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Factors Underlying Reduced Hospitalizations for Myocardial Infarction During the COVID-19 Pandemic

Andrew D. Wilcock, PhD; Jose R. Zubizarreta, PhD; Rishi K. Wadhera, MD, MPP, MPhil; Robert W. Yeh, MD, MSc; Kori S. Zachrison, MD, MSc; Lee H. Schwamm, MD; Ateev Mehrotra, MD, MPH

IMPORTANCE The incidence of hospital encounters for acute myocardial infarction (AMI) decreased sharply early in the COVID-19 pandemic and has not returned to prepandemic levels. There has been an ongoing debate about what mechanism may underlie this decline, including patients avoiding the hospital for treatment, excess mortality from COVID-19 among patients who would otherwise have had an AMI, a reduction in the incidence or severity of AMIs due to pandemic-related changes in behavior, or a preexisting temporal trend of lower AMI incidence.

OBJECTIVE To describe drivers of changing incidence in AMI hospital encounters during the COVID-19 pandemic.

DESIGN, SETTING, AND PARTICIPANTS This cross-sectional study used traditional Medicare claims from all patients enrolled in traditional Medicare from January 2016 to June 2023 (total of 2.85 billion patient-months) to calculate the rate of AMI hospital encounters (emergency department visits, observation stays, or inpatient admissions) per capita at all short-term acute care and critical access hospitals in the United States overall and by patient characteristics. Observed rates were compared with expected rates that accounted for shifts in population characteristics and the prepandemic temporal trend (as estimated over 2016-2019). Data were analyzed in November 2023.

MAIN OUTCOMES AND MEASURES Hospital encounters for AMI.

RESULTS On average, the study sample included 31 623 928 patients each month from January 2016 through June 2023, for a total of 2 846 153 487 patient-months during the 90-month study period. In June 2023, there were 0.044 AMI hospital encounters per 100 patients, which was 20% lower than in June 2019 (0.055 encounters per 100 patients). Early in the pandemic, AMI rates moved inversely with COVID-19 death rates and tracked patterns seen for other painful acute conditions, such as nephrolithiasis, suggesting these changes were associated with care avoidance. Changes in patient characteristics driven by excess deaths during the pandemic explained little of the decline. Later in the pandemic, the decline may be explained by the long-standing downward trend in AMI incidence; by April 2022, the observed rate of encounters matched the expected rate that accounted for this trend. During the full pandemic period, from March 2020 to June 2023, there were an estimated 5% (95% prediction interval, 1%-9%) fewer AMI hospital encounters than expected.

CONCLUSIONS AND RELEVANCE The early reduction in AMI encounters was likely driven by care avoidance, while ongoing reductions through June 2023 likely reflect long-standing temporal trends. During the pandemic, there were 5% fewer AMI encounters than expected.

Editor's Note

Supplemental content

Author Affiliations: Author affiliations are listed at the end of this article.

Corresponding Author: Ateev Mehrotra, MD, MPH, Department of Health Services, Policy, and Practice, Brown University School of Public Health, 121 S Main St, Providence, RI 02903 (ateev_mehrotra@brown.edu).

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Early in the COVID-19 pandemic, hospitalizations for acute myocardial infarction (AMI) decreased sharply.[1-4] There has been substantial debate on what underlies this shortfall in hospitalizations and why it has been sustained.[5,6] Clarifying the underlying mechanisms could guide appropriate clinical and public health responses.

One potential explanation is that AMI incidence has been decreasing for decades (eTable 1 in Supplement 1) and the reduction in hospitalizations during the pandemic period could have been in part due to a continuation of these temporal trends. A second potential explanation is that the decline may have been due to shifts in the patient population. Older and sicker patients, who are at higher AMI risk, were more likely to die of COVID-19,[7] thereby reducing the number of AMI hospital encounters. A third potential explanation is that AMI incidence may have been reduced by the profound changes in daily life observed early in the pandemic, including less socialization; increased infection prevention measures, such as mask wearing; reductions in air pollution; and changes in physical activity. Together, these may have mitigated the proximate causes of acute cardiovascular disease.[6] A fourth explanation is that patients may have avoided the hospital even for severe conditions, such as AMI, due to fear of contracting COVID-19.[6,8-11] Prior work has not explored these different mechanisms, and understanding their role could help inform responses during future public health crises as well as strategies to improve cardiovascular care delivery.

