prompted care seeking, or severity of illness within the ED. We also did not directly observe whether some care for patients who avoided visiting the ED was delivered in other settings, including doctor's offices, other outpatient centers, or telemedicine. We only included primary ED diagnoses for these conditions. These diagnoses are sometimes provisional and may change throughout the hospitalization process as additional data or test results emerge. However, we do not think that the provision nature of some diagnoses would affect our comparison of 2020 to 2019, or a comparison across different periods during 2020. Finally, we observed higher visits for some conditions in the pre-pandemic period in 2020 compared to 2019, which appear unrelated to the pandemic. We also have found pre-pandemic visit rates to differ between early 2020 and early 2019 for other conditions, notably substance use visits, which were substantially higher in early 2020, versus the same period in 2019. [27] To address this we presented the relative declines compared to 2019 and to the pre-pandemic to offer two views of the relative visit changes.

We found that ED visits for most serious cardiovascular conditions (NSTEMI, IS, HS, and HF) declined substantially in the early-pandemic, with mixed evidence for STEMI, but visit rates broadly recovered to 2019 levels by August 2020. There were important differences across conditions, with larger declines for HF, and for NSTEMI versus STEMI,

and a more rapid rebound for HS versus IS. ED avoidance for serious cardiovascular conditions requires continued close monitoring and potential public health or other interventions, particularly throughout 2021 with rising COVID-19 cases and reimpositions of stay-at-home orders.

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Credit author statement

Jesse Pines: Conceptualization; Methodology; Writing – Original Draft; **Mark Zocchi:** Conceptualization; Methodology; Writing –

Review & Editing; Formal Analysis; **Bernard Black:** Methodology; Formal Analysis; Writing – Review & Editing; **Pablo Celedon:** Methodology; Software; Data Curation; Writing – Review & Editing. **Jestin Carlson:** Conceptualization; Methodology; Writing – Review & Editing. **Ali Moghtaderi:** Methodology; Formal Analysis; Writing – Review & Editing; **Arvind Venkat:** Conceptualization; Methodology; Supervision; Project administration; Writing – Review & Editing.

Declaration of Competing Interest

JMP has been a consultant to CSL Behring, Medtronic, Abbott Point-of-Care, Novo Nordisk, National Quality Forum, and Beckman-Coulter on unrelated work. No other authors have any potential conflicts to disclose.