We describe changes in the incidence of AMI hospital encounters in the US among traditional Medicare patients from January 2016 through June 2023. We compare the observed AMI incidence with an expected incidence based on demographic characteristics, disease burden, and preexisting temporal trends. To characterize broader changes in care seeking, we compare AMI hospital encounter trends with trends in COVID-19 mortality and other acute painful conditions, such as nephrolithiasis, for which patients typically seek emergent care.

Key Points

Question What underlies the sustained reduction in acute myocardial infarction (AMI) hospital encounters that began during the COVID-19 pandemic?

Findings This cross-sectional study of Medicare patients found that early declines in AMI encounters appear to have been driven by patients avoiding the hospital for treatment during the pandemic, and later declines appear to have been driven by a long-standing, preexisting downward trend in AMI incidence; controlling for this downward trend, AMI rates returned to expected levels by April 2022. During the full pandemic period, there were 5% fewer AMI encounters than expected.

Meaning The sustained reduction in AMI hospital encounters during the COVID-19 pandemic appears to have been driven by 2 different mechanisms.

Methods

Our study population included all traditional Medicare enrollees in a given month from January 2016 through June 2023. We defined AMI hospital encounters as any emergency department visit, observation stay, or inpatient stay with a primary diagnosis of myocardial infarction (codes in eMethods 1 in Supplement 1). Data were analyzed in November 2023.

Harvard Medical School's institutional review board approved our study and the waiver of patient consent owing to the use of deidentified data. The study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Statistical Analysis

We compared the observed AMI encounters per 100 people in each study month vs an estimated expected rate. The expected rate incorporated sociodemographic and chronic disease burden risk factors of patients alive in each month and along with the linear decline in AMI hospital encounters from 2016 through 2019. We calculated prediction intervals (PIs) to estimate uncertainty around our expected rates (details in eMethods 2 in Supplement 1).

The shortfall of AMIs between March 2020 and June 2023 was the difference in the observed and expected AMI hospital encounter rate. When observed hospital encounters fell inside the PI around the expected rate, we judged that AMI hospital encounters had returned to their expected rate. In subgroup analyses, we created observed and expected counts broken down by AMI severity (ST-segment elevation myocardial infarction [STEMI] vs non-STEMI) (eFigure 1 in Supplement 1) and key subpopulations, including age, sex, self-reported race and ethnicity (American Indian or Alaska Native, Asian or Pacific Islander, Black or African American, Hispanic, non-Hispanic White, other, and unknown), and region of country. In sensitivity analyses, we compared inpatient AMI trends among traditional Medicare and Medicare Advantage enrollees (eFigure 2 in Supplement 1).

To help separate the contributions of pandemic-associated physiological changes vs care-seeking changes, we compared AMI hospital encounter trends vs monthly COVID-19 death rates and trends in nephrolithiasis and biliary disease (2 painful and emergent conditions with different pathophysiology). If care-seeking trends tracked COVID-19 death trends, this would support the hypothesis that patients avoided hospitals more when community COVID-19 prevalence was high. If AMI trends tracked nephrolithiasis and biliary disease trends, this would support the hypothesis that AMI incidence was not differentially affected, and patients were avoiding the hospital more broadly.

Analyses were conducted in Stata version 17.0 (StataCorp LLC) and SAS Enterprise version 7.1 (SAS Institute Inc) software.

Results

On average, our study sample included 31 623 928 patients each month from January 2016 through June 2023, for a total of

2 846 153 487 patient-months during the 90-month period (1 556 845 957 female patient-months [54.7%]) (eTable 2 in Supplement 1).

In June 2019, there were 0.055 AMI hospital encounters per 100 patients; in June 2023, there were 0.044 AMI hospital encounters per 100 patients (20% lower). Accounting for changes in the characteristics of the patient population (eFigure 3 and eTable 3 in Supplement 1), which were impacted by competing risks of COVID-19 deaths, explained little in the reduction in AMI hospital encounters. However, additionally accounting for a preexisting temporal trend (**Figure 1**) explained much of the AMI hospital encounter reduction later in the pandemic. After accounting for this trend, we observed no difference between observed and expected AMI hospital encounters after the omicron wave of COVID-19 subsided in April 2022. During the full pandemic period, from March 2020 to June 2023, there were an estimated 5% (95% PI, 1%-9%) fewer AMI hospital encounters than expected (eTable 4 in Supplement 1).

The difference between observed and expected AMI encounters over the first half of 2023 varied by patient characteristics (**Figure 2**). There were more observed encounters than expected among older patients (aged ≥85 years, excess of 16.2% [95% PI, 5.8%-26.6%]) and women (excess of 8.5%; 95% PI, 1.6%-15.4%]).

Relative differences between observed and expected hospital encounters for AMI, nephrolithiasis, and biliary disease tracked closely over the pandemic period (**Figure 3**; eFigure 4 in Supplement 1 for observed vs expected plots) and were inversely correlated with COVID-19 death rates.

Discussion

Our results do not support several proposed explanations for the decrease in AMI hospital encounters during the pandemic but lend support to others. Although older and sicker patients at higher risk of AMI were more likely to die of COVID-19,[7] accounting for this differential death rate alone had little impact on the expected number of AMI encounters. Early in the pandemic, our results support the hypothesis that care avoidance drove the decline given that increases and decreases in AMI hospital encounters moved inversely with COVID-19 death rates and closely followed trends for other acute painful conditions with different pathophysiology. Fewer AMI hospital encounters during this period may have been driven by clinicians recommending patients avoid the hospital[12] or patients deciding on their own to avoid care.

Later in the pandemic, we found that the decline in AMI hospital encounters was likely due to a different mechanism. During the last 3 decades, there has been a well-established decline in AMI incidence from 1% to 5% per year (eTable 1 in Supplement 1). Proposed mechanisms underlying this trend include reduced smoking, better diets, greater use of hypertension and other cardiovascular medications, and improved diagnostic and treatment procedures, such as percutaneous coronary interventions.[13] With this perspective, the 20% fewer AMI hospital encounters per capita we observed in June 2023 compared with June 2019 would be viewed as a public health success.

During the entire pandemic (March 2020 to June 2023), we estimate 5% fewer AMIs than expected were treated in a hospital. The clinical implications of this shortfall are unclear. If these patients had received care, they could have received treatment that decreases the long-term morbidity associated with their condition. The decrease in STEMI hospitalizations during the first months of the pandemic is particularly concerning and could partially explain the increase in population-level cardiovascular deaths observed during the pandemic.[14,15] Also, AMI encounters for some groups (eg, aged ≥85 years) were higher in 2023 than expected. It is possible that this more recent increase was driven by hospital avoidance earlier in the pandemic. Future research should quantify the longer-term impact of this loss in treatment. Our findings could inform public health messaging in future pandemics as our results imply that messaging needs to emphasize that regardless of infectious risk, patients need to continue to seek treatment for urgent medical issues, such as AMI.

Limitations

There are several key limitations to our analysis. We evaluated the traditional Medicare population; it is unclear whether similar trends would be seen in other populations, although we do see similar patterns in the Medicare Advantage population. In our models, we assumed the monthly decline in AMI hospital encounters between 2016 and 2019 would continue at the same linear rate though June 2023. Using a different period (eg, 2010-2019) or assuming a different functional form of the decline (eg, logarithmic) will generate different expected AMI hospital incidence. Although the observed decline is consistent with prior literature (eTable 1 in Supplement 1), it is possible the rate of decline has changed in more recent years. We were limited in what outcomes we could capture. For example, we could not assess whether fewer AMI hospital encounters had increased disability rates.

Conclusions

Compared with 2019, AMI hospital encounters per capita remained substantially lower in 2023. In the early part of the pandemic, the decline was likely due to care avoidance, while ongoing reductions may reflect a long-standing trend in AMI incidence.