Appendix 1. Weekly means

	Jan 1 - Mar 10				Mar 11 - Apr 21				Apr 22 - Aug 25			
	Means (SD)				Means (SD)				Means (SD)			
	2019		2020		2019		2020		2019		2020	
ED Visits/Week												
All ED Visits	834.9	(342.6)	840.6	(343.9)	842.5	(342.6)	561.8	(266.0)	839.7	(346.0)	657.7	(279.8)
Ages												
18–44 y	374.1	(182.8)	375.4	(185.4)	374.2	(179.8)	258.6	(143.8)	379.5	(184.7)	294.6	(147.7)
45–64 y	242.9	(103.3)	241.4	(101.6)	245.6	(104.7)	165.0	(78.3)	243.6	(104.4)	191.2	(81.8)
65+ y	217.9	(95.1)	223.7	(96.8)	222.8	(96.6)	138.2	(67.1)	216.6	(93.7)	171.8	(77.8)
Gender												
Male	355.0	(153.2)	362.9	(156.4)	360.8	(155.6)	263.1	(128.4)	365.2	(160.3)	300.8	(134.3)
Female	479.9	(196.4)	477.6	(194.8)	481.8	(194.5)	298.7	(143.6)	474.5	(193.7)	356.9	(151.4)
Facility Characteristics												
ED Location												
Small metro and non-metro (N = 28)	657.3	(317.8)	651.2	(309.7)	659.2	(312.6)	443.0	(223.2)	653.6	(312.9)	519.6	(242.6)
Medium metro (N = 54)	840.9	(328.2)	846.3	(328.5)	849.7	(331.0)	567.3	(256.5)	845.2	(333.7)	672.4	(283.4)
Large central metro (N = 26)	931.7	(340.7)	944.9	(343.0)	940.8	(336.3)	624.0	(282.5)	942.5	(340.9)	715.0	(267.0)
ED Size												
Small (<30,000 visits/y, N = 36)	358.0	(124.6)	367.6	(133.4)	363.9	(127.3)	242.4	(103.4)	358.4	(127.6)	300.4	(116.9)
Medium (30,000–59,999 visits/y, N = 57)	754.5	(160.5)	743.5	(160.4)	763.2	(163.0)	498.7	(156.5)	757.9	(163.0)	579.3	(136.6)
Large (60,000 visits/y, N = 18)	1260.2	(202.4)	1239.3	(216.3)	1266.8	(197.9)	827.0	(234.2)	1270.5	(199.3)	968.0	(214.9)
Type												
Community hospital (N = 101)	793.1	(330.8)	798.5	(331.4)	800.3	(331.2)	530.8	(251.1)	795.1	(332.4)	620.5	(263.4)
Academic Hospital (N = 7)	1165.1	(239.4)	1173.2	(245.2)	1176.7	(228.1)	806.8	(252.5)	1192.5	(228.7)	951.9	(226.7)
ED Visits/Week for Serious Cardiac Conditions												
STEMI	1.36	(1.36)	1.31	(1.28)	1.35	(1.31)	1.13	(1.21)	1.33	(1.37)	1.21	(1.29)
NSTEMI	2.65	(2.50)	2.88	(2.53)	2.78	(2.71)	1.84	(1.76)	2.57	(2.42)	2.24	(2.03)
Ischemic Stroke	4.13	(3.64)	4.08	(3.32)	3.99	(3.63)	2.84	(2.60)	4.02	(3.38)	3.61	(3.00)
Hemorrhagic Stroke	1.30	(1.57)	1.18	(1.46)	1.17	(1.44)	0.91	(1.27)	1.13	(1.49)	1.07	(1.45)
Heart Failure	8.57	(5.76)	9.24	(5.84)	8.10	(5.25)	5.48	(4.17)	7.16	(4.74)	6.99	(5.19)
Any serious cardiac condition	18.00	(11.06)	18.69	(10.64)	17.38	(10.51)	12.21	(7.62)	16.22	(9.80)	15.12	(9.46)

Notes: Weekly means are weighted by 2019 ED volume at each facility.

Appendix 2. 2020/2019 visit ratios for serious conditions by facility characteristics

	Jan 1 - Mar 10		Mar 11 - Apr 21		Apr 22 -Oct 27	
	Ratio	(95% CI)	Ratio	(95% CI)	Ratio	(95% CI)
STEMI						
All EDs	0.96	(0.87, 1.06)	0.84	(0.74, 0.94)	0.91	(0.85, 0.96)
ED location						
Small metro and non-metro	0.90	(0.75, 1.05)	0.85	(0.63, 1.08)	0.93	(0.81, 1.04)
Large fringe and medium metro	1.00	(0.87, 1.13)	0.81	(0.68, 0.94)	0.92	(0.85, 0.98)
Large central metro	0.92	(0.73, 1.11)	0.91	(0.74, 1.09)	0.87	(0.74, 1.00)
ED size						
Small EDs	0.96	(0.79, 1.13)	0.69	(0.48, 0.89)	1.04	(0.93, 1.15)
Medium EDs	0.89	(0.78, 1.00)	0.87	(0.72, 1.01)	0.88	(0.78, 0.97)
Large EDs	1.01	(0.83, 1.20)	0.80	(0.65, 0.95)	0.88	(0.80, 0.97)