ARTICLE INFORMATION

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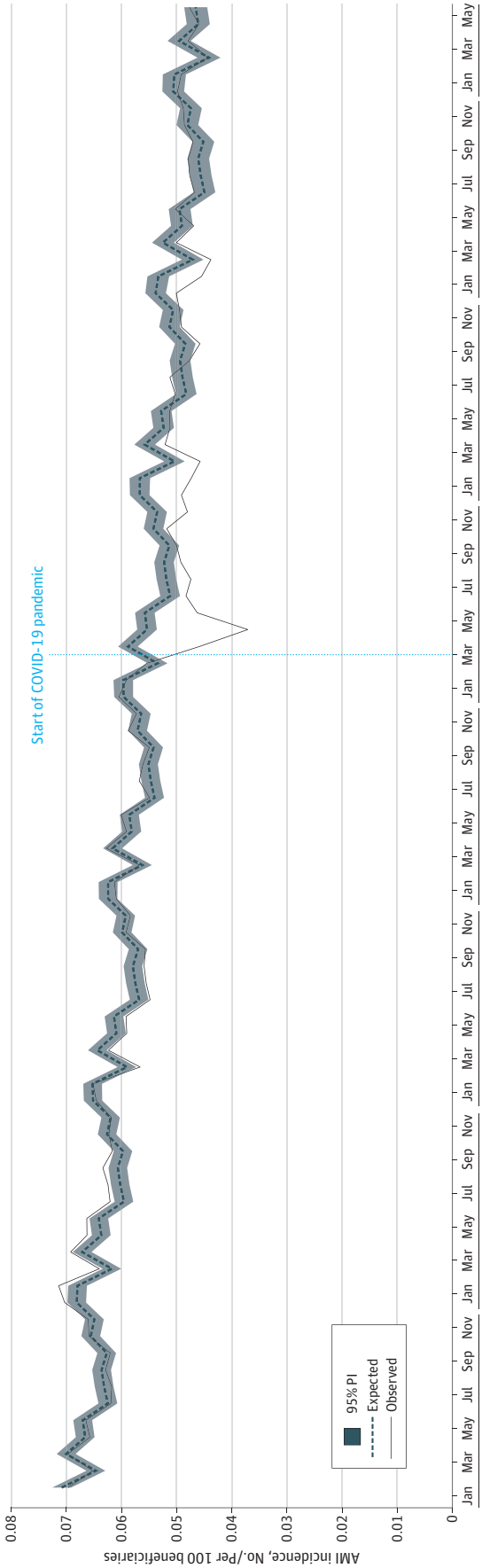
Author Affiliations: Department of Health Care Policy, Harvard Medical School, Boston, Massachusetts (Wilcock, Zubizarreta); Department of Biostatistics, Harvard T.H. Chan School of Public Health, Boston, Massachusetts (Zubizarreta); Department of Statistics, Harvard University, Cambridge, Massachusetts (Zubizarreta); Department of Medicine, Harvard Medical School, Boston, Massachusetts (Wadhera, Yeh); Department of Health Policy and Management,

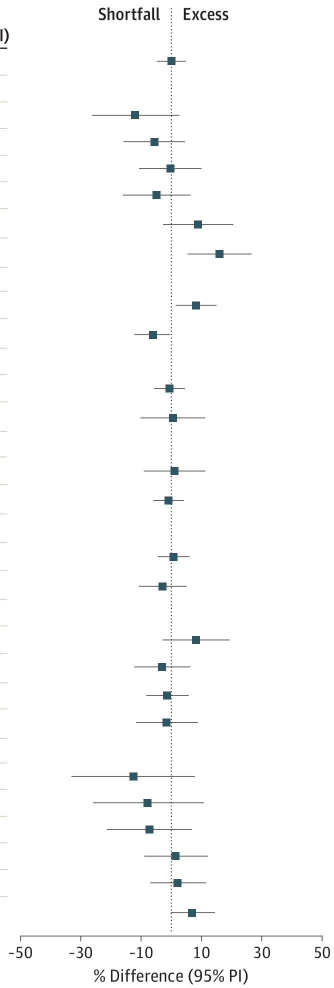
Figure 1. Observed and Expected Incidence of Acute Myocardial Infarction (AMI) Hospital Encounters per Capita in Traditional Medicare, January 2016 to June 2023