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	Jan 1 - Mar 10		Mar 11 - Apr 21		Apr 22 -Oct 27	
	Ratio	(95% CI)	Ratio (95% CI)		Ratio	(95% CI)
ED type						
Community hospitals	0.99	(0.88, 1.09)	0.84	(0.73, 0.95)	0.92	(0.87, 0.98)
Academic hospitals	0.85	(0.65, 1.04)	0.84	(0.65, 1.03)	0.82	(0.69, 0.94)
NSTEMI						
All EDs	1.09	(0.98, 1.19)	0.66	(0.57, 0.76)	0.87	(0.81, 0.93)
ED location						
Small metro and non-metro	1.25	(1.04, 1.46)	0.74	(0.58, 0.89)	0.91	(0.65, 1.16)
Medium metro	1.06	(0.9, 1.21)	0.64	(0.5, 0.77)	0.87	(0.79, 0.94)
Large central metro	1.07	(0.94, 1.19)	0.69	(0.58, 0.80)	0.85	(0.74, 0.97)
ED size						
Small EDs	0.94	(0.73, 1.15)	0.73	(0.55, 0.91)	0.94	(0.82, 1.06)
Medium EDs	1.02	(0.93, 1.11)	0.70	(0.61, 0.78)	0.87	(0.79, 0.94)
Large EDs	1.15	(0.93, 1.37)	0.59	(0.43, 0.76)	0.83	(0.71, 0.95)
ED type						
Community hospitals	1.13	(1.02, 1.24)	0.69	(0.58, 0.80)	0.90	(0.83, 0.97)
Academic hospitals	0.88	(0.75, 1.01)	0.54	(0.43, 0.65)	0.72	(0.65, 0.79)
Ischemic stroke						
All EDs	0.99	(0.91, 1.07)	0.71	(0.65, 0.78)	0.90	(0.85, 0.94)
ED location						
Small metro and non-metro	1.03	(0.95, 1.12)	0.72	(0.57, 0.87)	0.94	(0.89, 0.99)
Large fringe and medium metro	0.92	(0.83, 1.02)	0.69	(0.6, 0.77)	0.89	(0.83, 0.95)
Large central metro	1.12	(0.98, 1.27)	0.77	(0.67, 0.87)	0.90	(0.81, 0.98)
ED size						
Small EDs	1.15	(0.95, 1.36)	0.72	(0.60, 0.84)	0.94	(0.85, 1.02)
Medium EDs	1.00	(0.89, 1.10)	0.69	(0.60, 0.79)	0.87	(0.80, 0.95)
Large EDs	0.92	(0.78, 1.06)	0.70	(0.60, 0.80)	0.88	(0.81, 0.96)
ED type						
Community hospitals	1.00	(0.93, 1.07)	0.71	(0.64, 0.78)	0.90	(0.85, 0.95)
Academic hospitals	0.93	(0.62, 1.24)	0.74	(0.57, 0.91)	0.91	(0.81, 1.00)
Hemorrhagic stroke						
All EDs	0.91	(0.83, 0.99)	0.78	(0.67, 0.90)	0.95	(0.89, 1.01)
ED location						
Small metro and non-metro	0.81	(0.56, 1.05)	0.93	(0.54, 1.31)	0.94	(0.75, 1.13)
Medium metro	0.94	(0.82, 1.05)	0.75	(0.6, 0.90)	0.95	(0.87, 1.03)
Large central metro	0.90	(0.78, 1.01)	0.79	(0.59, 0.99)	0.94	(0.84, 1.04)
ED size						
Small EDs	1.28	(0.99, 1.58)	0.92	(0.58, 1.27)	1.10	(1.01, 1.19)
Medium EDs	0.81	(0.69, 0.92)	0.72	(0.58, 0.86)	0.87	(0.75, 0.98)
Large EDs	0.95	(0.82, 1.09)	0.79	(0.60, 0.99)	0.97	(0.88, 1.07)
ED type						
Community hospitals	0.87	(0.78, 0.95)	0.78	(0.64, 0.92)	0.93	(0.86, 1.00)
Academic hospitals	1.07	(0.92, 1.22)	0.80	(0.66, 0.93)	0.99	(0.92, 1.07)
Heart failure						
All EDs	1.08	(1.00, 1.15)	0.68	(0.63, 0.73)	0.98	(0.92, 1.03)
ED location						
Small metro and non-metro	1.07	(0.89, 1.26)	0.73	(0.64, 0.81)	1.05	(0.87, 1.23)
Medium metro	1.06	(0.97, 1.16)	0.66	(0.6, 0.72)	0.97	(0.9, 1.05)
Large central metro	1.11	(0.97, 1.25)	0.68	(0.56, 0.80)	0.94	(0.88, 1.01)
ED size						
Small EDs	1.19	(1.01, 1.37)	0.66	(0.52, 0.81)	0.94	(0.81, 1.07)
Medium EDs	1.09	(1.00, 1.18)	0.63	(0.58, 0.68)	0.94	(0.86, 1.01)
Large EDs	1.01	(0.87, 1.15)	0.73	(0.62, 0.84)	1.00	(0.90, 1.09)
ED type						
Community hospitals	1.09	(1.01, 1.17)	0.68	(0.62, 0.73)	0.97	(0.91, 1.03)
Academic hospitals	1.03	(0.84, 1.22)	0.68	(0.54, 0.83)	1.02	(0.90, 1.14)
Any serious cardiac condition						
All EDs	1.04	(0.99, 1.09)	0.70	(0.67, 0.74)	0.93	(0.90, 0.96)
ED location						
Small metro and non-metro	1.06	(0.96, 1.17)	0.75	(0.69, 0.81)	0.99	(0.91, 1.06)
Medium metro	1.02	(0.95, 1.08)	0.68	(0.64, 0.72)	0.93	(0.89, 0.96)
Large central metro	1.07	(1.01, 1.14)	0.73	(0.66, 0.79)	0.91	(0.86, 0.96)
ED size						
Small EDs	1.12	(1.02, 1.23)	0.70	(0.61, 0.80)	0.96	(0.89, 1.02)
Medium EDs	1.02	(0.97, 1.08)	0.68	(0.64, 0.72)	0.90	(0.85, 0.95)
Large EDs	1.00	(0.90, 1.11)	0.71	(0.63, 0.78)	0.93	(0.88, 0.97)
ED type						
Community hospitals	1.05	(1.01, 1.09)	0.70	(0.67, 0.74)	0.93	(0.90, 0.97)
Academic hospitals	0.98	(0.82, 1.13)	0.69	(0.61, 0.78)	0.93	(0.88, 0.98)

Notes: Large central metro (N = 26), medium metro, including hospitals in non-central areas of large metro areas (N = 54), small metro and non-metro (N = 28); small EDs (N = 36), medium EDs (N = 57), large EDs (N = 18); community hospitals (N = 101), academic hospitals (N = 7).

Appendix 3. Weekly means for serious conditions by facility characteristics

	Jan 1 - Mar 10				Mar 11 - Apr 21				Apr 22 -Oct 27			
	Means (SD)				Means (SD)				Means (SD)			
	2019	2020	2019	2020	2019	2020	2019	2020				
STEMI visits/week												
All EDs	1.36	(1.36)	1.31	(1.28)	1.35	(1.31)	1.13	(1.21)	1.33	(1.37)	1.21	(1.29)
ED location												
Small metro and non-metro	1.12	(1.26)	1.01	(1.16)	1.19	(1.37)	1.01	(1.23)	1.09	(1.24)	1.01	(1.15)
Medium metro	1.46	(1.42)	1.47	(1.31)	1.54	(1.39)	1.24	(1.24)	1.50	(1.46)	1.37	(1.36)
Large central metro	1.32	(1.29)	1.21	(1.25)	1.12	(1.06)	1.02	(1.11)	1.18	(1.24)	1.03	(1.18)
ED size												
Small EDs	0.60	(0.79)	0.57	(0.81)	0.60	(0.79)	0.41	(0.67)	0.51	(0.77)	0.53	(0.77)
Medium EDs	1.27	(1.25)	1.13	(1.15)	1.25	(1.21)	1.08	(1.09)	1.22	(1.26)	1.07	(1.17)
Large EDs	1.95	(1.55)	1.98	(1.37)	1.97	(1.46)	1.57	(1.41)	2.01	(1.52)	1.78	(1.46)
ED type												
Community hospitals	1.30	(1.32)	1.28	(1.28)	1.32	(1.30)	1.11	(1.20)	1.28	(1.32)	1.18	(1.27)
Academic hospitals	1.84	(1.58)	1.55	(1.27)	1.62	(1.38)	1.36	(1.28)	1.79	(1.62)	1.46	(1.39)
NSTEMI visits/week												
All EDs	2.65	(2.50)	2.88	(2.53)	2.78	(2.71)	1.84	(1.76)	2.57	(2.42)	2.24	(2.03)
ED location												
Small metro and non-metro	2.09	(2.10)	2.62	(2.56)	2.28	(2.29)	1.68	(1.68)	2.12	(2.06)	1.93	(1.80)
Medium metro	2.95	(2.80)	3.11	(2.70)	3.17	(3.14)	2.01	(1.87)	2.94	(2.70)	2.55	(2.22)
Large central metro	2.46	(2.00)	2.61	(2.13)	2.36	(1.86)	1.64	(1.54)	2.19	(1.92)	1.87	(1.69)
ED size												
Small EDs	1.05	(1.13)	0.99	(1.25)	0.90	(1.21)	0.66	(0.85)	0.92	(1.10)	0.86	(1.03)
Medium EDs	2.57	(2.26)	2.62	(2.00)	2.45	(1.92)	1.72	(1.58)	2.44	(2.00)	2.11	(1.77)
Large EDs	3.70	(2.96)	4.25	(3.05)	4.46	(3.60)	2.64	(1.97)	3.76	(3.03)	3.13	(2.38)
ED type												
Community hospitals	2.47	(2.32)	2.79	(2.51)	2.63	(2.66)	1.81	(1.73)	2.41	(2.26)	2.17	(2.00)
Academic hospitals	4.06	(3.26)	3.57	(2.60)	3.92	(2.77)	2.11	(1.93)	3.86	(3.11)	2.78	(2.20)
Ischemic stroke visits/week												
All EDs	4.13	(3.64)	4.08	(3.32)	3.99	(3.63)	2.84	(2.60)	4.02	(3.38)	3.61	(3.00)
ED location												
Small metro and non-metro	2.93	(2.49)	3.03	(2.56)	2.85	(2.47)	2.06	(2.08)	3.02	(2.58)	2.83	(2.47)
Medium metro	4.85	(4.23)	4.48	(3.31)	4.72	(4.07)	3.25	(2.72)	4.50	(3.65)	4.00	(3.09)