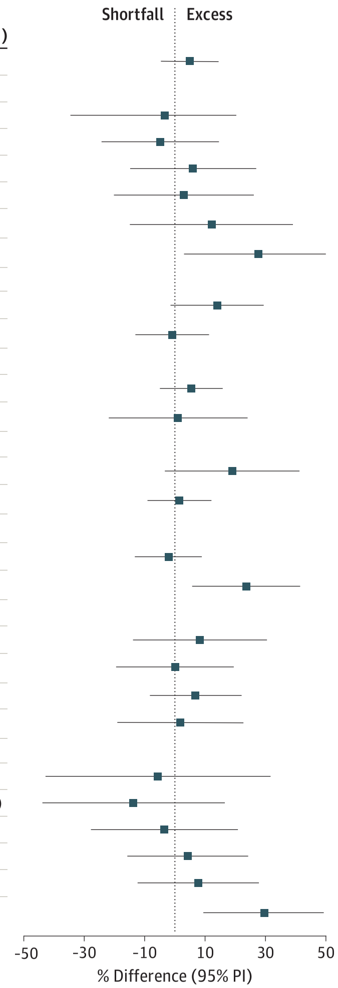


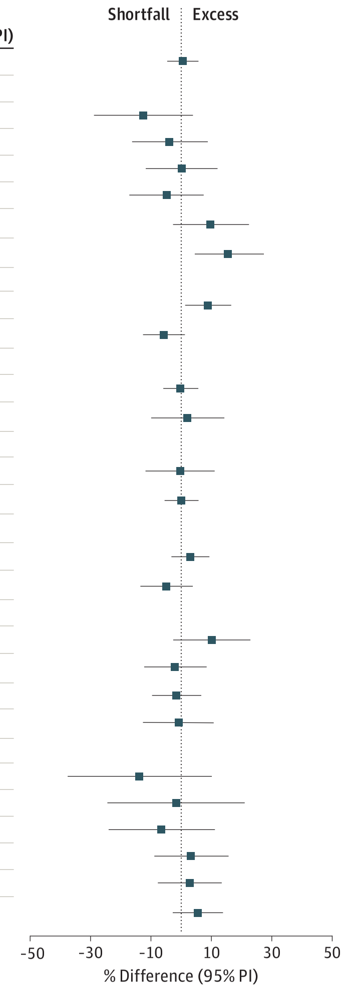
Monthly trends in observed and expected AMI hospital encounters per 100 traditional Medicare (fee-for-service) beneficiaries from January 2016 through June 2023. Hospital encounters included emergency department visits, observation stays, or inpatient stays in an acute care or critical access hospital. Expected encounters were adjusted for patient characteristics (age, sex, self-reported race and ethnicity, Medicaid status, metropolitan residence, census region, counts of chronic conditions), seasonality, and a prepandemic temporal trend defined as 2016 through 2019. The COVID-19 pandemic began in March 2020. Observed encounters falling inside the range of expected encounters, defined by our prediction interval (PI), indicate a return to prepandemic levels of incidence.

Figure 2. Relative Differences Between Observed vs Expected Hospital Encounters for Acute Myocardial Infarction (AMI), January to June 2023