Large central metro	3.55	(2.67)	3.98	(3.59)	3.38	(3.03)	2.60	(2.52)	3.78	(3.15)	3.38	(3.00)
ED size												
Small EDs	1.21	(1.24)	1.40	(1.42)	1.41	(1.51)	1.01	(1.20)	1.35	(1.41)	1.27	(1.42)
Medium EDs	3.82	(3.10)	3.80	(3.16)	3.57	(2.90)	2.47	(2.15)	3.75	(3.02)	3.27	(2.66)
Large EDs	6.35	(4.16)	5.84	(3.24)	6.27	(4.44)	4.38	(2.98)	6.05	(3.64)	5.34	(3.15)
ED type												
Community hospitals	3.80	(3.22)	3.80	(2.92)	3.72	(3.07)	2.63	(2.33)	3.71	(2.98)	3.32	(2.63)
Academic hospitals	6.70	(5.36)	6.23	(5.06)	6.14	(6.12)	4.53	(3.74)	6.52	(4.97)	5.91	(4.40)
Hemorrhagic stroke visits/week												
All EDs	1.30	(1.57)	1.18	(1.46)	1.17	(1.44)	0.91	(1.27)	1.13	(1.49)	1.07	(1.45)
ED location												
Small metro and non-metro	0.79	(1.09)	0.64	(0.88)	0.66	(0.90)	0.61	(0.94)	0.64	(0.88)	0.61	(0.89)
Medium metro	1.39	(1.59)	1.30	(1.46)	1.25	(1.45)	0.94	(1.28)	1.23	(1.50)	1.17	(1.44)
Large central metro	1.46	(1.70)	1.31	(1.64)	1.32	(1.61)	1.05	(1.40)	1.26	(1.69)	1.19	(1.69)
ED size												
Small EDs	0.37	(0.62)	0.47	(0.70)	0.41	(0.66)	0.38	(0.57)	0.34	(0.62)	0.38	(0.66)
Medium EDs	1.23	(1.47)	0.99	(1.30)	1.06	(1.34)	0.76	(1.10)	1.04	(1.37)	0.90	(1.31)
Large EDs	1.97	(1.80)	1.87	(1.71)	1.80	(1.66)	1.43	(1.59)	1.76	(1.78)	1.71	(1.71)
ED type												
Community hospitals	1.16	(1.35)	1.00	(1.17)	1.04	(1.24)	0.81	(1.07)	0.98	(1.18)	0.91	(1.13)
Academic hospitals	2.44	(2.43)	2.62	(2.41)	2.15	(2.28)	1.71	(2.18)	2.35	(2.66)	2.34	(2.63)
Heart failure visits/week												
All EDs	8.57	(5.76)	9.24	(5.84)	8.10	(5.25)	5.48	(4.17)	7.16	(4.74)	6.99	(5.19)
ED location												
Small metro and non-metro	7.77	(5.59)	8.35	(6.24)	7.27	(4.70)	5.29	(3.97)	6.42	(4.81)	6.73	(5.49)
Medium metro	9.15	(6.31)	9.74	(6.10)	8.74	(5.89)	5.78	(4.58)	7.65	(5.12)	7.45	(5.62)
Large central metro	8.00	(4.60)	8.89	(4.96)	7.43	(4.04)	5.06	(3.41)	6.71	(3.78)	6.33	(3.98)
ED size												
Small EDs	2.93	(2.27)	3.49	(2.86)	3.24	(2.24)	2.15	(2.00)	2.62	(2.10)	2.46	(2.06)
Medium EDs	8.31	(4.73)	9.07	(5.36)	8.27	(4.65)	5.22	(3.43)	7.04	(4.07)	6.61	(4.27)
Large EDs	12.18	(6.32)	12.30	(5.54)	10.41	(5.80)	7.55	(4.90)	9.88	(5.07)	9.85	(5.92)
ED type												
Community hospitals	8.05	(5.35)	8.76	(5.77)	7.63	(4.77)	5.15	(3.95)	6.73	(4.45)	6.52	(4.68)
Academic hospitals	12.66	(7.09)	13.05	(4.94)	11.81	(7.08)	8.08	(4.88)	10.55	(5.51)	10.75	(7.14)
Any serious cardiac condition visits/week												
All EDs	18.00	(11.06)	18.69	(10.64)	17.38	(10.51)	12.21	(7.62)	16.22	(9.80)	15.12	(9.46)
ED location												

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	Jan 1 - Mar 10				Mar 11 - Apr 21				Apr 22 - Oct 27			
	Means (SD)				Means (SD)				Means (SD)			
	2019		2020		2019		2020		2019		2020	
Small metro and non-metro	14.70	(9.53)	15.64	(10.11)	14.24	(8.93)	10.64	(7.19)	13.30	(8.69)	13.11	(9.08)
Medium metro	19.80	(12.44)	20.10	(11.21)	19.42	(11.90)	13.22	(8.23)	17.82	(10.85)	16.54	(10.31)
Large central metro	16.78	(8.33)	18.01	(9.36)	15.62	(7.52)	11.36	(6.36)	15.12	(7.67)	13.80	(7.47)
ED size												
Small EDs	6.15	(3.66)	6.92	(4.22)	6.56	(3.95)	4.62	(3.17)	5.75	(3.55)	5.51	(3.49)
Medium EDs	17.20	(8.41)	17.61	(8.68)	16.60	(7.52)	11.25	(5.74)	15.49	(7.46)	13.96	(7.14)
Large EDs	26.15	(11.95)	26.26	(10.00)	24.91	(12.25)	17.57	(8.21)	23.45	(10.52)	21.80	(10.17)
ED type												
Community hospitals	16.78	(9.62)	17.64	(9.96)	16.34	(9.06)	11.51	(6.91)	15.10	(8.55)	14.10	(8.27)
Academic hospitals	27.70	(15.88)	27.02	(12.06)	25.63	(16.07)	17.78	(10.20)	25.06	(13.81)	23.24	(13.47)

Notes: Weekly means are weighted by 2019 ED volume at each facility. Large central metro (N = 26), medium metro (N = 54), small metro and non-metro (N = 28); small EDs (N = 36), medium EDs (N = 57), large EDs (N = 18); community hospitals (N = 101), academic hospitals (N = 7).