Characteristic	AMI, % Difference (95% PI)	STEMI, % Difference (95% PI)	NSTEMI % Difference (95% PI)
Overall	0.3 (−4.2 to 4.8)	4.8 (−4.8 to 14.3)	0.2 (-4.8 to 5.3)
Age, y			
<65	-11.8 (-26.4 to 2.8)	-3.6 (-35.0 to 27.8)	-13.2 (-29.6 to 3.2)
65-69	-5.4 (-15.8 to 5.1)	-5.0 (-24.6 to 14.7)	-4.3 (-16.6 to 8.0)
70-74	0.0 (-10.4 to 10.4)	6.0 (-15.0 to 26.9)	-0.4 (-12.4 to 11.6)
75-79	-4.7 (-15.6 to 6.2)	3.0 (-20.0 to 26.0)	-5.3 (-17.6 to 7.1)
80-84	9.2 (-2.3 to 20.6)	12.3 (-15.0 to 39.7)	9.3 (-3.2 to 21.8)
≥85	16.2 (5.8 to 26.6)	27.8 (3.0 to 52.6)	15.4 (3.9 to 26.8)
Sex			
Female	8.5 (1.6 to 15.4)	14.0 (-1.5 to 29.6)	8.5 (0.8 to 16.1)
Male	-5.9 (-11.8 to 0.1)	-0.9 (-13.0 to 11.3)	-6.3 (-13.1 to 0.5)
Race			
White	-0.3 (-5.3 to 4.7)	5.4 (-5.2 to 15.9)	-0.6 (-6.3 to 5.0)
Non-White	0.7 (-10.0 to 11.4)	0.8 (-22.3 to 24.0)	1.5 (-10.5 to 13.5)
Medicaid status			
Dual	1.4 (-8.7 to 11.6)	19.1 (-3.4 to 41.6)	-0.8 (-12.1 to 10.5)
Nondual	-0.7 (-5.7 to 4.2)	1.5 (-9.1 to 12.0)	-0.3 (-6.0 to 5.3)
Rurality			
Metropolitan	1.2 (-4.3 to 6.6)	-2.2 (-13.4 to 9.0)	2.7 (-3.6 to 8.9)
Nonmetropolitan	-2.6 (-10.5 to 5.3)	23.6 (5.6 to 41.6)	-5.5 (-14.2 to 3.2)
Census region			
Northeast	8.3 (-2.8 to 19.5)	8.3 (-14.1 to 30.7)	9.6 (-3.2 to 22.4)
Midwest	-2.9 (-12.0 to 6.2)	0.0 (-19.8 to 19.7)	-2.4 (-12.6 to 7.9)
South	-1.2 (-8.3 to 5.8)	6.6 (-8.9 to 22.0)	-2.0 (-9.9 to 5.9)
West	-1.3 (-11.5 to 9.0)	1.7 (-19.5 to 23.0)	-1.4 (-13.1 to 10.2)
Chronic conditions			
No information	-12.3 (-32.6 to 8.0)	-5.8 (-43.3 to 31.6)	-14.3 (-38.3 to 9.7)
0	-7.6 (-25.9 to 10.8)	-13.9 (-44.5 to 16.7)	-2.3 (-25.2 to 20.5)
1-3	-7.0 (-21.3 to 7.3)	-3.7 (-28.4 to 20.9)	-7.1 (-24.5 to 10.3)
4-6	1.8 (-8.8 to 12.4)	4.2 (-15.9 to 24.4)	2.7 (-9.8 to 15.1)
7-9	2.4 (-6.9 to 11.8)	7.8 (-12.6 to 28.1)	2.2 (-8.3 to 12.7)
≥10	7.1 (-0.5 to 14.7)	29.7 (9.6 to 49.8)	5.1 (-3.2 to 13.3)