Appendix 4. Total visit counts

	Jan 1 - Mar 10				Mar 11 - Apr 21				Apr 22 - Aug 25			
	No. (%)				No. (%)				No. (%)			
	2019		2020		2019		2020		2019		2020	
ED Visits/Week												
All ED Visits	707,859	(100.0)	713,603	(100.0)	428,892	(100.0)	286,039	(100.0)	1,918,400	(100.0)	1,512,141	(100.0)
Ages												
18–44 y	312,935	(44.2)	314,403	(44.1)	188,353	(43.9)	129,969	(45.4)	856,783	(44.7)	667,249	(44.1)
45–64 y	204,956	(29.0)	204,178	(28.6)	124,269	(29.0)	83,765	(29.3)	554,003	(28.9)	439,271	(29.0)
65+ y	189,968	(26.8)	195,022	(27.3)	116,270	(27.1)	72,305	(25.3)	507,614	(26.5)	405,621	(26.8)
Gender												
Male	299,499	(42.3)	306,625	(43.0)	182,566	(42.6)	132,768	(46.4)	830,078	(43.3)	686,995	(45.4)
Female	408,360	(57.7)	406,978	(57.0)	246,326	(57.4)	153,271	(53.6)	1,088,322	(56.7)	825,146	(54.6)
Facility Characteristics												
ED Location												
Small metro and non-metro (N = 28)	207,054	(29.3)	210,118	(29.4)	125,700	(29.3)	82,680	(28.9)	564,727	(29.4)	429,802	(28.4)
Medium metro (N = 54)	373,536	(52.8)	376,678	(52.8)	226,546	(52.8)	151,375	(52.9)	1,012,294	(52.8)	807,153	(53.4)
Large central metro (N = 26)	127,269	(18.0)	126,807	(17.8)	76,646	(17.9)	51,984	(18.2)	341,379	(17.8)	275,186	(18.2)
ED Size												
Small (<30,000 visits/y, N = 36)	108,456	(15.3)	107,310	(15.0)	66,034	(15.4)	42,810	(15.0)	292,254	(15.2)	235,788	(15.6)
Medium (30,000–59,999 visits/y, N = 57)	402,158	(56.8)	388,655	(54.5)	243,876	(56.9)	156,339	(54.7)	1,089,301	(56.8)	818,496	(54.1)
Large (60,000 visits/y, N = 18)	197,245	(27.9)	217,638	(30.5)	118,982	(27.7)	86,890	(30.4)	536,845	(28.0)	457,857	(30.3)
Type												
Community hospital (N = 101)	629,311	(88.9)	634,571	(88.9)	381,194	(88.9)	253,383	(88.6)	1,700,923	(88.7)	1,339,016	(88.6)
Academic Hospital (N = 7)	78,548	(11.1)	79,032	(11.1)	47,698	(11.1)	32,656	(11.4)	217,477	(11.3)	173,125	(11.4)
ED Visits for Serious Cardiac Conditions												
STEMI	1148	(0.2)	1114	(0.2)	691	(0.2)	583	(0.2)	2995	(0.2)	2779	(0.2)
NSTEMI	2233	(0.3)	2404	(0.3)	1351	(0.3)	923	(0.3)	5794	(0.3)	5097	(0.3)
Ischemic Stroke	3332	(0.5)	3379	(0.5)	1941	(0.5)	1407	(0.5)	8859	(0.5)	8026	(0.5)
Hemorrhagic Stroke	1031	(0.1)	947	(0.1)	563	(0.1)	444	(0.2)	2411	(0.1)	2304	(0.2)
Heart Failure	7136	(1.0)	7843	(1.1)	4172	(1.0)	2784	(1.0)	16,217	(0.8)	15,808	(1.0)
Any serious cardiac condition	14,880	(2.1)	15,687	(2.2)	8718	(2.0)	6141	(2.1)	36,276	(1.9)	34,014	(2.2)

Appendix 5. International classification of diseases, tenth revision (ICD-10) codes used for serious cardiac conditions

Condition	ICD-10 codes
STEMI	I21.XX, I22.XX, excluding I21.4 and I22.2
NSTEMI	I21.4, I22.2
Ischemic stroke	G46.0–G46.7, I63.00–I63.9, I67.81, I67.82, I67.89
Hemorrhagic stroke	I60.00–I60.9, I61.0–I61.9, I62.00–I62.03, I62.1, I62.9
Heart failure	I09.81, I11.0, I13.0, I13.2, I50.1, I50.20, I50.21, I50.22, I50.23, I50.30, I50.31, I50.32, I50.33, I50.40, I50.41, I50.42, I50.43, I50.810, I50.811, I50.812, I50.813, I50.814, I50.82, I50.83, I50.84, I50.89, I50.9

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