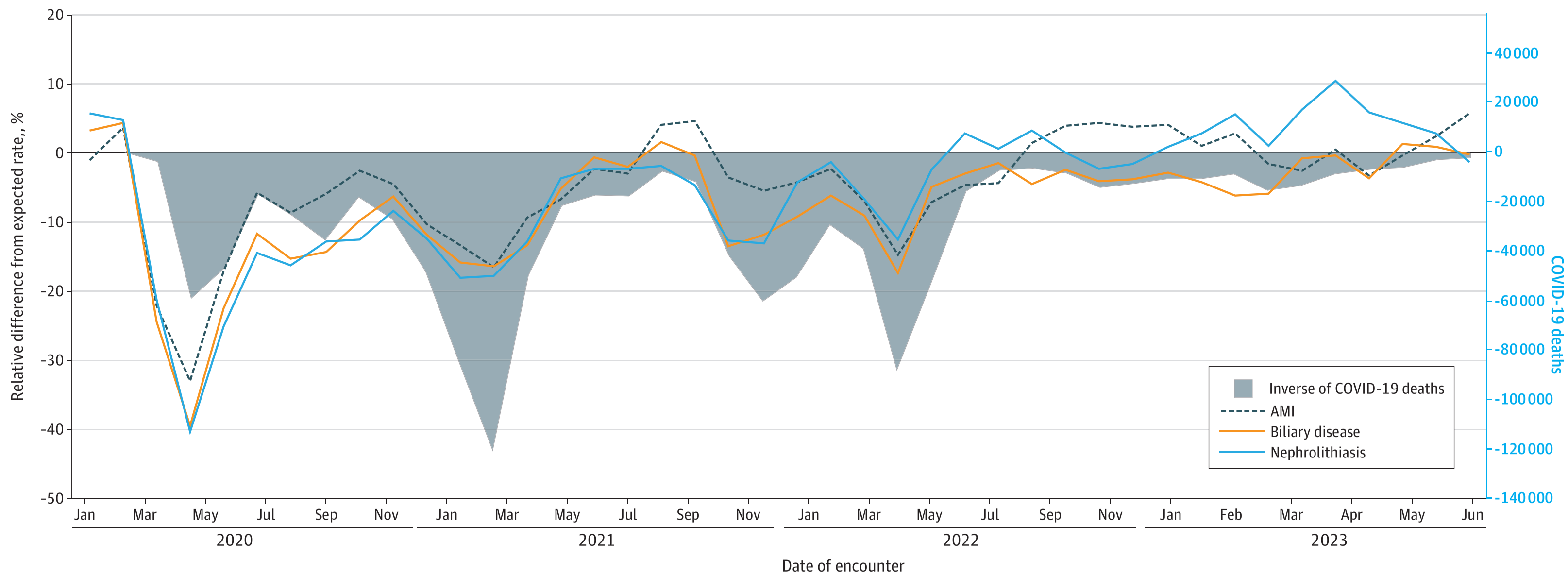






Percentage difference refers to the observed rate's percentage above or below the expected rate over the same period. Race and ethnicity data were self-reported. Non-White includes American Indian or Alaska Native, Asian or Pacific Islander, Black or African American, Hispanic, other, and unknown. NSTEMI indicates non–ST-segment elevation myocardial infarction; PI, prediction interval; STEMI, NSTEMI indicates ST-segment elevation myocardial infarction.

Figure 3. Relative Differences Between Observed and Expected Hospital Encounters for Acute Myocardial Infarction (AMI), Biliary Disease, and Nephrolithiasis Shown Over the Inverse of Monthly COVID-19–Related Deaths, January 2020 to June 2023



Relative differences between observed and expected hospital encounters for AMI, biliary disease, and nephrolithiasis per 100 traditional Medicare (fee-for-service) beneficiaries from January 2020 through June 2023. Relative differences are shown as the percentage above or below the expected rate in a given month. Expected rates were adjusted for patient characteristics (age, sex, self-reported race and ethnicity, Medicaid status, metropolitan residence, census region, counts of chronic conditions), seasonality, and a prepandemic temporal trend defined as 2016 through 2019. Differences are overlaid on the number of COVID-19–related deaths in a given month (measure of COVID-19 infection rates). To better illustrate the comparison between relative differences and COVID-19 incidence, we converted deaths to a negative count by multiplying them by −1 (inverse of COVID-19–related deaths).

Harvard T.H. Chan School of Public Health, Boston, Massachusetts (Wadhera); Richard A. and Susan F. Smith Center for Outcomes Research, Beth Israel Deaconess Medical Center, Boston, Massachusetts (Wadhera, Yeh); Department of Emergency Medicine, Harvard Medical School, Boston, Massachusetts (Zachrison); Department of Emergency Medicine, Massachusetts General Hospital, Boston (Zachrison); Department of Neurology, Yale School of Medicine, New Haven, Connecticut (Schwamm); Department of Biomedical Informatics and Data Science, Yale School of Medicine, New Haven, Connecticut (Schwamm); Department of Health Services, Policy, and Practice, Brown University School of Public Health, Providence, Rhode Island (Mehrotra).

Author Contributions: Dr Wilcock had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Concept and design: Wilcock, Mehrotra.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: Wilcock.
Critical review of the manuscript for important intellectual content: All authors.
Statistical analysis: Wilcock, Zubizarreta, Zachrison.
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